













Medical Research Council

The New LMB Building Project

Stage E Report Volume 2 Appendix 2 – Engineering Services

SPECIFICATION FOR MECHANICAL SERVICES INSTALLATIONS

REVISED STAGE E ISSUE INCLUDING AGREED VE November 2008

KJ TAIT 4 Hills Road Cambridge CB2 1JP T 01223 460 508 F 01223 351 093 www.kjtait.com

RMF Engineering, Inc. 190 West Ostend Street Baltimore, MD 21230 **T** 410-576-0505 **F** 410-385-0327 <u>www.rmf.com</u> KJ TAIT ENGINEERS



MEDICAL RESEARCH COUNCIL

ISSUE HISTORY

ISSUE 1.0	-	1 st Issue – Stage E Costing	-	23 June 2007
ISSUE 2.0	-	Draft Stage E Issue	-	05 July 2007
ISSUE 3.0	-	Final Stage E Issue	-	04 December 2007
ISSUE 4.0	-	Revised Stage E Issue For Comment	-	17 November 2008
ISSUE 5.0	-	Revised Stage E Issue Includ	ing Agr	eed VE
		Minor revisions	-	28 November 2008

THE NEW LMB BUILDING PROJECT CAMBRIDGE

SPECIFICATION FOR MECHANICAL SERVICES INSTALLATION

ISSUE 5.0

KJ TAIT ENGINEERS 4 HILLS ROAD CAMBRIDGE CB2 1JP

TEL: +44 (0)1223 460508 FAX: +44 (0)1223 351093

NOVEMBER 2008





A64 GENERAL CONDITIONS (SELF CONTAINED SPECIFICATION)	3
N20 SPECIAL PURPOSE FIXTURES, FURNISHINGS AND EQUIPMENT	
R10 RAINWATER PIPEWORK/GUTTERS	61
R11 FOUL DRAINAGE ABOVE GROUND	
R14 LABORATORY/INDUSTRIAL WASTE DRAINAGE	77
S10 COLD WATER	
S11 HOT WATER	
S17 WATER RECLAMATION SYSTEM	
S20 TREATED/DEIONISED/DISTILLED WATER	
S32 NATURAL GAS	
S34 MEDICAL/LABORATORY GAS	
S52 CLEAN STEAM	
S61 DBY BISEBS	
S65 FIRE HYDBANTS	162
S70 GAS FIRE FIGHTING	165
T13 PACKAGED STEAM GENERATORS	171
T14 HEAT PLIMPS	182
T20 PRIMARY HEAT DISTRIBUTION	194
T31 LOW TEMPERATURE HOT WATER HEATING	201
	218
W60 GENTRAL CONTROL/BUILDING MANAGEMENT	
Y11 PIPELINE ANCILLARIES	
Y21 WATER TANKS/CISTERNS	
Y22 HEAT EXCHANGERS	
Y24 IRACE HEATING	
Y25 CLEANING AND CHEMICAL TREATMENT	
Y30 AIR DUCTLINES AND ANCILLARIES	
Y40 AIR HANDLING UNITS	
Y41 FANS	
Y43 HEATING/COOLING COILS	
Y45 SILENCERS/ACOUSTIC TREATMENT	
Y46 GRILLES/DIFFUSERS/LOUVRES	
Y50 THERMAL INSULATION	
Y51 TESTING AND COMMISSIONING	
Y52 VIBRATION ISOLATION MOUNTINGS	
Y54 IDENTIFICATION - MECHANICAL	
Y60 CONDUIT AND CABLE TRUNKING	
Y61 HV/LV CABLES AND WIRING	
Y63 SUPPORT COMPONENTS - CABLES	
Y71 LV SWITCHGEAR AND DISTRIBUTION BOARDS	
Y72 CONTACTORS AND STARTERS	
Y74 ACCESSORIES FOR ELECTRICAL SERVICES	
Y80 EARTHING AND BONDING	
Y81 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES	
Y82 IDENTIFICATION - ELECTRICAL	
Y90 FIXING TO BUILDING FABRIC	
Y91 PAINTING AND ANTI-CORROSION TREATMENTS	
Y92 MOTOR DRIVES - ELECTRIC	
APPENDIX A - PREFERRED MECHANICAL MANUFACTUERS LIST	486485481
APPENDIX B - PIPEWORK SPECIFICATIONS	490488483
APPENDIX C - VALVE SCHEDULE	491489
APPENDIX D - BOREHOLE TEST RESULTS	493401

A64 GENERAL CONDITIONS (SELF CONTAINED SPECIFICATION)

100.000 PROJECT PARTICULARS

100.010 THE PROJECT:

- Particulars of the project as a whole are
 - As given in the Main Contract Preliminaries.

100.020 THE EMPLOYER:

• As given in the Main Contract Preliminaries.

100.030 THE PURCHASER:

As given in the Main Contract Preliminaries.

100.040 CONTRACT ADMINISTRATOR:

The term Contract Administrator (CA) is used throughout this specification and his duties will be carried out by

• As given in the Main Contract Preliminaries.

100.050 PROJECT MANAGER:

• As given in the Main Contract Preliminaries.

100.060 THE ARCHITECT:

As given in the Main Contract Preliminaries.

100.070 QUANTITY SURVEYOR:

As given in the Main Contract Preliminaries.

100.090 MECHANICAL SERVICES CONSULTING ENGINEER:

- RMF Engineering Inc, 190 West Ostend Street, Baltimore MD 21330 Tel
- KJ Tait Engineers, 4 Hills Road, Cambridge CB2 1JP. Tel: 01223 460508

100.100 ELECTRICAL SERVICES CONSULTING ENGINEER:

- RMF Engineering Inc. 190 West Ostend Street, Baltimore MD 21330 Tel:
- KJ Tait Engineers, 4 Hills Road, Cambridge CB2 1JP. Tel: 01223 460508

100.120 STRUCTURAL ENGINEER:

As given in the Main Contract Preliminaries.

100.130 PLANNING SUPERVISOR:

• As given in the Main Contract Preliminaries.

100.140 STATUTORY AUTHORITIES:

As given in the Main Contract Preliminaries.

100.150 UTILITY SERVICE PROVIDERS

• As given in the Main Contract Preliminaries.

200.000 DEFINITIONS

200.010 GENERAL:

Where used in the documentation the following definitions shall apply and shall be interpreted as such:

- Works: All services shown on the drawings and described in the specification shall be deemed to be included in the contract.
- Drawings: The tender drawings.
- Elsewhere: Detailed or specified elsewhere in other clauses, sections, shown on the drawings or contained in the specification or conditions of contract.
- Services: Services means the inclusion of one or more system.

- of the Works to function.
- Design process: All the activities necessary to convert design input into design output
- granted in writing only. In the event of the CA not accepting that submitted, resubmit Review of any submittal by the CA shall not mean that the CA is responsible for the responsibilities.
- Competent person: A person, by reason of theoretical and practical training or actual in question and is authorised to perform such a task or function.
- Duct: An enclosed space specifically intended for the distribution of services, with direct access for personnel.
- e.g. the space between ceiling and floor above. See Building Regulations.
- parks etc.
- Concealed Services: Includes installations within ducts, trenches or cavities.
- ٠ areas
- Terminal Units: Terminal units such as radiators, convectors, fan coil units, induction units, variable or constant volume air boxes and other like equipment.
- Ancillaries: All specified fittings, accessories, inserts, test points, bracketing, terminal equipment connected to and installed in the engineering services system.
- CIBSE: The Chartered Institution of Building Services Engineers
- BSRIA: The Building Services Research and Information Association
- IEE: The Institution of Electrical Engineers
- IOP: Institute of Plumbing
- LPC: Loss Prevention Council •
- HSE: Health and Safety Executive
- As given in the Main Contract Preliminaries.

200.020 DEFINITIONS OF TECHNICAL TERMS The definitions of technical terms associated with the engineering services installations are those included the latest edition of:

- CIBSE Guides; Commissioning Codes; Technical Memoranda; Building Energy Codes; Lighting Guides; Application Manuals;
- IOP Plumbing Engineering Services Design Guide
- BSRIA Technical Publications
- Loss Prevention Council Rules for Automatic Sprinkler Installations
- BS 7671 Requirements for Electrical Installations (IEE Wiring Regulations)
 - British Standards, including Codes of Practice.
 - Statutory Acts.
- As given in the Main Contract Preliminaries.

300.000 TENDERING INSTRUCTIONS

300.010 GENERAL:

٠

•

This section outlines the tendering procedures and requirements.

300.020 SCOPE:

These conditions are supplementary to those stated in the invitation to tender and on the Form and Tender and Agreement.

300.030 TENDER DOCUMENTS

The tender documents consist of the following:

KJ TAIT ENGINEERS

System: All equipment, accessories, controls, supports and ancillary items, including supply, installation, connection, testing, commissioning and setting to work necessary for that section

Review: Give notice and submit details to the CA for his comment and review, which shall be alternative details for review or modify that submitted in accordance with the CA comments. correctness of the submittal or its suitability for purpose and does not relieve any contract

experience or both, is competent to perform the task or function or assume the responsibility

Trench: A covered horizontal service space in the floor or ground with access from above. Cavity: A space enclosed within the elements of a building within which services are installed, Service Areas: Includes areas within a building with limited finishes such as loading bays, car

Exposed Services: Includes installations outdoors or unprotected within service or occupied

A64

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE GENERAL CONDITIONS (SELF CONTAINED SPECIFICATION)

• As given in the Main Contract Preliminaries.

300.040 PRIVACY OF INFORMATION:

The information contained in the tender documentation shall be treated as private and confidential.

300.050 CHECKING DOCUMENTS:

Check the tender documentation for obvious errors and omissions. Should any such errors or omissions be discovered inform the office issuing the documents immediately in writing in order that a correction may be issued before the date for submission of the tender.

300.060 TENDER ACKNOWLEDGEMENT:

Acknowledge receipt of the tender documentation and confirm submission of a tender in accordance with the instructions to tender.

300.070 PERIOD OF VALIDITY:

Tenders must remain open for consideration (unless previously withdrawn) for a period from the date fixed for submission of tenders of not less than as given in the Main Contract Preliminaries. The date for possession/commencement is as given in the Main Contract Preliminaries.

300.080 TENDER PROCEDURE:

Tendering procedure is in accordance with the principles of as given in the Main Contract Preliminaries.

300.090 ACCEPTANCE OF INSTRUCTIONS:

The submission of a tender will denote the acceptance of an undertaking to comply with all the clauses contained in the tender documentation unless items of non-compliance are identified as part of the tender submission.

300.100 ACCEPTANCE OF TENDER:

The Employer and his representatives

- Offer no guarantee that the lowest, or any tender, will be recommended for acceptance or accepted.
- Will not be responsible for any cost incurred in the preparation of any tender.

300.120 INSPECTION OF SUPPLEMENTARY DOCUMENTS:

Supplementary documents relating to the contract are available for inspection prior to the submission of the tender.

No adjustment shall be made in the tender sum or claim for additional monies or an extension of time allowed due to failure to inspect the above documents and to make due allowance for the information contained therein.

300.130 SITE VISIT:

Before tendering, ascertain the nature of the site, access thereto and all local conditions and restrictions likely to affect the execution of the Contract Works.

- Inspect any existing installations relevant to the works and study any relevant existing records.
- No claims will be allowed after submission of a tender for lack of information or other reasons which could have been resolved by such a visit to the site.
- Arrangements for visiting the site must be made with prior agreement through:
- As given in the Main Contract Preliminaries.

300.140 RETURN OF DRAWINGS AND SPECIFICATIONS:

The complete tender documentation is to be returned to the office of issue when requested should the Tenderer not be successful in their bid.

300.150 ALTERATIONS TO TENDER DOCUMENTS:

No alterations or erasures to the text of any part of the tender documentation shall be permitted. Any tender containing such alterations or erasures may be rejected.

300.160 TENDER ERRORS:

- Errors in the priced subcontract specification will be dealt with in accordance with the Code of • Procedure for Single Stage Selective Tendering 1996. (The word 'specification' being substituted for 'bills of quantities').
- In the event of a Tenderer discovering a genuine error in their tender after it has been deposited, attention in writing may be drawn to the error and an amendment submitted. The amendment may be accepted if deposited on or before the time fixed for receipt of tenders.
- No adjustment shall be permitted to the sum inserted in the form of tender after the date and time fixed for receipt of tenders.

300.170 UNQUALIFIED TENDERS:

- Other than as part of an alternative offer as described elsewhere, no account will be taken of any qualification or special conditions that a Tenderer may impose on their tender.
- Any tender containing such additional conditions may be rejected.

300.180 ALTERNATIVES:

- Alternative equipment, specialists or methods of carrying out the works in addition to those described in the tender documents may be submitted. Alternative offers shall be indicated on the appropriate document and include:
 - Details of the alternative equipment, specialist or method proposed.
 - Full technical data for each such alternative together with details of any consequential amendments to the design and/or other parts of the works.
 - A detailed breakdown of any omissions or additions to the basic tender sum indicated on the appropriate document.
- Include for all necessary measures to ensure alternative manufacturer's equipment and the total installation is equivalent to that specified.
- The Tenderer shall include the costs necessary for re-sizing and reselection of associated equipment (including pipework, ductwork and cable sizes) resulting from the proposed alternative together with all resulting design and coordination.
- Alternative offers will only be considered if accompanied by a compliant tender.

300.190 EXCLUSIONS:

If any part(s) of the Works cannot be tendered as defined in the tender documents, the CA must be informed as soon as possible, defining the relevant part(s) and stating the reasons for the inability to tender.

300.195 INTERPRETATION OF THE TENDER DOCUMENTATION:

- Should there be any doubt about the precise meaning of any item for any reason whatsoever, the tenderer must inform the office of issue of the tender documents in writing in order that the correct meaning may be given.
- Any clarification of the meaning or intent shall be issued in writing only and no other means of communication shall be valid. All Tenderers will be notified of any such explanation. No liability will be admitted, nor claim allowed, in respect of errors in a tender due to mistakes that should have been rectified in the manner described above.

300.196 DRAWINGS AND SPECIFICATIONS:

The Tenderer shall carefully and thoroughly examine the drawings and the Specification and fully acquaint himself with the work to be done, as no allowance for claims will be considered for any alleged deficiency of work or materials.

The Tenderer must as part of his Tender return, identify any equipment that he intends to select that causes any change of spatial requirements or allowances made in the Tender Scheme.

The Tender Drawings are prepared primarily to describe in a basic manner the design of the mechanical, electrical, and plumbing works, the working principles of the systems and the general intended methods of installation. They are intended to be read in conjunction with the Specification to facilitate the preparation of the Sub-Contractors estimate and Tender and to enable all other participants to appreciate the interrelation of the mechanical, electrical, lift and plumbing works and the main works as a whole.

The Tender Drawings are accordingly part diagrammatic with runs of piping, ducts, cable, conduit and the like being shown to small scale and not necessarily indicating exact installation positions.

However, the design is generally co-ordinated with the structure

The Sub-Contractor shall take his own dimensions (where full Bills of Quantities are not provided and for contractor design elements) for both the preparation of his Tender and for the execution of the work, and he alone shall be responsible for the accuracy of such dimensions and of drawings.

The Tender Drawings shall not be utilised exclusively for the detailed pricing of the works. The Tenderer shall allow for all necessary sets, bends, transformations and supports to complete the installation. Where the Sub-Contractor elects to depart from the principles and general arrangements depicted on the Tender Drawings he shall be responsible for undertaking detailed checks on the duties of all equipment affected, informing the Architect and adjusting the sizing of plant as required. The Sub-Contractor shall not proceed with the order of re-sized equipment until he has provided the necessary calculations to the Architect. The Sub-Contractor shall note that reduced size plant need not be accepted by the Architect and that all costs arising from such change shall remain the Sub-Contractor's responsibility.

300.200 PROCUREMENT OF MATERIALS:

Allow for the procurement of materials and equipment from suppliers at such a time, and in such a manner as may be necessary to allow for the completion of the Works in accordance with the contract programme.

Clearly state in the tender submission any foreseen difficulties with delivery periods for selected equipment or proposed alternatives.

No additional costs resulting from non-compliance will be accepted.

300.210 SUBLETTING:

- Where it is proposed to sublet any portion(s) of the Works a schedule must be submitted with the tender.
- The schedule should define such portion(s) and give for each the details of the proposed company.

310,000 TENDER SUBMISSION

310.010 GENERAL:

This section details the particular the tender submission requirements.

310.020 RETURN OF TENDER:

• The tender documentation is to be returned to:

- As given in the Main Contract Preliminaries.
- The tender documentation is to reach the return address not later than:
- As given in the Main Contract Preliminaries.

310.030 TENDER SUBMISSION DELIVERABLES:

- To be compliant the tender submission must include the following deliverables as detailed elsewhere:
 - A tender pricing schedule completed in full.
 - A Bill of Quantities completed in full. ٠
 - Method statements. •
 - Outline programme. •
 - Form of tender. •
 - Declaration of non-collusion
 - As given in the Main Contract Preliminaries.

310.031 TENDER STAGE METHOD STATEMENTS: Method statements must be submitted:

- Before the execution of the Contract.
- As given in the Main Contract Preliminaries.

Provide the following method statements in addition to those stated elsewhere:

Health and safety statement to include:

- Management procedures.
- Any significant and unavoidable risks that might arise as a result of executing the Works. An outline of the health and safety procedures to be undertaken to safeguard the operatives and of any person who may be affected by the Works.
- A copy of the company's health and safety policy document including risk assessment procedures
- Accident records for the last five years
- Details of any Health and Safety Executive enforcement action Details of staff responsible for health and safety on this project with details of their •
- qualifications and duties.
- Management procedures to be adopted for the project. • Managing and resourcing of design duties and responsibilities including design capability. • Commissioning and testing procedures and management. •

- Quality control management and procedures. •
 - The method statement must:
 - Indicate the quality control programme
 - Demonstrate compliance with the contract in regard to materials and workmanship. Demonstrate the establishment of standards by means of sample installation and
 - submission of samples prior to installation.
- Statement outlining the management team, stating the definition of each person's role, and the commitment to the project.
 - Include the curriculum vitae and references for each of the key personnel that will be used on the project.
 - A line management diagram starting at the site supervisors and rising through the management levels.
- Details shall be provided for both site and office based teams staff.
- As given in the Main Contract Preliminaries. •
- The Tenderer, at his discretion and at the same time, can submit method statements for other parts of the Works.

310.032 PROGRAMME:

Submit with the tender a programme indicating the sequence and timing of the principal parts of the works including periods for planning, design, procurement, installation and commissioning.

310.040 MAINTENANCE CONTRACT:

As given in the Main Contract Preliminaries.

310.050 PROPOSALS FOR ANNUAL MAINTENANCE CONTRACT:

As given in the Main Contract Preliminaries.

320.000 PRICING AND COSTS

320.010 GENERAL:

This section details particular requirements for the pricing of the tender documentation and cost procedures during the contract.

320.020 BASIS OF CONTRACT:

- The contract shall be
- As given in the Main Contract Preliminaries.

320.030 SUBMISSION OF PRICED CONTRACT SPECIFICATION: The priced contract specification must be submitted

- with the Tender.
- As given in the Main Contract Preliminaries.

320.030 TENDER PRICING DOCUMENT:

Alterations and gualifications to the specification must not be made without the written consent of the CA. Tenders containing such alterations or qualifications may be rejected.

Costs relating to items in the specification that are not priced will be deemed to have been included elsewhere in the tender.

The Tenderer shall complete all sections of the tender pricing document in full. Items described in the pricing document are abbreviated for the purpose of the schedule. The Tenderer is to make full allowance for all works associated with the installation of a particular element. Items entered in the pricing document shall be deemed to include all costs involved in carrying out the Works.

- Where required the Tenderer must identify separately the cost of all items specifically described under preliminaries.
- Provisional items will be adjusted at the final agreed rates when information is issued in respect of these items.

320.040 SCHEDULE OF RATES:

A schedule of rates must be submitted

- With the tender.
- As given in the Main Contract Preliminaries. •
- The schedule of rates must include rates for all significant items of work.

A quantified schedule of rates accepted by the CA shall only constitute part of the contract in the following respects:

- The descriptions of the works and the rates and prices contained therein shall be used for the purpose of adjusting variations
- The quantities contained therein shall be used to facilitate the preparation and the checking of interim applications for payment
- The provisional and prime cost sums contained therein shall be subject to adjustment in accordance with the rules and procedures contained in the contract conditions.
- As given in the Main Contract Preliminaries.

320.050 ERRORS:

Errors in the priced subcontract specification will be dealt with in accordance with the Code of Procedure for Single Stage Selective Tendering 1996. (The word 'specification' being substituted for 'bills of quantities')

320.060 PROVISIONAL SUMS:

Include in the contract price the provisional sums detailed in

- the forms of tender
- As given in the Main Contract Preliminaries.
- Any part or the whole of these sums unexpended will be deducted from the final amount due.

320.070 PRIME COST SUMS:

The term Prime Cost Sum shall mean the nett cost paid for an item or items of equipment or material or work executed.

The Tenderer shall indicate the percentage addition required for any profit and costs for handling, ordering and Main Contractor's discount, etc., in addition to P C Sum in

- the forms of tender
- As given in the Main Contract Preliminaries.
- Where prime cost sums are included these shall be at the disposal of the CA who shall give written instructions for their expenditure and the CA shall have the power to nominate persons or firms to execute work or supply goods against such sums.
- All prime cost sums shall be adjusted by the CA in the final account, the work undertaken or goods supplied against such sums being charged on the basis of the net accounts of the installers or suppliers, plus the percentage addition stated in the tender to cover profit.

320.080 OVERTIME AND ALLOWANCES:

- Include for all necessary overtime and other expenses in the contract price that may be necessary in order to complete the Works in compliance with the contract programme.
- Payment will be made for the extra cost of overtime only if a prior written CA instruction to work such overtime has been issued together with agreement to accept the costs involved.

320.090 SUBMISSION OF FINAL ACCOUNT:

Submit a draft final account to the CA using the contract procedures for checking purposes together with all the necessary supporting documents.

• As given in the Main Contract Preliminaries. Prepare the valuation of variations, omissions and provisional work forming part of the Works and where appropriate in accordance with principles defined in this sub-clause. The basis for the determination of such valuation shall be the Quantified Schedule of Rates prepared and submitted at the time of tender and accepted by the CA. All valuations as aforesaid prepared shall be submitted using the contract procedures to the CA for approval.

320.100 INSTRUCTIONS AND VARIATIONS:

All instructions shall be issued in writing and confirmed in a similar manner. Submit the cost of each variation showing the quantities and rates applicable for all materials, etc. employed in accordance with the agreed contract schedule of rates. Submit to the CA

 As given in the Main Contract Preliminaries. No work will be certified for payment until all the necessary information is provided.

320.110 DAYWORKS:

Where authority is given for work to be executed on a daywork basis, original vouchers giving the full particulars of hours worked, names of craftsmen and labourers, description of work executed and materials and plant used, must be forwarded to the CA. Submit to the CA using contract procedures not later than the end of the week following that in which the work has been executed.

- The daywork sheets shall be numbered in sequence, and all sheets are to be signed by the
 - As given in the Main Contract Preliminaries. Such signatures are only to be taken as certifying that the time, materials and plant are correct, and shall not be held to justify a claim that the work shall be so charged or that it cannot be measured and priced according to the terms of the contract.
- The value of work accepted by the CA to be paid on a daywork basis shall be calculated in the manner and in accordance with the rates guoted in the daywork schedule.
- Dayworks shall be allowed only in the case of works that cannot be measured and valued.

320.120 DAYWORK PERCENTAGES:

- For method of completing daywork percentages on page 3 of Form NSC/T Part 2.
 - Include Provisional Sums for dayworks within the province of the following:
- Include against each sum, daywork percentages required for the operation of Conditions NSC/S clauses 4.6.4 and 4.13.3.
- As given in the Main Contract Preliminaries.

400.000 CONTRACT CONDITIONS

400.010 CONDITIONS OF CONTRACT:

The conditions of the Main Contract are

As given in the Main Contract Preliminaries.

400.020 CONDITIONS OF SUB-CONTRACT:

- The conditions of Sub-Contract applicable to the engineering services are • As given in the Main Contract Preliminaries.
- The Sub-Contract to be entered into between the Main Contractor and the Sub-Contractor shall be
 - As given in the Main Contract Preliminaries.

400.040 INSURANCES:

- Under the terms and conditions of the Main Contract the Contractor is required to secure certain policies of insurance, the benefits of which extend to the Sub-Contractor, either partly or in whole. Examine these policies and obtain such supplementary cover as shall be necessary.
- The successful Tenderer will be required to insure and indemnify the Main Contractor against such obligations in respect of the Sub-Contract as those for which the Main Contractor is liable and must produce insurance policies on demand.

400.050 EMPLOYER/SUB-CONTRACTOR FORM OF AGREEMENT:

- The Sub-Contractor will be required to enter into an Employer/Sub-Contractor Form of Agreement. The agreement shall be
- As given in the Main Contract Preliminaries.
- The Agreement shall be signed under seal prior to commencing work on site.
- The Sub-Contractor will not, on this contract, be required to enter into an Employer/Sub-Contractor Form of Agreement.

400.060 ADDITIONAL DETAILS:

Additional details relevant to the contract are as given in the Main Contract Preliminaries.

410.000 PARTICULAR CONDITIONS

410.010 GENERAL:

This section details particular conditions and requirements for the project.

410.020 INFORMATION PROVIDED BY OTHERS:

Instructions, drawings, or other information required to be provided by the CA will be provided in due time upon written request provided always that such information is not requested unreasonably distant from nor unreasonably close to the date upon which it is necessary. Provide written request to the CA in good time for any information required.

410.030 PROVIDE EVERYTHING NECESSARY:

Provide everything necessary for the proper execution and completion of the contract works to the true intent and meaning of the contract documents.

Details of construction or materials which have not been referred to in the contract documents but the necessity for which my reasonably be implied or inferred from the said documents or which are usually or essential to the completion of the Works, shall be installed with no additional cost.

410.040 SUPPLY OF INFORMATION:

The CA will provide supplementary information from time to time as may be necessary to enable the completion of the Works in accordance with the contract conditions. Allow for such progressive release of further information by the CA during the course of executing the Works.

In order to facilitate the orderly and timely production of all further information that shall be considered necessary, submit to the CA for approval a programme indicating the progressive release of such information to enable the completion of the Works in accordance with the contract conditions.

410.041 CO-ORDINATION OF TRADES:

Allow for co-ordinating the contract works with the works of other trades and installations which may be on site during the period of the contract.

410.042 CO-OPERATION WITH OTHERS:

Ensure that the contract works integrates with that of others and that full co-operation is maintained during the execution of the Works with that of others.

Co-operate with the Contractor, other subcontractors, suppliers, local authorities and statutory undertakings in the execution of the Works.

In the event of any extra costs being caused by failure to programme and arrange the execution of the Works so that it fully integrates with that of others, the installer of the Works may be liable for any additional costs thereby incurred.

 In particular, the following works carried out by others will require close and careful liaison and cooperation. Electrical Engineering Services.

410.050 NOTICE OF OPERATIONS:

Work that requires interruption or interference with the operation of any existing services or buildings shall not be commenced without prior written permission of the CA.

As given in the Main Contract Preliminaries, number of days notice of intention to proceed with such works shall be given to the CA.

410.060 NOISE AND NUISANCE:

Ensure that the contract works are undertaken with as little noise as possible.

Ensure no nuisance by noisy working is caused to •

- the Employer
- occupants of premises next to the site boundary

• As given in the Main Contract Preliminaries. Take all necessary precautions to prevent nuisance from smoke, rubbish and other causes. Fit all compressors, percussion tools and vehicles with effective silencers of a type recommended by the manufacturer's of the equipment.

410.070 SUPPRESSORS:

Ensure all internal combustion engines used in the execution of the contract works are fitted with efficient suppressors in the ignition system in accordance with the recommendations of British Standards so as to prevent electrical interference to radio or television receiving equipment in the vicinity.

All temporary electrical installations, such as motors or the like, shall be prevented from creating such interference and shall be fitted with suppressor equipment in accordance with British Standards and to the satisfaction of the CA.

410.080 PROGRAMME:

Provide a detailed programme(s) clearly illustrating how the overall programme

- will be achieved within the contract period.
- demonstrate compliance with the Main Contract programme. Provide the detailed programme
- within one month of the award of the contract
- As given in the Main Contract Preliminaries. •

Due allowance is to be made in the programme(s) for, but not limited to, the following: The latest dates for release of final information required from the CA.

- Required method statements.
- Ordering dates and manufacturing periods. The proposed delivery to site for each item of major plant to be clearly defined.
- The period required for the production, approval and issue of: • builder's work information
 - co-ordination drawings •
 - installation drawings
 - shop drawings. •

Allow adequate time for the examination and approval by the CA. Actual activities of production, adjustment, resubmission and review must be identified

- Installation periods for each system
- Work resulting from instructions issued in respect to the expenditure of provisional sums. •
- Concurrent work by other trades. •
- Any temporary works necessary for the completion of the engineering services installations.
- Period required for operating the systems, load simulation tests and final adjustment.
- Environmental load testing.
- Period for instructing the Employer training.
- Pre-commissioning, commissioning and performance testing of the engineering services installations.
 - and operating and maintenance instruction manuals.
- Provide programme information as
 - simple bar chart type.
 - critical path network.
 - As given in the Main Contract Preliminaries.
- allowance for the following.
- Commissioning, demonstration and instruction procedures. ٠
- Provision of written notice before each (or series of) test, inspection, commissioning or Main Contract Preliminaries.
- Demonstration to the CA that test instruments and equipment are accurate.

The period required and latest dates for the production, approval and issue of record drawings

• Provide a separate and detailed commissioning programme for agreement with the CA. Make due

demonstration procedures are to be carried out, not less than number of days as given in the

A64

• As given in the Main Contract Preliminaries.

410.090 PROGRESS:

At regular intervals as agreed with the CA provide progress reports during the execution of the contract works in addition to any other similar information required by the contract conditions. The reports shall include:

- particulars of materials and equipment on site, or installed •
- site labour employed •
- progress of the works
- As given in the Main Contract Preliminaries.
- Record progress of the Works weekly on a copy of the programme.

Mark up for inspection and record purposes a set of the latest drawings as the works progress. The progress drawings shall be available for inspection by the CA at any time.

410.100 ORDERING SCHEDULE:

- Prepare an ordering schedule for submission to the CA that shall indicate the following data: •
 - Item of material or plant ٠
 - Manufacturer ٠
 - Date of order and reference number ٠
 - ٠ Acknowledgement of order and reference
 - Delivery period quoted •
 - Date required on site •
 - Allowable programme float ٠
 - Date delivered to site
 - As given in the Main Contract Preliminaries.
- Update and modify and submit the ordering schedule on a regular basis as agreed with the CA. Indicate on the schedule any possible problems and when delivery to site has been achieved.

410.110 CONTINUITY OF THE WORKS:

No undertaking is given that the works will necessarily be able to proceed continuously.

No claim will be allowed for discontinuity of work due to the necessity to conform to the contract programme.

410.120 DRYING OUT:

Make due allowance in the sequence of the work to provide heat for drying out. This activity shall not relieve any responsibilities to hand over the installation in good order.

The interim period from the time of commencement of use for drying out to the handover shall not be considered as constituting any part of the defect liability period.

410.121 FROST:

The Sub-Contractor shall not execute any work likely to be adversely affected by frost or inclement weather and he shall make good damage so caused at his own expense.

410.130 WORKING HOURS: Working hours shall be As given in the Main Contract Preliminaries.

410.140 ACCESS TO THE SITE: Access to the site shall be As given in the Main Contract Preliminaries.

410.150 METHOD AND SEQUENCE OF WORK: As given in the Main Contract Preliminaries.

410.160 USE OF THE SITE: As given in the Main Contract Preliminaries.

410.170 WORKING AREA: As given in the Main Contract Preliminaries.

410.180 POLICE REGULATIONS: Ascertain and comply with any Police regulations or requirements as may affect the contract works.

410.190 USE OR DISPOSAL OF MATERIALS:

- Remove from the site any rubbish and debris arising out of the execution of the contract works • on a daily basis.
- Do not discharge any oil, noxious liquids or gases and all water discharged shall be reasonably free from impurities.
- As given in the Main Contract Preliminaries.

410.191 PROHIBITED MATERIALS:

Prohibited Materials shall be any materials or substances which are generally known (whether by reference to the publication 'good practice in the selection of construction materials' (1997: Ove Arup & Partners)or otherwise) or which the contractor ought reasonably to have known at the time of specification/construction or use to be deleterious to health and safety or to the structural integrity of the project or which are not in accordance with British Standards or Codes of Practice where such exist or equivalent standards or requirements.

410.200 STORAGE:

Weatherproof, safe and secure storage shall be provided for all materials and equipment. All materials and equipment and materials shall be offloaded, stored and transported in accordance with manufacturer's recommendations. All electrical equipment and components shall be kept dry and free from dust. Plug, cap or seal open ends on all ductwork, tubes, conduit, trunking and associated equipment whilst

in storage and during transportation to site.

Provide racks to prevent distortion of pipes, conduit and similar materials.

410.210 PROTECTION AND PACKAGING:

All plant, equipment, materials and prefabricated elements of the Works shall be properly packaged and protected against damage during delivery, storage and until fully, finally and properly installed and set to work.

Submit to the CA a method statement on protection proposals for both stored and installed plant, equipment and materials.

Protection shall also include adverse effects of environmental conditions prevalent in the stored and installed location.

Any plant or equipment subject to incorrect storage or inadequate protection will be deemed unacceptable for incorporation into the works and new plant or equipment will be required as a replacement.

Damaged plant, equipment and materials or that suffering from deterioration shall be replaced prior to handover.

All plant, equipment and materials shall be protected against ingress of water and dust, formation of condensation, extremes and rapid changes of temperature, building works and operations of others. All open ends of pipes, ducts, conduit, and trunking etc shall be capped except when being worked upon.

After removal of any temporary protection paint parts liable to corrosion.

 Filter media shall only be installed when the plant items concerned are commissioned and tested. Install items such as grilles, diffusers, light fittings, switches, electrical accessories etc as near to practical completion as practicable.

410.211 BLANK ENDS:

During erection all open ends of pipes, conduits, etc., must be properly capped or plugged. The Contractor shall include for all such plugs and also plugs, spades and caps for Sectional Testing as required. All pipework to be thoroughly cleaned of all rubble, cement droppings, etc., before testing.

410.220 CONFIDENTIALITY:

No information related to the contract works shall be given to the press or other media without the written permission of the CA or Employer.

410.230 PHOTOGRAPHS:

Provide progress colour photographs of the contract works. The frequency, location, and photograph size shall be agreed with the CA. All photographs shall be dated and location stated. The number of prints of all photographs to be submitted to the CA shall be as given in the Main Contract Preliminaries.

No unauthorised photographs of the site or the Works or any part thereof shall be taken except with the permission in writing of the CA.

Photographs shall not be published or otherwise circulated without the permission of the CA.

- Provide photographs of all areas in which the Works are to be installed prior to the commencement of the contract works. All photographs are to be numerically identified and crossreferenced to marked up plans showing the position, direction and field of view for the respective photograph.
 - Submit photographs to the CA within (as given in the Main Contract Preliminaries) weeks of commencement of the contract.
 - Photographs shall record the condition of:
 - Existing services
 - Ceilings
 - Carpets •
 - Wall finishes
 - Fixed equipment
 - As given in the Main Contract Preliminaries.

410.240 MATERIALS USED:

No acoustic insulation or thermal insulation or sound attenuation materials shall be manufactured with any form of animal hair.

All materials supplied shall be a type that will not support bacteria.

Deleterious materials shall not be utilised on any part of the Works. Deleterious materials include but not limited to:

- halon/CFC's •
- asbestos or products containing asbestos •
- urea formaldehyde or materials which may release formaldehyde
- materials comprised in whole or part of man-made and/or naturally occurring mineral fibres which have a diameter of 3 microns or less and a length of 200 microns or less or which contain fibres not sealed or otherwise not stabilised to ensure that fibre migration is prevented
- lead where the metal or its corrosion products may be directly ingested, inhaled or absorbed
- any other substances generally known to be deleterious at the time of installation
- As given in the Main Contract Preliminaries.

All jointing materials shall be of a type approved by the respective authority. Warrant that deleterious materials are not incorporated in the Works.

410.250 ADVERTISING:

No form of advertising will be allowed on any part of the site or the Works without written CA approval.

410.260 PATENT RIGHTS:

Indemnify against all claims, costs or expenses in connection with any patented, copy righted or protected articles supplied and used on or in connection with the Works.

- Any payments or royalties payable in one sum or by instalments shall be included in the contract price and paid to whom so ever they may become due.
- In the event of any claim being made in connection with such patented or protected articles, conduct any negotiations or litigation in connection with such claim at own expense.

410.270 BENEFICIAL USE OF INSTALLATIONS:

- Systems shall not be used before practical completion without prior approval of the CA.
- Systems used before practical completion not for the benefit of the Employer must have all defective consumable elements replaced by new including:
 - lamps and tubes
 - filters

Replacement of consumable elements shall be not more than (as given in the Main Contract Preliminaries) days prior to practical completion.

- If instructed by the CA operate the installations or any part of them prior to practical completion, provided that such operation is practicable and does not prejudice the responsibilities and obligations under the contract.
- All costs arising from the use of such installations will be reimbursed at rates or where no such rates are applicable at reasonable rates agreed with the CA before commencing operation of the installations.

410.280 DEFECTS LIABILITY:

Liability for making good defects in the Works shall be for a period of twenty four months from the date of issue of the certificate of practical completion for the installations. If it is necessary to replace or renew any portion of the contract works as part of liability for defects, the defects liability period in respect of that portion of the contract Works shall be deemed to commence from the date of such replacement or renewal. The CA may require that new tests be carried out to demonstrate that the plant is continuing to work satisfactorily if the replacement or renewal may affect the efficiency of the Works or any portions

thereof. In the remedying of defects in the contract Works take all necessary precautions to minimise the risk

- of damage to the buildings, the decorations, the fittings and the equipment. In the event of such damage occurring bear the cost of replacement or making good, subject to the proviso of being granted the benefit of any settlement in respect of such damage accepted by
- the insurers under the insurance policies taken out in accordance with the requirements of the contract.
- finished at the time of the contract Works being offered for acceptance and which does not prejudice the issue of a practical completion certificate. This work may be requested to be executed out of normal hours and no additional costs will be accepted for this action.
- Prior to practical completion submit a method statement for the approval of the CA outlining how the defects which arise during the defects liability period will be rectified to ensure that disruption to the use of the building is kept to a practical minimum.
- No additional costs will be accepted for undertaking works executed out of normal hours.

410.290 RIGHT OF ACCESS DURING DEFECTS LIABILITY PERIOD: Right of access will not be unreasonably withheld, at all reasonable working hours and at own risk and expense, to any part of the contract works for the purpose of inspecting the working of the installations or to the records of the working and the performance thereof. Subject to CA approval, that shall not be unreasonably withheld, undertake any tests considered necessary at own risk and expense.

During the defects liability period and all necessary remedial works and/or rectification of defective materials and equipment liaise closely with the Employer's staff. All such work shall be carried out in such a manner as to avoid or minimise shut-down time and inconvenience to the Employer.

410.300 RATIONALISATION OF COMPONENTS:

Similar items of apparatus and equipment shall be made and provided by the same manufacturer where practicable and corresponding parts of all apparatus and equipment shall be interchangeable to reduce the need for different attention and spares.

410.310 SUPPLY OF COMPUTER HARDWARE AND SOFTWARE:

Obtain on behalf of the end user all appropriate licences, permissions, copyright waivers, rights of use and the like from the owners of the software rights. Ensure that the end user is properly registered with the software supplier for support and appropriate updating. Ensure that application software is written in compliance with BS 7649.

410.320 FIRE PRECAUTIONS:

Take all reasonable fire precautions in respect of stores, workshops and other installations. Where it is necessary to use any naked flame or welding equipment in executing the contract works and where combustible materials are in use, adequate protection shall be given to other adjacent materials and personnel. Suitable fire extinguishers shall be readily available at the position where such work is proceeding.

410.321 INTERFERENCE WITH TRAFFIC:

Agree with the CA a programme for the carrying out and the completion of any work not finally

Maximum facilities for access and transit shall be provided in all works that may interfere with the traffic on the roads, paths and footways. Should any part of the Works be executed in such a way as to cause unnecessary obstruction to traffic with neglect to remove or remedy the same forthwith when called upon to do so, then any obstruction shall be removed and the costs recovered.

410.330 DAMAGE TO STRUCTURE:

- Exercise due care and attention in carrying out the contract works and be fully responsible for any damage caused to the structure or building finishes.
- Obtain permission from the CA before any holes are cut in floors, walls or steelwork, etc.

410.335 METHOD STATEMENTS:

- Submit method statements to the CA prior to commencement of the contract works for the following work activities
- Each item of work
- As given in the Main Contract Preliminaries.

410.340 INSPECTION BEFORE CONCEALMENT:

Whenever work requiring inspection or testing is subsequently to be concealed give the following the notice to the CA so that inspections may be made or tests witnessed before concealment

- 21 days notice
- As given in the Main Contract Preliminaries.

410.350 EQUIPMENT GUARANTEES:

Plant and equipment guarantees shall commence at the date of practical completion and run for a minimum of 24 12 months after this date.

Any costs associated with this requirement shall be included in the contract price.

410.360 SITE MODIFICATIONS:

Site modifications to assemblies shall not be made without written approval of the CA. Where site modifications to assemblies are authorised undertake in accordance with manufacturer's certified drawings and instructions.

Ensure that all modifications undertaken comply with the relevant standards and all test certification obtained.

410.370 DIMENSIONS:

- · Where installations are dependent upon site dimensions ensure that these are available before proceeding with the Works.
- Dimensions should not be scaled from drawings.
- Where dimensions are indicated on drawings check these on site, as appropriate, to ensure building construction tolerances and manufacturing tolerances can be accommodated.
- Equipment should not be ordered or manufactured using dimensions indicated on the Tender drawings.

410.371 SITE DOCUMENTATION:

Notwithstanding the requirements of the Main Contract preliminaries, each Sub-Contractor shall allow for and provide in a maintained, indexed library the following:-

<!(if !supportLists)>(a) <!(endif)>Relevant copies of all technical equipment schedules "as delivered to site".

(b) Relevant technical literature on each type of equipment or component used within the installation.

(c) Copies of all relevant information. (Technical queries, relevant instructions, current installation/working drawings, current programme).

Copies of all signed daywork sheets. (d)

All of the above is to be accessible whilst the site is open for inspection by the Architect or his

representative.

All of the above shall be kept up to date and in good order and must be maintained complete.

430.000 QUALITY

430.010 QUALITY CONTROL:

Prepare and submit to the CA a method statement to indicate fully the quality control programme for the contract works Time scale

Within 2 weeks of contract appointment (no) as given in the Main Contract Preliminaries.

430.020 WORKMANSHIP AND MATERIALS:

All materials, articles and workmanship shall be of the best guality and execution as detailed in the specification and drawings.

All equipment and materials to be installed shall be new unless otherwise indicated. All equipment shall be installed in accordance with the manufacturer's written instructions and recommendations.

All materials considered by the CA to be unsound or not in accordance with the specification shall immediately be removed and properly replaced to the satisfaction of the CA at no additional cost. All work carried out imperfectly or with faulty materials must be immediately removed and properly replaced to the satisfaction of the CA at no additional cost. The manufactured articles specified shall serve as a quality standard. Where manufactured items are not specified by name submit with the tender all necessary details of proposed articles. The CA shall approve these articles before their use is permitted.

430.030 DEFECTS:

Agree with the CA a system of recording defects that should include

- A reference to identify the defect
- Description of the defect •
- Remedial works proposed •
- Agreement to remedial works proposed •
- Confirmation of defect clearance
- As given in the Main Contract Preliminaries.

500.000 ORGANISATION AND DESIGN MANAGEMENT

500.010 SITE STAFF:

- Refer to the Main Contract preliminaries.
- Employ a competent full-time site based project manager/engineer and supporting team dedicated full time to the project and not involved in the installation of the Works who shall have full authority to act in connection with the contract works.
- Staff of sufficient number and competence in the opinion of the CA, shall be provided as necessary for design, drawing and technical information production, programming and administration to ensure efficient and satisfactory execution of the contract works.
- Provide all necessary superintendence during the execution of the contract works. The said staff shall be in attendance on site during the whole time that work is in progress.
- Employ on the site suitable qualified engineering staff to be in charge of the contract works from commencement to completion. The said staff shall be in attendance on site during the whole time that work is in progress.
- Responsibility for all drawings and technical information production shall be undertaken by a • nominated engineer
- Curriculum Vitae shall be submitted with the tender for all key staff
- Any change made to the appointment of staff during the contract works shall be agreed with the CA with maximum notice being provided.
- If the CA is of the opinion that any member of the site staff has been guilty of a serious breach of his duties, he may by notice require that person to be replaced within (as given in the Main

A64

A64

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **GENERAL CONDITIONS (SELF CONTAINED SPECIFICATION)**

Contract Preliminaries) weeks of the notification.

The Tenderer must include with his Tender his management proposals together with details of his supervisory Staff intended to be employed on the works. The Sub-Contractors Management proposals may on acceptance of tender be incorporated into and form part of the Sub-Contract. Where the Sub-Contractor has a design or design development responsibility his management proposals must include details of his design staff. The management proposals shall include the following information in respect of all supervisory/design staff:-

(if !supportLists) ·	(endif) Organisation Chart - Both off and on Site
(if !supportLists) ·	(endif) Name
(if !supportLists) ·	(endif) Title and Function
(if !supportLists) ·	(endif) Relevant Experience and References
(if !supportLists) ·	(endif) Duration and percentage of employment on the Works

The above proposals shall include the Sub-Contractors proposed Field Staff Organisation Chart showing lines of responsibility within the field staff and reporting lines of authority with key Head Office Managers/Directors with particular regard to Safety, Quality, Project Controls and Project Management.

The above information does not in any way relieve the Sub-Contractor of the obligations to provide suitable and adequate management to complete the works.

500.011 SITE FOREMAN:

The Mechanical / Electrical Contractors shall allow for retaining on site a competent Engineer / Foreman on-site at all times when work is being done in connection with the Mechanical / Electrical Services Installations. The Engineer / Foreman to be a minimum of SJIB Technician grade with a minimum of 12 years experience.

510.000 SUBMITTALS AND APPROVALS

510.010 GENERAL:

This section outlines the requirements and procedures for submittals to the CA.

510.020 SUBMITTALS:

Prior to any orders being placed the CA shall review all drawings and manufacturer's details. Submittals shall be in a clear, definable and easily read format with the specified technical details. notes, performance data and calculations where applicable all in the English language.

Where drawings are to be examined the manufacturer's details shown on the drawings must have been previously approved.

Include all costs for attending meetings associated with the submittal review procedure. Meetings will be held at (as given in the Main Contract Preliminaries)...

Agree with the CA where samples of materials offered for review are to be sent. Issue progressively drawings, calculations and submittals as agreed in advance with the CA for review.

All correspondence related to the examination and review procedure shall be directed through the office of the (as given in the Main Contract Preliminaries)..

The timescale for review or comment or otherwise on all submittals shall be

- 20 working days from the date of receipt by the CA.
- As given in the Main Contract Preliminaries.

510.030 SCHEDULE OF DRAWINGS AND SUBMITTALS:

Provide a schedule of all proposed drawings and submittals required for comment. The schedule shall be provided

- 4 weeks from contract appointment
- As given in the Main Contract Preliminaries.

Indicate as a minimum the following information on the schedule:

Drawing number and revision number •

- Drawing title and service
- Scale •
- Latest date required on site and/or for manufacturing purposes
- Date required for final comment
- Date for submission for comment •
- Date of commencement of drawing production •

As given in the Main Contract Preliminaries. •

The schedule shall be updated as necessary on a regular basis at intervals agreed with the CA during the contract period.

The programme for production of drawings and other submittals should include the necessary time for:

- Submission
- Examination
- Alterations and re-submission in the event of the initial submission not being accepted
- Final issue •
- As given in the Main Contract Preliminaries. •

Allow adequate time in the programme in order not to cause delays. The full extent of all submittals shall be indicated in the schedule. Group submittals for a particular part of the building or building engineering service as agreed with the CA.

510.050 EQUIPMENT PERFORMANCE DETAILS:

Details of the equipment selected for inclusion into the Works shall include the following information: • Plant item description, reference identification and serial number.

- Electrical input rating kVA, Volts, Phase. •
- Operating mode duty, standby, generator etc. •
- Starting characteristics starter type, current, starts/hour and starting time. •
- Performance characteristics (full load current and power factor).
- Noise level. •
- Weiaht. •

 As given in the Main Contract Preliminaries. The format of the information shall be as agreed with the CA.

510.051 PREPARATION OF DRAWINGS:

Agree with the CA a document numbering system prior to preparing any documents. All drawings shall be prepared using a computer aided draughting system and the software used to produce drawings shall be approved prior to commencement of drawing production. Each service shall be represented by a separate layer/overlay, for subsequent easy modification. Prior to commencement of drawing production agree the sequence of layers, pen colours and sizes. The medium for transfer of information shall be

- Paper and electronic.
- AutoCAD drawing files shall be
- DWG
- DXF

Drawing plots shall be "A" size to British Standard, with an agreed logo/title block. The standard drawing size is to be

- A1
- A0
- A3
- Scales used on drawings shall be
- selected to convey clearly the proposals
- Generally in accordance with existing original as-installed drawings: 1:20 for plant rooms and sections; 1:50 for general arrangement and co-ordinated plans.

510.060 REVIEW OF SUBMITTALS:

Submittals will be examined for

- compliance in principle with the design intent
- Such examination shall not relieve any responsibilities and obligations under the contract.

A64

Examination of any submittal by the CA shall not mean that the CA is responsible for the correctness of the drawing or submittal or its suitability for purpose. These responsibilities shall remain as defined elsewhere and as the contract.

Allow adequate time in the programme for submittals with due allowance for incorporation of comments and resubmission in order not to cause delays.

Each package shall contain all drawings, design calculations, support information, manufacturer's literature, etc necessary to facilitate examination by the CA.

Revised items on drawings shall be clearly indicated and annotated with a revision number/letter. Submittals will be returned indicating "A", "B" or "C" action.

"A" action

- Examined no comments •
- Examined for construction purposes
- "B" action
- Examined subject to minor amendments
- Examined subject to incorporation of comments indicated •
- For construction provided that work is in compliance with comments made
- "C" action
- Examined subject to major amendments •
- Rejected with or without comments

In this case the drawings shall be re-submitted after correction or with further information added. Drawings and submittals with "B" or "C" action, shall be adjusted/revised for comments immediately and re-submitted to the CA within 10 days or earlier if site progress dictates.

Where drawings are revised and updated during the construction stage these shall be issued to the CA for examination of the revision only, the revision being clearly marked.

- Builder's work information and installation drawings shall not be examined in detail but shall be examined by the CA for general suitability.
- Record drawings are to be prepared as the contract works progress and shall be examined in the same manner as for other submittals.
- The timescale for review or comment or otherwise of record drawings shall be 20 working days from the date of receipt by the CA.

510.070 MISTAKES IN SUBMITTALS:

Examination and/or issue on a CA instruction of submittals shall not be deemed to remove any duties, obligations and responsibilities under the contract.

Be responsible for any error, discrepancy or omission in any submittal, presentation or drawing prepared or where others have prepared these for submittal.

The said indemnity shall be subject to the proviso that such error, discrepancy or omission is not due to any inaccurate data, drawing or information provided by the employer or by the CA on his behalf.

510.080 SAMPLES:

Provide free of charge samples of material and workmanship proposed to be used in the Works. Samples shall include all alternative finishes available if required.

In the case of articles of special construction:

• drawings may be temporarily substituted for the samples

drawings when approved will be retained until the articles concerned are supplied, as a sample The samples submitted and approved, shall remain the property of the Employer until the completion of the contract.

Approval of the CA shall be obtained before equipment is placed on order

- The CA will undertake to approve samples within 4 weeks from receipt. Samples to be submitted:
- All visible mechanical engineering services items out-with plant rooms. Include all alternative finishes available for the following samples:
- TBC

510.081 FORM AND NUMBER OF SUBMITTALS TO BE PROVIDED: All submittals shall be issued to the

- CA •
- Copied to the remainder of the design team.
- Provide drawn information in the following forms:

- Initial copies for comment
 - print form
 - CAD format
- comply with BS EN ISO 13567-1
 - comply with BS EN ISO 13567-2
- Final copies for distribution
- print form •
- CAD format
- comply with BS EN ISO 13567-1
- comply with BS EN ISO 13567-2
- Provide copies of drawn information as follows:
 - Sketch drawings
 - Initial copies for comment (no) 4
 - Final copies for design team (no) 4
- Schematic drawings
 - Initial copies for comment (no) 4
 - Final copies for design team (no) 4
- Detailed design drawings
 - Initial copies for comment (no) 4
 - Final copies for design team (no) 4
- Co-ordination drawings
 - Initial copies for comment (no) 4
 - Final copies for design team (no) 4
- Installation drawings
 - Initial copies for comment (no) 4
 - Final copies for design team (no) 4
- Installation wiring drawings
 - Initial copies for comment (no) 4
 - Final copies for design team (no) 4
- Shop drawings
 - Initial copies for comment (no) 4
 - Final copies for design team (no) 4
- Manufacturer's drawings
 - Initial copies for comment (no) 4
- Final copies for design team (no) 4
- Manufacturer's certified drawings
- Initial copies for comment (no) 4
- Final copies for design team (no) 4
- Builder's work information
- Initial copies for comment (no) 4
- Final copies for design team (no) 4
- Controls logic diagrams
 - Initial copies for comment (no) 4
 - Final copies for design team (no) 4
- Switchgear, starter and control instrumentation panel drawings
- Initial copies for comment (no) 4
- Final copies for design team (no) 4
- As-installed drawings
- Site record copy in print form (no) 4

510.090 REVISIONS TO DRAWINGS:

Where revisions take place either under the authority of a CA instruction, or by written agreement with the CA or when revised architectural, structural or services information is issued, all drawings shall be modified accordingly and shall be re-issued for construction purposes subject to examination by the CA

The issue of revised drawings shall be in accordance with and with regard to the agreed programme for construction and where time is available re-issues shall be grouped together, as agreed with the CA.

520.000 OBLIGATIONS AND RESPONSIBILITIES

520.010 GENERAL:

This section details the specific obligations, duties and responsibilities undertaken as part of the contract works.

520.020 OBLIGATIONS:

Undertake responsibility for all works defined in the work sections and shown on the drawings, and in particular the following:

- Undertake the responsibility for resolving final spatial co-ordination
- Check the provisions for, and adequacy of builder's work information previously issued prior to the award of the contract
- Co-ordinating the engineering services, with each other and with the building structure and fabric
- Undertake the role of lead co-ordinator and agree principles of co-ordination with all parties • concerned. Incorporate details provided by others into the:
 - installation information
- Provide the following drawings as defined elsewhere:
- ٠ Co-ordination
- Installation •
- Manufacturing ٠
- Manufacturer's certified ٠
- Shop drawings
- Installation wiring drawings
- Provide builders work details based on the installation, manufacturing and shop drawings.
- Negotiate with public and other authorities for provision of necessary incoming services.
- Obtaining final approvals of any appropriate authority.
- Prepare such reports, calculations and details as required for submission to any appropriate • authority including the coordination of such information by suppliers, specialists, etc needed to be included in any submission.
- Fully re-evaluate and take full responsibility for all parts of the design and building elements that may be affected by acceptance of alternative plant selections
- Undertake specific detailed design tasks as defined in this work section
- Undertake all on-site co-ordination with all other trades, disciplines, manufacturer's and suppliers Provide:
 - suitable accommodation ٠
 - workshops •
 - stores
- clearance on completion
- Supply, deliver to site, unload, store, protect and co-ordinate movement of all plant, equipment and materials required for the works.
- Including lifting and hoisting.
- Fix and install correctly all plant, equipment and materials and ensuring that all associated works are correctly executed
- Undertake the fire stopping of all holes associated with the works
- Install fire barriers where a fire rated partition is penetrated
- Inspect all plant, equipment and materials as delivered or where specified at the manufacturer's works
- Inspection and/or tests to be carried out at the works jointly with the CA for equipment as ٠ defined elsewhere
- Include for the travel and other expenses of the CA for the inspection and/or tests carried out at the works
- Preparation of the operating and maintenance manuals, planned maintenance schedules.
- Appoint a specialist responsible for the preparation of the operating instructions and maintenance manual
- Undertake the testing and commissioning of the works.
- Appoint an independent commissioning specialist responsible for the testing and commissioning of the works.

A64

Providing a commissioning report in accordance with Building Regulations.

520.030 DESIGN RESPONSIBILITIES:

Detailed design responsibilities shall include the activities listed below, in addition to those activities normally undertaken through the custom and practice of the industry. Responsibility of the suitability and correctness of the design or other obligations as defined in the contract documentation will not be affected by comments of the CA. The design responsibilities shall include: (note; electrical cable sizing includes Automatic Controls)

- Check the provisions for, and adequacy of the preliminary builder's work drawings or information • previously issued by others prior to the award of the contract
- Detail the final or supplementary builder's work information based on manufacturer's information. Provide fully dimensioned drawings.
- Detail all access requirements including access to false ceilings and ducts for maintenance. Provide fully dimensioned and annotated drawings.
- Location of drain and vent points and pipework gradients.
- Detailed design and locations of brackets and supports.
 - Submit details of all types of brackets and supports including fixing details prior to installation.
- Submit load calculations prior to installation.
- Detailed design and location of expansion anchors and guide locations.
- Submit details of all expansion anchors and guides, including fixing details, load and thrust • calculations for comment prior to installation.
- Calculating all pump system resistances based on the final equipment selection and co-ordinated installation drawings.
- Calculating all final fan system resistances based on the final equipment selection and coordinated installation drawings.
- Calculating system water capacities and guantities of chemical additives
- Design and selection of sound attenuation equipment to satisfy the particular performance requirements of the specification and the defined spatial allowances.
- Acoustic design or modification of equipment to attain the particular performance requirements of the specification.
- Final selection of all anti-vibration mountings to suit the particular application of the mounts. Detailed design and sizing of refrigerant pipework between items of equipment provided as part of
- the works.
- Preparing detailed electrical wiring diagrams of all equipment supplied showing all • interconnections between equipment to enable all necessary wiring to be undertaken.
- Capacity, location, routes and design of electrical conduit systems. • • Including trunking where used in lieu of multi-conduit installation.
- Detailed design of automatic controls systems insofar as it is required to meet with operational and spatial requirements of the specification. The installer shall be responsible for ensuring the full compatibility of the plant and equipment with the specified function and for the design and incorporation of all interfaces (including relays or other devices or modifications to hardware or software)
- Dimensioning of, and final installation details of, automatic control panels to suit the detailed requirement of the agreed supplier of the controls equipment. The installer shall be responsible for ensuring that:
 - Control panel cable entry/exits are possible in the final location.
 - Safe operating and maintenance clearances are provided.
- Final locations of:
- Test points
- Control sensors
- Detectors
- Thermostats
- Gauges
- Sizing of cable terminations for all items of equipment.
- Appropriate for the rating of fuses installed in plug tops for the rating of the connected equipment. Design of cable or cable containment terminations on to electrical equipment. Dimensioning of and final installation details of electrical switchgear including:

- The cable entry details for the selected location.
- Provision of adequate safe operating and maintenance clearances.
- Detailed design of earthing and bonding requirements for:
- mechanical engineering services ٠
- electrical engineering services
- architectural elements
- structural elements
- Ensuring cable size selections as specified are not invalidated by the selection of alternative routes during installation or selection of alternative manufacturer's
- Final detailed design of fire alarm system component and cabling requirements to meet with the particular manufacturer and the engineering specification requirements.
- The Installer's design obligations shall include, but not be limited to, as applicable to his Sub-Contract package, the following and as detailed within their own specific specifications:-

Fabrication drawings and the co-ordinated installation working drawings and record drawings.

Drain and vent point locations and pipework gradients in accordance with BSRIA documents Application Guide 1/89 Flushing and cleaning of Water Systems.

Bracket and support detailed design and locations. (All types, loads and locations must be declared to the Management Contractor prior to installation for comment (10 working days)).

Details of Electrical wiring diagrams of all equipment supplied by the Installer showing all interconnections between equipment to enable the necessary wiring to be undertaken.

Details of all equipment component design and selection necessary insofar as such items have been selected by the Sub-Contractor for that item of equipment to meet the engineering specification and performance indicated.

Dimensioning of, and final installation details of, the Automatic Control panels to suit the detailed requirement of the particular agreed manufacturer's of controls equipment and cable entry/exit accommodation such that:

Cable entry is possible in the selected location.

Doors are not fouled by other plant, equipment, services or structural elements.

Safe operating and maintenance clearances are provided in all access positions when installed on site.

Fire alarm systems, component and cabling requirements to meet with particular manufacturer's and the engineering specification's requirements.

Attenuator design and selection to satisfy the particular and performance requirements of the specification, including spatial allowances made within tender drawings.

Design of elements of the scheme provided by the Sub-Contractor for self-weight and other applied forces/loadings in reasonable use. In particular any buried tanks or pipework will require designed anchorage encasement or foundations.

Thermal expansion accommodation and anchorage, including provision of bellows or bends.

Sprinkler system, component and cabling requirements to meet the particular performance requirements of the engineering specification.

Acoustic design or modification of equipment to meet with the noise levels specified. All levels to be achieved with all plant operating to the sound levels given by SBA in the revised stage E report.

Final valve, damper and access locations.

Application Guide 8/91 pre-commission of cleaning of water system.

Design of the Diesel Generator and Boiler/Flue Systems to meet with the generator/boiler manufacturer, Environmental Health Office and requirement of discharging the flue gas at the required velocity and altitude. A copy of the Clean Air application will be made available on request.

Selection of all anti-vibration mountings to suit the particular application of the mounts. Final locations of control sensors, detectors and thermostats.

Capacity, location and design of electrical conduit system, similarly trunking where used in lieu of mullet-conduit installation.

Duct platforms, access covers and gratings, ladders and additional structural steelwork where required and detailed in the Sub-Contract documentation.

Selection of regulation devices to comply with CIBSE Technical Memorandum TM8.

sizes are specified.

Ensuring cable sizing selections as specified.

Detailed design of earthing and bonding requirements for electrical engineering services, mechanical engineering services, architectural and structural elements requiring earthing and bonding.

Design of cable or cable trunking terminations on to electrical equipment provided under the Sub-Contract and dimensioning of and final installation details of electrical switchgear to ensure that:

Cable entry is possible in the selected location.

Doors are not fouled by other plant, equipment, services or structural elements.

site.

Design associates with the Diesel Generator as detailed in the particular specification.

Fuse sizes installed in plug tops are appropriate for the rating of connected equipment (where applicable).

Sizing and detailed design of refrigeration pipework between items of equipment provided under contract works.

The Sub-Contractor shall include within his tender for the supply and installation of any components associated with the above design requirements which may not necessarily be detailed on the tender drawings or in the tender specification.

520.040 ALTERNATIVE EQUIPMENT:

Where the CA has accepted proposed alternative equipment or materials prior to the award of the contract and which subsequently varies the main works and/or the Works in any way whatsoever, then:

- Be responsible for meeting all the additional costs and technical requirements arising from such a change
- No claim for additional costs or delay to the completion of the works will be allowed.

- System water capacities and chemical additives and arranging of the facilities required by BSRIA
- Sizing of cable terminations on items of equipment provided under the Sub-Contract where cable
- Safe operating and maintenance clearances are provided in all access positions when installed on

change shall remain the Contractors responsibility.

Undertake the redesign of all engineering services and builder's work affected by these equipment • changes at no additional cost or extension or delay to the programme.

Should any alternative item proposed not carry appropriate certification, ensure independent testing is carried out to confirm compliance at no additional cost.

Whilst mechanical and electrical services items may be considered on an "or approved equivalent" basis the following should be noted.

1. In the first instance that the named items are priced.

2. That "equivalent" items and any associated cost implications are separately identified.

3. That named items are retained unless there is a budgetary or technical reason to change to "approved equivalent" items.

4. That relevant parties (client, design team, sub contractor etc) are satisfied with all items to be installed whether they are named or "approved equivalent".

5. As a general principal and unless exceptional/extenuating circumstances dictate otherwise, "approved equivalent" items shall not be considered after tender return stage.

520.050 CO-ORDINATION OF SERVICES:

All aspects of the works require detailed co-ordination to avoid any possible clash or conflict with other trades and disciplines. Undertake such co-ordination in relation to the works.

 No extra cost or claim will be allowed due to conflict of works or installations, where full liaison with other trades and disciplines would have prevented such an occurrence.

When any new, revised or updated architectural, structural or services information is issued by the CA under the authority of an instruction, examine such information and if necessary modify the works accordingly to prevent any clashes or abortive work due to such instruction.

- No extra cost or claim will be allowed to cover any clashes or abortive work that result from not • requesting an explanation or seeking clarification in respect of any such revision.
- No extra cost or claim will be allowed due to conflict of works or installations, where full liaison with other trades and disciplines would have prevented such an occurrence.

Where a Main-Contractor Services Co-Ordinator is not provided (refer to Main Prelims), the Mechanical Subcontractor shall be responsible for lead co-ordination of the engineering services installations.

The Mechanical and Electrical Sub-contractor shall allow for retaining on-site a competent Engineer/Foreman at all times when work is being carried out in connection with the Mechanical / Electrical Services Installation. Engineer/Foreman shall be minimum of SJIB Technician grade with a minimum of 12 years experience.

The Sub-Contractor shall be responsible for the full co-ordination and proper execution and completion of the installations detailed as his responsibility within the contract specification and drawings and shall ensure that it is co-ordinated and compatible with the remainder of the project design. The positions of equipment, pipework, valves etc, indicated on the drawings are given for tendering purposes only and the exact co-ordinated positions shall be proposed by the Sub-Contractor for approval by the Architect. The Sub-Contractor's tender price shall include for any modifications that may be necessary to provide fully co-ordinated and installed engineering services.

The Sub-Contractor shall take his own dimensions for both the preparation of his Tender and for the execution of the work, and he alone shall be responsible for the accuracy of such dimensions and of drawings made there from.

The tender drawings shall not be utilised exclusively for the detailed pricing of the works. The Tenderer shall allow for all necessary sets, bends, transformations and supports to complete the installation. Where the Sub-Contractor elects to depart from the principles and general arrangements depicted on the tender drawings he shall be responsible for undertaking detailed checks on the duties of all equipment affected, informing the Architect and adjusting the sizing of plant as required. The Sub-Contractor shall not proceed with the order of resized equipment until he has provided the necessary calculations to the Architect. The Sub-Contractor shall note that reduced size plant need not be accepted by the Architect and that all costs arising from such

The Tender drawings for each of the engineering services installations do not indicate the presence of other engineering services or supports for suspended ceilings, etc. The Sub-Contractor is responsible for ensuring liaison with all trades to ensure that all engineering services are accommodated satisfactorily in the building, particularly in ducts, voids, cavities, and other potentially congested areas. The Sub-Contractor shall, without cost to the Employer, make any alterations that may be found necessary due to non-compliance with this clause.

The Sub-Contractor shall acquaint himself with the general arrangement of all services and ensure that in fixing any work it will not obstruct the fixing or future maintenance of any other services. He shall also co-ordinate the engineering services with other trades and take all necessary precaution to ensure that the progress of any trade does not impeded the progress of any other trade that all engineering services are accommodated satisfactorily.

The Sub-Contractor shall allow for obtaining and co-ordinating the submission of fully co-ordinated engineering services installation drawings and shop drawings from all his Sub-Contractor's and suppliers and all related builders work drawings. The drawings are to be compatible, correctly annotated and cross-referenced at their interfaces.

The Sub-Contractor shall agree with all his Sub-Contractor's and suppliers and be responsible for the positions of their work or materials including pipe runs in ducts, conduits and cables, etc and the positions of holes, chases, recesses, fixing and the like, before work is put in hand, in order to ensure that they do not conflict with other work.

The Sub-Contractor shall be responsible for taking all his own dimensions on site, checking levels and marking out for the builders work and shall allow for such work in his Tender. The Sub-Contractor shall ensure that setting out of plant and equipment, pipes and ducts, etc permits it to fit into the space allocated and allow access for maintenance and replacement purposes.

To ensure co-ordination between his Sub-Contractor's and suppliers the Sub-Contractor shall allow for arranging and attending any necessary meetings with the relevant Sub-Contractor's and/or suppliers in order to agreed such priorities as are necessary and in order to monitor progress, obtaining the necessary data for and preparing co-ordinated drawings of all the work involved in the engineering services installation together with its associated builders work and giving all necessary instructions to overcome any potential conflicts. Where such co-ordination requires any amendment to the drawings or specifications prepared by the Employer's Consultants, the matter shall be referred to the Main Contractor in the first instance.

These activities shall be carried out to ensure that any amendments or revisions to data can be implemented without delaying progress of any part of the Works. The Sub-Contractor shall allow for the costs of all amendments or revisions required to provide a properly co-ordinated engineering services installation.

Each Sub-Contractor shall incorporate sufficient reasonable programme periods and monies for the execution of their responsibility of the installation drawings, no programme allowance can or will be made for non compliance.

As for the installation/working and builderswork drawings, the Mechanical Sub-Contractor shall produce composite drawings with his own and all other contract package requirements properly defined.

No drafting should proceed until each Sub-Contract has agreed overall spatial relationship with the remaining Sub-Contracts and the remaining form and structure.

Any installation that proceeds either without a suitably produced and commented drawing or without detailed information of the other local Sub-Contract packages, structure or architectural form is entirely at the Sub-Contractor's risk, no abortive costs will be allowed to rectify any problems arising.

A64

Where scheme revisions are required in the Main Contract works or other Sub-Contract works due to the Sub-Contractors variation or revision then the costs for such revision will be the Sub-Contractors responsibility include the design team consultant's costs.

Comments by the Architect shall not relieve the Sub-Contractor of his responsibility for the suitability and correctness of the Sub-Contractor's design and his other obligations within the contract documentation.

The Sub-Contractor shall be responsible for an omission, errors or any discrepancies in the drawings and other particulars supplied by him or his suppliers, whether such drawings or particulars have been commented upon by the Architect or not, provided that such omission, errors or discrepancies are not due to inaccurate information of particulars furnished in writing to the Sub-Contractor by the Architect.

520.060 CO-ORDINATION OF SERVICES ON SITE:

Allow for co-ordinating the contract works with the works of other trades and installations which may be on site during the period of the contract either during or prior to their incorporation into the works. Where minor clashes of services occur on site that were not foreseeable at the design or co-ordination drawing stage then these clashes or minor co-ordination matters shall be resolved by discussion and agreement with other trades and disciplines. The CA shall be informed of the action to be taken by an approved means.

No instructions will be issued to cover such minor clashes.

520.061 ACCESS FOR PLANT INSTALLATION AND SUBSEQUENT REMOVAL:

- Before work is put in hand and orders are placed for boiler(s), tank(s), cylinder(s), calorifier(s), pressure vessel(s) and all other large plant, the Sub-Contractor is to check on site or with the drawings if the plant has to be ordered before the building work is at a suitable point, the dimensions of all doorways, etc, serving as access to ensure that each item can be admitted to its allotted position and installed in such a way together with all other services, and that it can be replaced with similar replacement equipment at some future date.
- The Sub-Contractor is to allow within his tender (or agree cranage requirements with the main contractor) for cranage of equipment to the installed position on site.

The Sub-Contractor can be called upon to demonstrate that plant and equipment can be removed for replacement or maintenance purposes and replaced, using the same materials except gaskets. Should he find during installation that he cannot make any equipment removable, then he must modify the arrangement in conjunction with the engineer and all other concerned. On no account can the engineer accept equipment that cannot be readily maintained in position, unless specifically agreed in a particular case in writing when maintenance after removal would be accepted.

520.070 SURVEYS:

- Ascertain the nature of the site and all local conditions and restrictions likely to affect the execution of the Works.
- Before commencing work, carry out a survey and examination of buildings, structure and engineering services affected by the works.
- Examine all available drawings of the engineering services and report any discrepancies to the CA.

520.080 SITE DIMENSIONS AND LEVELS:

Install all engineering services using a laser levelling system wherever possible and co-ordinate the measurements with all other trades and disciplines to prevent any clashes. Obtain all dimensions and levels on site for the actual setting out of the works. As the development advances measure on site all works by others that may foreseeably affect the

works. These dimensions shall be incorporated into the installation drawings or marked up on revised drawings if already issued.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **GENERAL CONDITIONS (SELF CONTAINED SPECIFICATION)**

- No extra cost or claim will be allowed for any errors arising from inaccurate setting out or failure to • check actual site dimensions.
- Reimbursement will be sought for any abortive expenditure.

520.081 SETTING OUT OF WORKS:

The Sub-Contractor shall set out the works and take all necessary site measurements to ensure that the works are built in accordance with the drawings and within the specified tolerances. The Sub-Contractor shall be totally responsible for the accuracy of the setting out his works and of site measurement. The Sub-Contractor shall, where required, check the setting out of other Contractors works which affect his own works.

The Sub-Contractor will be held responsible for all costs arising from any error caused by his inaccurate setting out or failure to take site dimensions or errors in such site dimensions of failure to build within the specified tolerances.

The Main Contractor may check the Sub-Contractor's setting out but this shall not relieve the Sub-Contractor of his responsibility for any error made. Where discrepancies are found the Sub-Contractor shall correct and reset out for further checking by the Main Contractor at no extra cost.

Before the work begins on site the Sub-Contractor shall submit his proposed methods of dimensional setting out, construction and checking that will satisfy the accuracy's required by the Sub-Contract.

Setting out shall comply with BS 5964 as a minimum. Where this is in conflict with the Specification, the Specification will take precedence. Where permitted deviations are referred to in the Specification they are deemed to be a total deviation. Sub-Contractors shall co-operate with other working in discreet areas to ensure that permitted deviations do not lead to out of tolerance dimensions between adjacent works.

Where systems to be installed under this Contract are to be run adjacent to or near to other systems the setting out of the services shall be the responsibility of the Sub-Contractor.

520.090 MAINTAINABILITY:

Demonstrate that all plant and equipment incorporated into the Works can be safely and easily maintained in full compliance with:

- Health and Safety legislation.
- CDM requirements. •
- British Standards.

Health Technical Memoranda. • Ensure that adequate space is provided for future replacement of plant or parts and that all access panels/doors are unobstructed.

The Sub-Contractor shall at time give proper consideration to the future maintenance of the plant and shall include for such component parts as are provided by the manufacturer of equipment and plant for this purpose. Under this clause the Sub-Contractor shall include for such items as; cleaning and access ports on pressure vessels and heat exchangers; easy access to oiling and greasing points; low level drain plugs and/or cocks in all vessels of plant or pipework fluids or gases.

Where pipes cross access routes at low level purpose made step-overs shall be installed to provide safe access.

This clause shall also cover the installation of equipment to give ease of subsequent removal of electric motors, thermostats, heat exchanger batteries, or other equipment, and of any other item to which it may be reasonably anticipated that maintenance would apply.

Every rotating, reciprocating or moving part of compressors, pumps, fans and other machines supplied by the Sub-Contractors shall be properly protected by manufacturer's standard or purpose made machine guards to comply with current issue of the Factories Act. All machine guards shall be manufactured from solid sheet metal or wire mesh or iron frame, all galvanised after manufacture and shall be so designed with hinges and/or removable sections to allow for maintenance and all necessary tachometer readings.

Inform all necessary parties when work necessitates such notices to be given.

540.000 HEALTH AND SAFETY

540.010 GENERAL:

- Refer to the Main Contract Preliminaries for the requirements of safety, health and welfare. Conform to all safety rules, regulations and codes of practice. Check that facilities provided by others fulfil the obligations and advise accordingly.

- Provide all necessary first aid facilities.
- Appoint a "competent person" on the site to manage health and safety during construction. • Ensure, so far as is reasonably practicable, that all persons employed on, or visiting, the site are adequately informed, instructed, trained, supervised and equipped such that they are able to carry out their duties safely.
- Ensure that safety helmets and other necessary protective clothing are available to site visitors. • All safety helmets and protective clothing must comply with the latest British Standards. • Ensure that only authorised persons are allowed into any construction area. •

- Ascertain the accuracy and sufficiency of information provided by the Employer or the CA to ensure the safety of all persons and the Works.
- Wherever possible labour saving lifting devices shall be used and materials sized to allow easy • manual lifting.
- As given in the Main Contract Preliminaries.

540.020 CDM REGULATIONS:

- The management of health and safety is to be undertaken in conformity with the requirements of The Construction (Design and Management) Regulations, The Construction (Design and Management) (Amendment) Regulations 2000, and the corresponding Approved Code of Practice.
- Comply with the requirements of the CDM Regulations by
- Compiling risk assessments
- Preparing method statements
- Providing information on the contract works that might affect the health and safety of any person
- Providing all necessary input to the health and safety plan
- Providing all necessary input to the health and safety file
- Supply any method statements and comply with all CDM procedures required by the Planning Supervisor and the Principal Contractor.
- As given in the Main Contract Preliminaries.

540.030 HEALTH AND SAFETY PLAN:

- A tender stage health and safety plan is included as part of the tender documents.
- The tender stage health and safety plan provides information required by the CDM Regulations and highlights significant risks to health and safety identified during the design stage.
- Develop the tender stage health and safety plan in accordance with the requirements of the CDM Regulations prior to the commencement of works on site
- The development of the health and safety plan shall not be limited to those particular risks identified in the tender stage health and safety plan but shall include consideration of all reasonably foreseeable risks
- The health and safety plan must be adequately developed, as far as is reasonably practicable allowing for any phasing of works, etc., in sufficient time to allow it to be submitted for approval prior to the commencement of any works on site.
- In the case of phased works the health and safety plan relating to the work content of any phase must be adequately developed and submitted for approval prior to the commencement of any work within that phase of the project.
- Where design activities are undertaken or there is involvement in the design of any elements of the contract works co-operate with and provide information to the Planning Supervisor in accordance with the designer's duties under the CDM regulations.
- Ensure that all sub-contractors are issued with copies of the health and safety plan prior to the submission of their tenders and that they price for compliance.

KJ TAIT ENGINEERS

520.100 TERMINAL UNIT LOCATIONS:

The positions of all connection points, accessories, apparatus, equipment and other room terminals shown on the tender drawings are approximate and for guidance in the preparation of the tender. Agree, with the CA, which terminals are subject to final positioning on site. Allow for the movement of all such terminals:

• Up to a radius of 2 m from the positions shown on the drawings. Mounting heights indicated in the tender documents are for tender purposes only. Confirm mounting heights with the CA before commencing work on site.

520.110 CO-OPERATE:

Co-operate with the contractor, other subcontractors, suppliers, local authorities and statutory undertakings in the execution of their work.

In particular, the following works carried out by others will require close and careful liaison and cooperation.

Electrical engineering services.

520.120 STATUTORY AUTHORITIES:

Orders for the incoming utility services shall be

- undertaken by others as given in the Main Contract Preliminaries.
- Liaise with the Statutory Authorities and provide any test notices required to ensure final connections are made in accordance with the requirements of the programme.

530.000 LOCAL AUTHORITY REQUIREMENTS

530.010 GENERAL:

This section details the requirements for compliance with Local Authority By-laws.

530.020 STATUTORY AUTHORITY APPROVALS:

- Notify the District Surveyor, Building Control Officer and Fire Officer directly in respect of all tests • and demonstrations relevant to life safety installations, and include for all necessary attendance, documentation, etc., to ensure full Statutory Authority approval of the installation.
- Include for all fees and charges legally required under such Act of Parliament, Regulations or By-Laws in respect of the Works.

The works shall be carried out in accordance with the requirements and regulations of all relevant local authorities, fire brigades, and water, gas and electricity authorities.

Any such portion of the works requiring the inspection and approval of such authorities shall not be built-in, covered or otherwise obscured until such approval has been obtained.

Authorities shall be notified as necessary about the connection of electricity, gas, Telecom, water and drainage.

The Sub-Contractor shall be responsible for liaison with the Main Contractor to facilitate the programme and co-ordination of the various utilities to meet his installation programme.

Unless otherwise specified, the whole of the works shall comply with the requirements of all relevant British Standard Codes of Practice.

530.030 AUTHORITY NOTICES:

- Documents requiring the Employer's signature shall be forwarded to the CA in time to meet the contract works programme in order for the necessary test and supply arrangements to be made.
- No additional costs or extension to programme shall be allowed due to reconnections, revisits etc by supply authorities or failure to programme the works.

530.040 BYE-LAWS, NOTICES, ETC:

Observe and comply with the requirements of all Statutes and Bye-Laws. Serve notices on the Authorities having control of the road surfaces before the same are broken up and likewise serve notices on the owners of sewers, drains, water, gas or other mains, electric cables, tramways and other services which may in any way be affected by the execution of the Works.

- Ensure that all sub-contractors complete appropriate assessments of the risks to health and safety ٠ in respect of their works as required under applicable statutory legislation, including The Management of Health and Safety at Work Regulations, The Control of Substances Hazardous to Health Regulations and The Control of Substances Hazardous to Health (Amendment) Regulations 2003.
- The health and safety plan shall be reviewed and revised as necessary in line with any information received or any changes in the requirements of the contract works. Any changes shall be promptly advised to all relevant parties.
- Ensure, so far as is reasonably practicable, that all sub-contractors, employees and self employed persons who are at work on the construction of the project conform with the requirements of the health and safety plan.

540.040 COSHH REGULATIONS:

- Comply with The Control of Substances Hazardous to Health Regulations and The Control of Substances Hazardous to Health (Amendment) Regulations 2003.
- Provide with the tender an assessment of the risks in undertaking the contract works
- Provide with the tender a method statement on the steps proposed to meet the requirements of the Regulations
- Undertake COSHH assessments for all activities and substances provided or used on site to assess their potential health hazards.
- Copies of all relevant COSHH assessments must be issued to the operatives concerned and strictly monitored. Particular attention must be given to the use of glues and sealant.
- Where the use of substances falling within the scope of the Regulations forms part of the contract works notify the CA in writing, together with the additional costs, if any, of use of non-hazardous alternative.
- Ensure during the course of the contract works, and under all circumstances, that all substances falling within the scope of the Regulations are positively so identified at all times and that they are transported, handled, stored, used and disposed of in strict accordance with their manufacturer's/supplier's recommendations.
- Where use of substances falling within the scope of the Regulations are required for the operation and maintenance of the completed contract works, ensure that
 - Suitable facilities are available for the on site storage of such substances and that all necessary warning/instruction notices are provided at the point of their storage and use
 - Provision of any special protective clothing, eye protection and similar safety equipment for the operation and maintenance of the Works and in sufficient quantity for
 - 1 year operation
 - Employer's staff have been fully trained in the use, handling, storage, transport and disposal of the substances concerned prior to handover.
 - The type, use and control of the substances have been fully and correctly identified in the operating and maintenance manuals/health and safety file.
- As given in the Main Contract Preliminaries.

540.050 ASBESTOS:

- No material or goods containing asbestos shall be incorporated in the contract works.
- Be responsible for certifying at practical completion of any section of the contract works that no asbestos or asbestos related materials have been incorporated or by any sub-contractor employed.
- As given in the Main Contract Preliminaries.

540.060 RISKS TO HEALTH AND SAFETY:

Submit a statement with the tender describing any significant and unavoidable risks which may arise as a result of carrying out the contract works and the measures proposed to safeguard the health and safety of operatives and of any person who may be affected by the contract works.

• As given in the Main Contract Preliminaries.

600.000 THE SITE

600.010 GENERAL: This section outlines information on the site.

600.020 SITE LOCATION: The site is located at address as given in the Main Contract Preliminaries.

600.030 DESCRIPTION OF THE SITE: As given in the Main Contract Preliminaries.

600.040 RISKS TO HEALTH AND SAFETY:

- The nature and condition of the site/building(s) cannot be fully and certainly ascertained before opening up.
- As given in the Main Contract Preliminaries.

The employer or the CA do not guarantee the accuracy and sufficiency of this information: Undertake responsibility to obtain any information required to ensure the safety of all persons and the Works.

Comply with the requirements of the CDM Regulations by

- · compiling risk assessments for the contract works.
- providing information on the contract works which might affect the health or safety of any person.
- providing appropriate input to the health and safety plan and file for the works.
- As given in the Main Contract Preliminaries.

600.050 ADDITIONAL DETAILS: As given in the Main Contract Preliminaries.

610.000 EXISTING SERVICES

610.010 GENERAL: This section provides information on existing services.

610.020 EXISTING MAINS/SERVICES:

Existing mains/engineering services comprise

- Although not restricted to: electricity; gas; water; telecoms
- Existing services shall not be interfered with, nor interrupted in any way without the prior written permission of the CA.
- Be responsible for any damage entailed and make good any such damage to the satisfaction of the CA at no extra cost.

610.021 CONNECTION TO EXISTING SERVICES: Give seven days notice to the Architect of your intention to connect into or isolate any of the existing services and await his approval for so doing. The Sub-Contractor shall make arrangements to allow connection of the new works to existing including providing details of the proposed works and obtaining written approval as necessary.

Include for all overtime and other additional payments necessary to ensure that the interruptions to existing services are carried out with the minimum possible inconvenience. Work without pause until the services are back to normal.

610.040 RISKS TO HEALTH AND SAFETY:

- The nature and condition of the existing services cannot be fully and certainly ascertained before opening up.
- As given in the Main Contract Preliminaries. •
- The Employer or the CA do not guarantee the accuracy and sufficiency of this information.
- Undertake responsibility to obtain any information required to ensure the safety of all persons and • the Works.
- Comply with the requirements of the CDM Regulations by •
- compiling risk assessments for the contract works.
- providing appropriate input to the health and safety plan and file for the works.
- As given in the Main Contract Preliminaries.

providing information on the contract works which might affect the health or safety of any person.

700.010 GENERAL:

This section outlines the extent of the works and provides a description in a brief manner of the scope of each of the building services installations.

700.020 SCOPE OF WORKS:

The engineering services included in the Works and covered by this contract comprise:

- Mechanical services. •
- Public health services. ٠
- Electrical services. •
- Automatic controls. •
- Building management system. ٠
- Fire control systems. •
- Smoke and heat exhaust systems.

700.030 EXTENT OF THE WORKS:

The extent of the Works is as follows: Mechanical services

- Incoming gas supply.
- Central refrigeration. ٠
- ٠ Central boiler plant.
- Air conditioning. •
- Ventilation and exhaust. •
- Heating distribution.
- ٠ Cooling distribution.
- Heat rejection plant and condenser water. ٠
- Thermal insulation. ٠
- Water treatment. •
- Acoustic and vibration control ٠
- Automatic controls. •
- Building management system. ٠
- Kitchen equipment. ٠
- ٠ Dry risers.
- Fire main and fire hose reels. ٠
- Spares and tools. ٠
- Compressed air services.
- Medical gas services.
- Testing and commissioning. ٠
- Record documentation.
- Public health services
 - Incoming mains water supply
 - Hot water service •
 - Cold water service
 - ٠ Mains water service
 - Thermal insulation
 - Water treatment
 - External irrigation systems. ٠
 - External water mains ٠
 - Soil, wastes and drainage •
 - Sanitary fittings
 - Drinking water coolers ٠
 - Fountains and pool supplies ٠
 - Spares and tools
 - Testing and commissioning
 - Record documentation

700.040 DESCRIPTION OF THE WORKS: The following clauses describe in a brief manner the extent of the engineering services. **INSERT SCOPE OF WORKS**

710.000 GENERAL DESIGN CRITERIA AND STANDARDS

710.010 GENERAL:

This section outlines the general design criteria and definitions applicable to the engineering services forming the contract Works.

710.020 GENERAL DESIGN CRITERIA:

- The criteria listed in the following clauses apply to all work sections included in the contract unless specified otherwise.
- The design of the engineering services is based on the criteria and design data stated in the following clauses
 - Changes or amendments shall be by prior written notice from the CA.

710.070 PLANT OPERATING CONDITIONS:

- Ensure all plant items are suitable for operation in the environment in which they are to be located. Ensure all plant, motors, starters and ancillary equipment etc. are suitable for operation at full
- capacity under the following conditions
- Height above sea level not exceeding 1000m.
- Air cooling at an average temperature over 24 hours not exceeding 35°C dry bulb. Maximum conditions of 40°C dry bulb and 50 per cent relative humidity.
- Supply voltage approximately sinusoidal

710.080 ELECTRICAL WIRING:

Where systems are specified as being maintained under fire conditions ensure wiring selected is suitable for the temperatures to be encountered.

710.100 STANDARDS AND REGULATIONS:

- Unless stated otherwise the Works shall comply with the appropriate British Standard (BS) or Code of Practice (CP) and where no BS or CP is applicable comply with
- the Agrement Certificate for the particular item. •
 - CIBSE recommendations and guides to current practice.
- BS 7671 Regulations for Electricity Installations
 - Including Amendment 2 (excluding paragraph 514).
- Including Amendment 2.
- Guidance published by IEE.
- As given in the Main Contract Preliminaries.
- Ensure all equipment and systems are designed and installed in accordance with the relevant • standards and that operational compatibility exists between the systems and any other system installed in the same location.
- All product and materials shall have product conformity certification (eg BSI Kitemark, BSI Safety Mark or CARES scheme) or product approval (eg British Board or Agrement Certificate) All products must have the recognised 'CE' mark attached.
- Provide certificates of compliance with British Standards, BSI Certification Schemes, and/or other Quality Assurance Schemes
 - when requested by the CA.
- As given in the Main Contract Preliminaries.
- In the absence of specific design, performance or installation standards being stated seek the instructions of the CA prior to commencement of the Works and with adequate time so as not to cause delay.
- When new editions, versions and amendments are published during the construction, seek the instructions of the CA with respect to any modifications or changes necessary. References to BSI documents shall be to the versions and amendments listed in the British Standards Catalogue and in subsequent issues of BSI Update Standards up to
- - one month prior to the tender issue date.

A64

A64

- As given in the Main Contract Preliminaries.
- The tender shall be based on the standards and regulations current
 - one month prior to the issue date of the tender.
 - As given in the Main Contract Preliminaries.

710.110 METRIC AND IMPERIAL CONVERSIONS:

- Some dimensions and units in metric have been converted from imperial units and approximated to the nearest practical dimension, i.e. 12" has been converted to 300 mm.
- Metric sizes have been used for both metric and imperial components.
- Where only imperial components are available the imperial size has been converted to the metric • equivalent size.
- Due allowance shall be made for metric and imperial conversions.

710.120 ELECTROMAGNETIC COMPATIBILITY:

- Ensure all equipment and systems are installed to provide electromagnetic compatibility within the system and with any other systems installed in the same area.
- Ensure all systems and buildings are assessed for protection to, and that such protection meets the requirements of, BS 6651.
- Ensure all equipment meets the requirements of the appropriate electromagnetic compatibility standard.
- Standard
 - Particular equipment •
 - Industrial, Scientific and Medical
 - BS EN 61000-6-4.
 - BS EN 55011.
- Household electrical appliances, portable tools and similar apparatus.
 - BS EN 55014.
 - Fluorescent lamps and Luminaires
 - BS EN 55015.
 - Information technology equipment
 - BS EN 55022.
 - ٠ Mains signalling
 - BS EN 50065.
 - Broadcast receivers and associated equipment ٠
 - BS EN 55013 and BS EN 55020.
 - Industrial process measurement and control • • BS EN 60801.
 - Other equipment to generic standards
 - Emissions
 - Domestic, commercial and light industrial
 - BS EN 61000-6-3.
 - Heavy industrial
 - BS EN 61000-6-4
 - Immunity
 - Domestic, commercial and light industrial
 - BS EN 61000-6-1
 - BS EN 55014-2
 - Heavy industrial
 - BS EN 61000-6-2.
- Ensure all apparatus covered by the Wireless Telegraphy Act meets regulations issued by the Radiocommunications Agency.
- Ensure all equipment and systems meet the requirements of BS 6328, BS 6701 and BS EN 41003.
- Ensure that all cable installations meet the minimum guidance separation in EMC of Installations and Recommended Cable Separations, published by the ECA.

710.130 PRESSURE DIRECTIVE:

All pressure equipment and assemblies with a maximum allowable pressure greater than 0.5 bar shall comply with the European Community (EU) Pressure Equipment Directive (PED) 97/23/EC. Pressure equipment shall include vessels, piping, safety accessories and pressure accessories. Assemblies shall mean several pieces of pressure equipment assembled to form an integrated, functional whole. Pressure equipment shall be marked as a minimum with: a) unique identification of the manufacturer

b) unique identification of model and serial number c) the year of manufacture

d) maximum/minimum allowable pressure limits e) CE marking

- Provide a declaration of conformity for all pressure equipment.
- Submit copies to the CA prior to installation into the Works. •
- Provide copies as part of the record documentation.
- As given in the Main Contract Preliminaries.
- Equipment must be:

a) Designed for adequate strength taking into account internal/external pressure, ambient and operational temperatures, static pressure and mass of contents in operating and test conditions, corrosion and erosion, fatigue, etc.

b) Provided with means to ensure safe handling and operation and of examination, draining and venting.

c) Provided with protection against exceeding the allowable limits of pressure. d) Where necessary, pressure equipment must be designed and fitted with suitable accessories to meet damage-limitation requirements in the event of external fire. Ensure all components or sub-assemblies in their finished assembly are used within their safe operating range and correctly installed and tested.

Ensure that adequate instructions are provided by the manufacture for the safe installation, testing and operation.

Instructions shall be provided to ensure for the safe maintenance and operation of the equipment when in operation.

Pressure equipment and assemblies below the specified pressure / volume thresholds must: a) be safe.

b) be designed and manufactured according to sound engineering practice.

710.140 ATEX DIRECTIVE:

All equipment and protective systems used in potentially explosive atmospheres shall comply with the ATEX Directive 94/9/EC of the European Parliament and the Council. Equipment meeting the requirements of the Directive shall have the CE symbol clearly affixed to indicate compliance

All equipment, protective systems and components must bear the specific marking of explosion protection as required by the ATEX Directive 94/9/EC in addition to the CE marking.

710.150 FACILITIES FOR REMOVAL OF EQUIPMENT:

- De-coupling facilities shall be provided for all services connections to equipment and plant and be located adjacent to the equipment such that any removable section, cover or the complete unit can be readily removed or withdrawn without the removal or disturbance to large sections of adjacent services.
- Ensure isolation and drain down of any item of equipment without isolating large sections of the remaining system.

710.160 SOFTWARE:

Obtain on behalf of the end user all appropriate licences, permissions, copyright waivers, rights of use and the like from the owners of the software rights. Ensure that the end user is properly registered with the software supplier for support and appropriate updating. Ensure that application software is written in compliance with BS 7649.

710.170 EU DECLARATION OF CONFORMITY:

Provide an EU Declaration of Conformity prior to delivery to site.

- As requested by the CA
- For all equipment.

KJ TAIT ENGINEERS

The declaration shall state the following as a minimum:

A64

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **GENERAL CONDITIONS (SELF CONTAINED SPECIFICATION)**

- The manufacturer or his authorised representative.
- Description of equipment. ٠
- The harmonised standard(s) that have been applied.
- The signatory who has been empowered to enter into commitments on behalf of the • manufacturer.
- The last two digits of the year in which the CE marking was affixed.
- Where only a Declaration of Incorporation for component parts of the assembly can be provided advise all aspects to be considered to enable others to provide a Declaration of Conformity.

710.200 YEAR 2000 COMPLIANCE

Ensure all machinery and equipment, supplied and used on the project, meets the conformity requirements as set out in DISC PD 2000-1 prepared by the BSI.

Year 2000 conformity means that there will not be an adverse effect either in performance or functionality due to dates after the Year 2000. In particular:

- No value for current date will cause any interruption in or adverse effect in performance.
- Date based functionality and performance must behave consistently for dates after the year ٠ 2000.
- In all interfaces and data storage of the century in any date must be specified either explicitly ٠ or by unambiguous algorithms or inference rules.
- Where this method is used, confirm details of how compliance is to be achieved. ٠
- Leap years must be recognised as a leap year.

Provide written confirmation of the measures taken to ensure Year 2000 compliance before any equipment incorporating any time or date dependent control logic into the Works.

720.000 BUILDERS WORK

720.010 BUILDERS WORK PROVIDED:

- Where structural and/or architectural facilities or provisions, for engineering services are already indicated check that these are correct, satisfactory and adequate for the purpose and confirm same in writing to the CA. Timescale:
 - Within weeks of the award of contract (no) 4
- Where the preliminary builder's work facilities issued prior to the award of contract are not correct or insufficient advise the CA immediately and obtain further instructions.
- Where alternative equipment or materials has been offered that the CA has accepted and which subsequently varies the works in any way whatsoever, then undertake the redesign of the associated builder's work.
- As given in the Main Contract Preliminaries.

720.020 BUILDER'S WORK RESPONSIBILITIES:

- The requirements for and responsibilities with regard to builder's work items are in addition to that normally provided as is normal custom and practice in the building industry.
- Confirm and amplify any information provided by the CA.
- Provide builder's work information, appropriate to the stage of design development. Revise, supplement and/or issue final information, drawings/details for the actual requirements of the contract works.
- Provide fully dimensioned drawings showing both size and position of builder's work making due reference to the structural engineering and architectural final dimensioned detailed drawings.
- As approved by the CA Mark out on site, all cut holes and chases required, any pockets cast in concrete, any inserts, any built in sleeves or similar items.
- All builders work information shall be provided to comply with the programme and include sufficient time for the necessary approvals.
- All materials provided for fixing by others are to be included in the contract works cost and supplied in accordance with the programme.
- As given in the Main Contract Preliminaries.

720.030 SCOPE OF BUILDER'S WORK:

All builder's work to be carried out by as given in the Main Contract Preliminaries.

- Builder's work excludes drilling and/or plugging walls, floors, ceilings etc., for fixings for services • and such work is included in the contract works.
- Provide the following as necessary for the complete installation all supporting steelwork
 - brackets, clamps and fixings
- Pipe, duct and cable sleeves through walls, floors, slabs etc.
- Supply all sleeves and hand-over to others for fixing Contract Preliminaries.
- Puddle flanges
- Supply all puddle flanges and hand-over to others for fixing
- Pipe and duct penetrations through the building envelope
- Carry out final weatherproof flashing over pipe or duct angle flange
- Sanitary fittings •
 - Undertake water and waste final connections to all sanitary fittings
- Fire dampers
 - Supply fire damper frame
 - Hand to others for fixing
 - Supply and install fire damper
- Duct and louvre connections to walls
 - Supply and installation of timber or angle iron frame and making good • By others
- External louvres.
- Agree fixing details with all parties prior to ordering louvres
- Concrete bases and plinths
- Provide all necessary dimensions and details for work by others.
- Supply and install holding down bolts
- Where equipment fixings are drilled into bases, undertake drilling and "making good" after installation.
- Making good around holding down bolts after installation • By others.
- Inertia pads and inertia block bases
 - Provide all necessary dimensions and details for work by others.
 - materials to others for correct fixing and final construction of base.
 - others to fix and fill the inertia block with concrete and make good. Steelwork bases
- - Provide all necessary dimensions and details for work by others.
 - weatherproofing by others.
- Secondary steelwork for support
- Provide all necessary dimensions and details for work by others.
- steelwork frame or concrete frame required for the support of engineering services Provide suitable secondary steelwork and undertake permanent fixing for the support of
- engineering services
- Anchor points and guides
- Provide all necessary dimensions and details for work by others. • Supply and hand over to others for fixing permanently to the building structure
- Ceiling grilles and diffusers
- Supply diffuser or grilles to others for fixing to tiles or ceiling support frame as applicable.
- Undertake final connection of diffuser or grille to ductwork spigot
- Wall or floor grilles or diffusers

Making good around sleeves to provide correct fire barrier shall be by as given in the Main

On ducts through roofs the provision and fixing of timber or metal up-stands will be by others

Preparation of bases to required tolerances for equipment with pockets for holding down

• Where neoprene inertia materials are to be provided in concrete bases supply and hand over Hand over framework for inertia block bases (including holding down bolts and AV mounts) for

Supply and hand over steelwork bases, plinths, channel support steels for fixing and

Provide suitable secondary steelwork for permanent fixing by others onto the main building

Preparation of holes and making good around fixing shall be by others for cast in fixings.

- Supply and fix grille or diffuser
- Preparation of holes or slots, fixing of timber frames and making good around frames for arilles or diffusers
 - By others
- Roof or wall fixed fans
 - Supply fixing frames, boxes or curbs (other than timber curb up-stands) and hand over to others to prepare hole, fix, weatherproof and make good
- Undertake final fixing of fans
- Anti-vibration mountings
- Install Anti-vibration mountings
- Undertake direct drilling fixings if applicable.

720.040 MARKING OUT OF BUILDER'S WORK HOLES ON SITE:

- If approved by the CA, mark on site actual locations of minor non-structural holes through walls, partitions, floors etc and also chases in non fair-faced walls, etc for conduits, pipes and the like in preference to providing drawings of such builder's work requirements. The CA is to be given the opportunity to inspect prior to work being carried out.
- The CA shall inspect all marking out on site prior to work commencing.
- Establish a method of working with the CA to ensure the works may proceed without hindrance.
- The maximum size for a non-structural hole for marking on site shall be as given in the Main Contract Preliminaries.

720.050 BUILDER'S WORK INFORMATION TO BE PROVIDED:

- All builder's work drawings shall be fully dimensioned.
- Builder's work drawings to be provided shall be as follows:
- Details of all bases for plant formed in concrete, brickwork or blockwork •
- to a scale of not less than 1:20
- Details of all attendant builders work, holes, chases, etc for conduits, cables and trunking etc and any item where access for a function of the installation is required
- to a scale of not less than 1:20
- Details of all types of purpose made brackets for supporting service or plant/equipment
- to a scale of not less than 1:20
- Details of all accesses into ceilings, ducts, etc
- to a scale of not less than 1:20
- Details of all special fixings, inserts, brackets, anchors, suspensions, supports etc
- to a scale of not less than 1:20
- Details of all sleeves, puddle flanges, access chambers
- to a scale not less than 1:20
- Submit all necessary load and thrust calculations with drawings/details.

720.060 STRUCTURAL STEELWORK:

- No steelwork shall be cut, drilled or welded without written approval from the CA. •
- The cutting and drilling of structural steelwork shall be agreed with the CA prior to the • commencement of the work and shall require application in writing with all necessary drawings/details.
- Fixings to steelwork shall be
- the approved clamp type
- All fixings shall be of the correct size and type for the fixing load applied and the type shall be approved prior to commencement of the works.
- As given in the Main Contract Preliminaries.

720.070 PRE-CAST CONCRETE:

- Holes may not be cut in precast concrete without written approval from the CA.
- Under no circumstances will holes be cut in pre-stressed concrete.
- As given in the Main Contract Preliminaries.

740.000 COMMISSIONING AND TESTING

740.010 DEFINITIONS:

A64

- Commissioning: The advancement of an installation from the stage of static completion to working order to the specified requirements
- Testing: The measurement and recording of specified quantifiable characteristics of an installation or parts thereof and includes off site testing.
- Setting to work: The process of setting a static system in motion Regulation: The process of adjusting the rates of fluid flow in a distribution system to achieve
- specified values
- Environmental testing: The measurement and recording of internal environmental conditions System proving: the measuring, recording, evaluating and reporting on the seasonal performance
- of the systems against their design values
- System demonstration: Demonstrating the capability of the installation to achieve and maintain the specified performance criteria
- Fine-tuning: The adjustment of the system where usage and system proving has shown such a need and includes the re-assessment of design values and control set points to achieve the required system performance.

740.020 PROGRAMME:

Prepare comprehensive programmes for the pre-commissioning checks, setting to work, testing, commissioning, system proving and environmental testing of the contract works. Timescale:

• Within weeks of contract appointment (no) 4

As given in the Main Contract Preliminaries. • Review and update the commissioning programme at agreed intervals and if necessary revise and amend the programme to suit the progress of the contract works.

• Due account shall be taken of any phasing requirements.

740.021 INSPECTION BEFORE CONCEALMENT:

Whenever work requiring inspection or testing is subsequently to be concealed, due notice shall be given to the Contract Administrator so that inspection may be made or tests witnessed before concealment.

Failure to give due notice, of at least 48 hours, shall necessitate the Sub-Contractor uncovering the works and reinstating it as his own expense.

The Contract Administrator reserves the right to forego his inspection, this will in no way relieve the Contractors responsibility to comply with the Specification.

740.030 COMMISSIONING SPECIALIST:

- Employ an independent company who specialises in testing and commissioning of building services to undertake the following:
 - All commissioning and testing activities associated with the contract works
 - Supervision of works testing
- The commissioning specialist shall be a member of The Commissioning Specialists Association
- Submit with the tender details of the independent company to be employed. • (CSA).

740.040 COMMISSIONING AND TESTING:

When the contract works or parts thereof are ready for testing and commissioning notify the CA in writing.

including all necessary instruments and recorders to monitor systems during commissioning system proving and environmental testing.

Provide information where access is required into ceiling voids, service risers etc and ensure these points are not closed up until the commissioning and testing is complete.

Where used in the documentation the following definitions shall apply and shall be interpreted as such:

- All necessary facilities shall be provided to enable tests to be witnessed and inspections carried out

Where commissioning, testing, balancing, adjustment, is undertaken in an area of the building taken over and occupied by the Employer, then take all necessary precautions against and be responsible for any damage caused whilst working in such areas for that purpose.

Prior to witnessing and inspection by the CA the contract works shall be fully tested, commissioned and be fully operational

Where portions of the work are required to be commissioned and tested separately, then upon final completion, demonstrate to the CA that all the several portions are capable of proper simultaneous operation in accordance with the requirements of the specification.

If testing demonstrates that the plant and equipment is not properly installed and/or not functioning correctly carry out such remedial measures and adjustments as may be necessary and repeat the commissioning and testing procedure to the satisfaction of the CA.

Complete all tests before any paint, cladding or similar materials are applied or before services are concealed.

Ensure all requirements such as cleanliness, protection from harmful external and internal elements are provided prior to commencement of commissioning

Undertake to:

- Commission, test, regulate and set to work the installations that form the contract works.
- Prepare comprehensive programmes, commissioning plans, schedules and method statements • and procedures supported by risk assessments for the pre-commissioning checks, setting to work, commissioning, system proving and environmental testing of the contract works.
- Comply with the requirements of the Building Regulations (Approved Document Part L2) for the inspection and commissioning of the building services systems. Prepare all necessary submittals including commissioning plans and reports. Obtain all compliance approvals from the building control bodies.
- Provide all specialist personnel including manufacturer's representatives and coordinate their activities, together with providing any attendance required.
- Prior to commencement of the works submit to the CA for approval sample pro-forma for the various commissioning record and certification documentation.
- Provide reports detailing progress of testing and commissioning activities at intervals agreed with ٠ CA.
- Maintain a diary/log of significant commissioning and testing activities.
- Measure and reconcile noise levels at agreed locations to verify compliance with design criteria.
- Submit to the CA all certification documents prior to any system being offered for final acceptance
- Confirm in writing to the CA that each installation has been correctly tested and commissioned and that the performance requirements can be achieved.
- Ensure all certification is attained and witnessed as necessary for inclusion in the record documentation.
- Submit a report for every test, demonstration, balance or commissioning activity witnessed, together with an engineering appraisal on the performance, either on or off-site.
- Co-ordinate and liaise with the Employer's representative.
- As given in the Main Contract Preliminaries.

Maintain on site full records of all testing, commissioning and performance testing.

The extent and proportion of results to be witnessed by the CA will be at the discretion of the CA.

- The CA will •
 - examine subsequent to setting to work and regulation of the contract works the results of the • commissioning and the documentary records thereof.
 - only witness test proceedings to establish a level of confidence in the commissioning results ٠ being presented.
 - confirm recorded results
 - determine if the specified requirements have been satisfied.
 - As given in the Main Contract Preliminaries.

740.050 STATIC TESTING:

Progressive static testing shall include the following tests, but other tests may be required and witnessed:

- Insulation resistance ٠
- Earth fault loop impedance ٠
- Earth continuity
- Pressure testing of hydraulic systems

A64 / 43

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **GENERAL CONDITIONS (SELF CONTAINED SPECIFICATION)**

• Air leakage testing of ductwork systems The CA shall be given the opportunity to witness all static tests. Advance notice of the tests shall be given to the CA. Timescale:

days prior to test (no) 10

740.060 PRE-COMMISSIONING CHECKS:

Ensure all pre-commissioning examinations and tests have been undertaken and that each system, including components, or item of equipment is complete and in a safe condition prior to start-up. All necessary notices shall be displayed.

740.070 FUEL FOR TESTING:

Fuel for testing and operating the contract works shall be • As given in the Main Contract Preliminaries.

740.071 MAINTENANCE DURING COMMISSIONING AND TESTING: Where the Sub-Contractors are required to operate plant and systems during commissioning or as otherwise described in the Sub-Contract Documents, the Sub-Contractor shall be responsible for their operation and maintenance as recommended by the manufacturers and as described in current Codes of Practice. Maintenance logs must be prepared by the Sub-Contractor. Any additional costs for

740.080 SYSTEM DEMONSTRATION:

- Subsequent to the completion of all testing and commissioning to the satisfaction of the CA and when directed operate the plant and demonstrate that the overall systems function correctly in accordance with the requirements of the specification.
- Fully run and operate the following systems to demonstrate correct function in accordance with the requirements of the specification:
 - All.
- of the plant.
- Provide the following: An operational report of the demonstration

740.090 PLANT AND EQUIPMENT PERFORMANCE TESTING: Where stated elsewhere plant and equipment shall be tested at the works of the manufacturer or in a recognised and approved testing facility to demonstrate the performance complies with the stated and specified duties.

These tests shall be in addition to works tests as stated elsewhere. Performance testing shall demonstrate but not limited to the following:

- Full, partial and minimum load
- Response to load change •
- Efficiency •
- Noise levels

The tests shall be conducted to simulate design conditions and all ancillary plant and equipment needed to support the tests together with all instrumentation shall be provided and included in the contract cost.

Upon successful completion of the performance tests the plant and equipment shall be thoroughly cleaned and returned to its new condition and correctly packaged for delivery to site. Test certificate records of the tests shall be issued to the CA as stated elsewhere.

740.100 INSPECTIONS AND TESTS:

Submit schedules indicating those parts of the contract works for which inspections and tests are required to substantiate conformity with the specification. Should any alternative item be proposed that does not carry appropriate certification, ensure independent testing is carried out at no expense to the contract works to confirm compliance. Provide method statements supported by risk assessments detailing the procedures for carrying out on site tests.

Agree in advance with all parties procedures for inspections and tests including periods of notice.

A64

replacement of plant or equipment resulting from failure by the Sub-Contractor to maintain or operate the plant or equipment in the correct manner, shall be borne by the Sub-Contractor.

During this period be responsible for the recording of results and the operation and maintenance

Where a test indicates non-compliance with the specification submit immediately details of the noncompliance and details for corrective action.

Maintain records of all specified inspections and tests performed including third party and works testing.

Maintain all records on site for inspection.

740.110 TEST CERTIFICATES AND RECORDS:

- Ensure that test certificates include:
- project title •
- details and date of test
- instruments used, serial numbers, calibration dates
- signature of those witnessing test
- installers name

specific location of the item in the contract works

The number of copies of each test certificate to be issued to the CA

- (no) 4
- Time scale
- within working days of the test (no) 5

740.120 WORKS TESTING:

- All costs of such tests
- All expenses of the CA to attend inspections and witness tests at the works of the manufacturer or other location away from the site.
 - Number of persons to be included shall be (no) 2

Where required provide method statements supported by risk assessments detailing the procedures for carrying out the tests.

Notify the CA and all other parties in advance of such tests and provide for approval a programme for the visit, procedures for inspections and testing to be undertaken. Timescale:

weeks in advance of works tests (no) 4

All ancillary plant and equipment needed to support the tests together with all instrumentation shall be provided and included in the contract price.

Should the tests indicate non-compliance with the specification submit immediately details of the noncompliance and proposals for corrective action. No additional costs or extension to the programme will be allowed for re-testing or other non-compliance corrective action.

Signed certificates of tests carried out at the manufacturer's works for any items of plant shall be forwarded to the CA prior to delivery of equipment to site.

Timescale:

• within working days of the tests (no) 5

Attendance by the CA or otherwise during specified inspections or tests will not reduce the obligations or responsibilities under the contract.

Carry out all tests required by legislation.

Upon successful completion of the testing the plant and equipment shall be thoroughly cleaned and returned to new condition and correctly packaged for delivery to site.

740.140 ROTATING EQUIPMENT:

Immediately prior to practical completion adjust, ease and lubricate moving parts as necessary to ensure easy and efficient operation.

Ensure that temporary electrical supplies are provided to enable rotating plant items delivered and/or installed to be run at regular intervals to avoid damage or deterioration.

If temporary electrical supplies are not available ensure that rotating plant is hand-turned.

740.150 SYSTEM RELIABILITY TRIALS:

Upon completion of the commissioning and prior to Practical Completion a system reliability trial will commence immediately. This trial shall run continuously for a period of 14 days during which time the responsible Sub-Contractor's shall be in regular attendance to carry out temperature and other recordings of the installations performance without adjustment to the equipment of installation in any way, without the prior sanction of the Architect.

During the period of the Trial for the Services Installation the Sub-Contractor shall simulate system loads to ensure the system is checked under load.

The load shall be varied to ensure the rate of system response and the accuracy of setpoints calibration is checked for all sensors and equipment.

During the period of the trial no repairs other than that classified as normal maintenance shall be carried out. Should in the judgement of the Design Team, it become apparent that plant requires substantial repairs or adjustments, then the trail will be re-started on completion of such repairs or adjustments.

With respect to defects, the following conditions shall apply:-

Should the replacement, renewal or remedial measures necessary during the defects liability (a) period affect the efficiency or proper operation of the Works or any portion thereof, the Architect may call for further tests to be carried out to demonstrate that the installation is working satisfactorily.

If, as part of his liability for defects, the appropriate Sub-Contractor replaces or renews any (b) portion of the Works, the Defects Liability period for any such portion of the Works will be deemed to commence from the date of such replacement or renewal.

Should the appropriate Sub-Contractor fail to remedy any fault or defect within a reasonable (C) period of time of its being reported, then the Main Contractor may proceed to undertake the remedial action utilising another person or firm. In such a situation, the remedial work carried out will be at the risk and expense of the Sub-Contractor in default.

740.160 SYSTEM RELIABILITY CHECKS:

The Sub-Contractor shall attend site twice within the ensuing twelve months from Practical Completion to demonstrate to the Client the satisfactory operation of the installed system at the extremes of their operating conditions. During these test should it become apparent that the plant requires substantial adjustments to meet the specified criteria, then once these adjustments are complete the Sub-Contractor shall be required to repeat the demonstration. Temperature and other recordings of the installations performance shall be collated and bound into the Operation and Maintenance Manuals.

Should the tests fail to demonstrate that the plant and equipment are properly installed and functioning correctly, the cause of the failure shall be investigated and should this be due to incorrect or faulty work by the Sub-Contractor or his Sub-Contractor's or suppliers, then the Sub-Contractor shall without delay, carry out such remedial measures and adjustments as may be necessary and repeat the commissioning and testing procedure to the satisfaction of the Architect.

Where it is not possible at the particular time of commissioning and testing for full load conditions to be obtained or simulated, the Sub-Contractor shall repeat such operations of full load or simulation thereof at a time when this can be achieved.

For the purposes of commissioning and testing of the installation the Sub Contactor shall provide all necessary skilled and unskilled labour and all necessary instruments and testing equipment.

800.000 DRAWING DEFINITIONS

800.010 GENERAL: This section defines each of the main drawing types and outlines the extent and content of drawn information.

800.020 THE TENDER DRAWINGS:

Drawings produced to enable those tendering to interpret the design and to submit a tender for executing all or any part of the Works as defined elsewhere. The tender drawings are KJ Tait tender/billing drawings

800.030 SKETCH DRAWINGS:

Line diagrams and layouts indicating basic proposals, location of main items of plant, routes of main pipes, air ducts and cable runs in such detail as to illustrate the incorporation of the engineering services within the project as a whole.

800.040 SCHEMATIC DRAWING:

A line diagram describing the interconnection of components in a system. The main features of a schematic drawing are as follows.

- A two dimensional layout drawing with divisions to show the distribution of the system between building levels. Or an isometric style layout indicating the distribution of systems across individual floor levels. The drawing is not necessarily constructed to scale.
- Includes all functional components which make up the system, i.e. plant items, pumps, fans, valves, strainers, terminals, electrical switchgear, distribution and components.
- Symbols and line conventions in accordance with BS EN ISO 3766, BS EN ISO 7518 and BS EN ISO 11091 Recommendations for symbols and other graphic conventions.
- Label the drawing with appropriate pipe, duct and cable sizes where these are not shown elsewhere.
- Indicate components which have a sensing and control function and show the links between them, • eg. building management systems, fire alarms and HV controls.
- Identify the major components indicated on the schematic drawing so that their whereabouts in specification and on other drawings can be easily determined.
- Commissioning data include all data essential to testing and commissioning including:
 - volumetric flow rates.
 - design total pressure losses at equipment •
 - locations of dampers
 - location of valves and flow measuring stations
 - electrical fault levels
 - current ratings
 - short circuit capacities and tripping times

800.050 DETAILED DESIGN DRAWING:

A drawing showing the intended locations of plant items and service routes in such detail as to indicate the design intent. The main features of detailed design drawings should be as follows:

- Plan layouts to a scale of at least 1:100.
- Plant areas to a scale of at least 1:50 and accompanied by cross-sections.
- The drawing will not indicate the precise position of services, but it should be feasible to install the services within the general routes indicated. It should be possible to produce co-ordination drawings or installation drawings without major re-routing of the services.
- Represent pipework by single line layouts.
- Represent ductwork by either double or single line layouts as required to ensure that the routes indicated are feasible.
- Symbols and line conventions in accordance with BS EN ISO 3766, BS EN ISO 7518 and BS EN ISO 11091 Recommendations for symbols and other graphic conventions.

Indicate on the drawing the space available for major service routing in both horizontal and vertical planes.

800.060 CO-ORDINATION DRAWING:

A drawing showing the inter-relationship of two or more engineering services and their relation to the structure and building fabric. The main features of a co-ordination drawing are as follows:

Plan layouts to a scale of at least 1:50, accompanied by cross-sections to a scale of at least 1:20 • for all congested areas.

- installed at the scaled-off positions shown on the drawing. Provide dimensions in areas where tolerances are minimal.
- Make allowance for the service at its widest point for spaces between pipe and duct runs. Allow for insulation, standard fitting dimensions and joint widths on the drawing.
- Make allowance for those plant items specified by the designer and identified in the design specification.
- Make allowance for installation working space and space to facilitate commissioning and maintenance.
- Indicate positions of main fixing points and supports where they have significance to the structural design.
- Arrange the services so that it is possible to demonstrate a feasible sequence of installation.
- Support the drawing with individual services drawings for clarity.
- Plantroom layouts to a scale of at least 1:20, accompanied by cross-sections and elevations to a scale of at least 1:20.

800.070 INSTALLATION DRAWING:

A drawing based on the detailed drawing or co-ordination drawing with the primary purpose of defining that information needed by the tradesmen on site to install the works. The main features of installation drawings should be as follows:

- Plan layouts to a scale of at least 1:50, accompanied by cross-sections to a scale of at least 1:20 • for all congested areas.
- A spatially co-ordinated drawing, i.e. no physical clashes between the system components when installed at the scaled-off positions shown on the drawing.
- Make allowance for inclusion of all supports and fixings necessary to install the works.
- Make allowance for the service at its widest point for spaces between pipe and duct runs. Allow for insulation, standard fitting dimensions and joint widths on the drawing.
- Make allowance for installation details provided from shop drawings.
- Make allowance for installation working space; space to facilitate commissioning and space to allow on-going operation and maintenance in accordance with the relevant health and safety requirements.
- Make allowance for plant and equipment including those which are chosen as alternatives to the designers specified option.
- Provide dimensions where the positioning of services is considered to be important enough not to leave to the tradesmen on site.
- Plantroom layouts to a scale of at least 1:20, accompanied by cross-sections and elevations to a scale of at least 1:20

800.080 INSTALLATION WIRING DIAGRAM:

Drawing showing the interconnection of electric components, panels etc in accordance with the design intent indicated in the schematic drawings and incorporating the details provided on manufacturer's certified drawings.

and cable identification and all terminal numbers.

800.090 SHOP DRAWINGS:

Drawing prepared by a fabricator or supplier unique to the project. Including supplier's drawings for ductwork, pre-fabricated pipework, sprinkler systems, control and switchgear panels and associated internal wiring.

800.100 MANUFACTURER'S DRAWING:

Drawing provided by a manufacturer or supplier to indicate a typical representation of the product, components or plant items to be supplied for a particular project.

800.110 MANUFACTURER'S CERTIFIED DRAWING: Drawing provided by a manufacturer or supplier to indicate details of the product, components or plant items and which the manufacturer or supplier guarantees the supplied equipment will comply with.

800.120 RECORD DRAWING:

A spatially co-ordinated drawing, i.e. no physical clashes between the system components when

- Indicate the following: maximum electrical loading for each supply cable; cable termination facilities;

Drawing showing the building and services installations as installed at the date of practical completion. The main features of the record drawings should be as follows.

- Provide a record of the locations of all the systems and components installed including pumps, • fans, valves, strainers, terminals, electrical switchgear, distribution and components.
- Use a scale not less than that of the installation drawings.
- Have marked on the drawings the positions of access points for operating and maintenance • purposes.
- The drawings should not be dimensioned unless the inclusion of a dimension is considered necessary for location.

800.130 BUILDER'S WORK DRAWING:

Design stage

A drawing to show the provisions required to accommodate the services which significantly affect the design of the building structure, fabric and external works. Also drawings (and schedules) of work to be carried out by building trade, and required to be costed at the design stage eg. plant bases.

Installation stage

Drawing to show requirements for building works necessary to facilitate the installation of the engineering services (other than where it is appropriate to mark out on site).

Builder's work drawn information to be provided shall include:

- Details of all bases for plant formed in concrete, brickwork or blockwork to a scale of not less than • 1:20
- Details of all attendant builders work, holes, chases, etc for conduits, cables and trunking etc and • any item where access for a function of the installation is required to a scale of not less than 1:100
- Details of all purpose made brackets for supporting service or plant/equipment to a scale of not less than 1:50
- Details of all accesses into ceilings, ducts, etc at a scale of not less than 1:50
- Details of all special fixings, inserts, brackets, anchors, suspensions, supports etc at a scale of not less than 1:20
- Details of all sleeves, puddle flanges, access chambers at a scale not less than 1:20

800.140 CONTROLS LOGIC DIAGRAMS:

Diagrams, drawings and/or schematic details of all control components and instruments showing the layout with each item uniquely identified together with a description of the controls operation and details of the associated interlocking.

800.150 SWITCHGEAR. STARTER AND CONTROL INSTRUMENTATIONAL PANEL DRAWINGS: Drawings showing the construction and internal wiring diagrams of the starters, panels and/or other devices.

800.160 AS-INSTALLED DRAWINGS:

Drawings/records retained on site to record the progress of and any site modifications to the Works including any changes to software.

800.170 PLANTROOM SCHEDULES AND SCHEMATICS:

Provide good quality plant and switch room drawings, schedules, schematics and instructions and hang in the respective plant room or any other appropriate location or where directed by the CA. Protect surfaces of such information by

pressure lamination •

 Framing under glass or other rigid, transparent, cleanable and protective surface Hang using suitable fixings and provide backboards if necessary

A sample shall be submitted for approval to the CA prior to commencing production.

- Schematic drawings of circuit layouts showing:
- Location, identification and duties of equipment
- Location of controls devices
- Circuit layout
- Valve schedules in the form of printed sheets showing the number, type, location, application/service and symbol, and normal operating position of each valve.
- Control schematics.

- First aid instructions for treatment of persons after electric shock.
- Location of isolating switch for electricity supply. • •
- Location of main incoming gas valve serving gas meter and isolation point. Location of main incoming water main and isolation point.
- Location of sprinkler fire main control valve.
- applicable to any system or item of plant and equipment. All other items required under Statutory or other regulations.
- 810.000 RECORD DOCUMENTATION

810.010 STANDARDS:

Provide operating and maintenance manuals, system records and full documentation in accordance with the following standards

- BS 7671 Requirements for electrical installations. (IEE Wiring regulations)
- BS EN 12170 Heating Systems with a trained operator
- BS EN 12171 Heating Systems not requiring a trained operator
- As given in the Main Contract Preliminaries.
- Comply with the requirements of the CDM Regulations in providing the appropriate input to the health and safety file for the contract works.

810.020 RECORD DOCUMENTS:

Provide:

- Record drawings and schedules. •
- Plant room and switch room drawings, schedules and schematics.
- Operating and maintenance manuals. ٠
- Blank maintenance logs. •
- Log books
 - in accordance with CIBSE TM 31.
- in compliance with the Building Regulations Part J. Ensure record documents clearly record the arrangements of the various sections of the Works as •
- actually installed and identify and locate all component parts. Ensure record documents make it possible to comprehend the extent and purpose of the Works
- and the method of operation thereof.
- how, in detail, it should be executed.
- spares and replacements to be ordered.
- Correlate record documents so that the terminology and the references used are consistent with those used in the physical identification of the component parts of the installations.
- Demonstrate as required throughout the execution of the contract works that complete and accurate records are being maintained and that the record documents are being progressively compiled as the work on site proceeds.

810.030 RECORD DRAWINGS AND SCHEDULES:

- Prepare record drawings and schedules based on the As Installed Drawings maintained on site during the progress of the contract works.
- The scale of the drawings shall be not less than 1:50.
- Each record drawing shall show the following information:

 - Description of drawing, drawing reference and scale. ٠
 - Name and address of the installer and the consultant. ٠
 - As given in the Main Contract Preliminaries.
- Endorse all such documents • 'Record drawings'
- Where agreed with the CA certain detailed information may be provided in schedule form.

Emergency operating procedures and telephone numbers for emergency call out service

Ensure record documents set out the extent to which maintenance and servicing is required and

Ensure record documents provide sufficient, readily accessible and proper information to enable

• The name of the contract and, where appropriate, the zone or floor designation.

- Where portions of the work are to be concealed, draft copies of record drawings shall be supplied • to the CA before the work is concealed in order to facilitate checking and examination.
- Prepare electrical drawings in accordance with BS EN 61082.
- Issue at practical completion the complete approved package of record drawings in the following numbers and format:
 - CAD format on CD disk. Each CD shall be labelled and the CD jewel cases shall be labelled ٠ identifying project title, issue date and index of contents.
 - Number of sets of complete record drawings (no) 4
 - 'White' prints.
 - Number of sets of complete record drawings (no) 4
- Provide reduced scale copies for inclusion in the operating and maintenance manuals as stated • elsewhere.

Record drawings and schedules must include, but are not limited to:

- Location, including level if buried, of utility service connections, including those provided by the appropriate Authority, indicating points of origin and termination, size and material of service, emergency shut-off isolation locations, pressure and/or other relevant information.
- Disposition and depth of all underground systems.
- Schematic drawings of each system indicating principal items of plant, equipment, zoning, means of isolation, etc. in sufficient detail to make it possible to comprehend the system operation and the inter-connections between various systems.
- Details of the principles of application of automatic controls and instrumentation.
- Diagrammatic dimensioned plans and sections of each system or service showing sizes and locations of all ancillaries, plant, equipment controls, test points, and means of isolation etc. including any items forming an integral part of the engineering systems provided by others (such as plenum ceilings, builders' work shafts, chimneys etc.).
- Identification of all terminals/cables etc. by size/type and duty/rating as recorded from the approved commissioning results.
- Detailed wiring drawings/diagrams/schedules for all systems, including controls, showing origin, route, cable/conduit size, type, number of conductors, length, termination size and identification, and measured conductor and earth continuity resistance of each circuit. Ensure routes indicate if cable/conduit is surface mounted, concealed in wall chase, in floor screed, cast in-situ, above false ceiling etc.
- Details of co-ordination of wiring and connections with cable core identification, notation of fire alarm, security, control and instrumentation and similar systems provided as part of the Works.
- Details to show inter-connections between the Works and equipment or systems provided by others to which wiring and connections are carried out as part of the Works.
- Location and identity of each room or space housing plant, machinery or apparatus.
- Dimensioned plans and sections of plantrooms, service subways, trenches, ducts and other congested areas where in the opinion of the CA smaller scale drawings cannot provide an adequate record. Indicate the location, identity, size and details of each piece of apparatus. The scale of drawings to be 1:20
- Manufacturer's drawings of equipment indicating
 - general arrangement and assembly of component parts which may require servicing.
 - internal wiring diagrams together with sufficient physical arrangement details to locate and identify component parts.
- Schedules as required to locate, reference and provide details of ratings and duty of all items incorporated into the Works together with all fixed and variable equipment settings established during commissioning.
- For each programmable control item
 - schedules indicating for each input and output point connected
 - full data in respect of that point including reference
 - type of input/output
 - connected equipment reference
 - set values of temperature or pressure etc
 - set values of start/stop/speed change times etc
 - alarm priority
 - control specification reference
 - any other such applicable parameters

- Each spare input and output point including reference, type of input/output and space for future entry of appropriate parameters as listed above.
- Logic flow diagrams for each individual control or monitoring specification and for each building services engineering system to illustrate the logical basis of the software design.
- alarm messages etc.
- As given in the Main Contract Preliminaries.

810.040 PLANT ROOM AND SWITCH ROOM DRAWINGS. SCHEDULES AND SCHEMATICS: Provide good quality plant and switch room drawings, schedules, schematics and instructions and hang in the respective plant room or any other appropriate location or where directed by the CA.

- Protect surfaces of such information by
 - Pressure lamination
- Framing under glass or other rigid, transparent, cleanable and protective surface
- Hang using suitable fixings and provide backboards if necessary
- A sample shall be submitted for approval to the CA prior to commencing production.
- Schematic drawings of circuit layouts showing: •
- Location, identification and duties of equipment
- Location of controls devices •
- Circuit lavout
- Valve schedules in the form of printed sheets showing the number, type, location, application/service and symbol, and normal operating position of each valve.
- Control schematics.
- Location of mechanical and electrical plant and equipment items.
- First aid instructions for treatment of persons after electric shock. •
- Location of isolating switch for electricity supply. •
- Location of main incoming gas valve serving gas meter and isolation point. •
- Location of main incoming water main and isolation point.
- Location of sprinkler fire main control valve. •
- Emergency operating procedures and telephone numbers for emergency call out service applicable to any system or item of plant and equipment.
- Location of metering facilities.
- All other items required under Statutory or other regulations.
- Prepare electrical drawings in accordance with BS EN 61082.
- As given in the Main Contract Preliminaries.

810.050 OPERATING AND MAINTENANCE MANUAL SPECIALIST:

- Employ a specialist to prepare the operating and maintenance manuals. Submit details of the proposed specialist to the CA for approval

810.060 PRESENTATION OF THE OPERATING AND MAINTENANCE MANUALS:

- Agree format and contents with the CA.
- Provide the operating and maintenance manuals in the following form: •
 - each indexed, divided and appropriately cover- titled. Fold drawings larger than A4 and include in the binder so that they may be unfolded without being detached from the rings.
 - Electronic format stored on DVD
- Provide copies of the operating and maintenance manual as follows: •
 - Draft copies for comment (no) 2
 - Final copies for Client use (no) 4
- Provide a draft copy of the operating and maintenance manual to the CA for comment • Timescale:
- Weeks before the contract completion date (no) 12
- The draft copy of the manual shall conform to the final format required by the specification to enable all relevant comments to be made by the CA.
- As given in the Main Contract Preliminaries.

810.070 OPERATING AND MAINTENANCE MANUALS:

Schedules setting out details of all initial values of user-defined variables, text statements for

• Encase the manuals in A4 size, plastic-covered, loose leaf, four ring binders with hard covers,

The operating and maintenance manuals must include:

- A full description of each of the systems installed, written to ensure that the Employer's staff fully understand the scope and facilities provided.
- A description of the mode of operation of all systems including services capacity and restrictions.
- Diagrammatic drawings of each system indicating principal items of plant, equipment, valves etc.
- A photo-reduction of all record drawings together with an index. Reduced size of drawings to be A3 and A1 as per working drawings.
- Legend of all colour-coded services.
- Schedules (system by system) of plant, equipment, valves, etc., stating their locations, duties and performance figures. Each item must have a unique number cross-referenced to the record and diagrammatic drawings and schedules.
- The name, address and telephone number of the manufacturer of every item of plant and equipment together with catalogue list numbers.
- Manufacturer's technical literature for all items of plant and equipment, assembled specifically for the project, excluding irrelevant matter and including detailed drawings, electrical circuit details and operating and maintenance instructions.
- A copy of all test certificates, inspection and test Records, commissioning and performance test records including, but not limited to, electrical circuit tests, corrosion tests, type tests, start and commissioning tests, for the installations and plant, equipment, valves, etc., used in the installations.
- A copy of all manufacturer's guarantees or warranties, together with maintenance agreements • offered by subcontractors and manufacturer's.
- Copies of insurance and inspecting Authority certificates and reports.
- Starting up, operating and shutting down instructions for all equipment and systems installed.
- Control sequences for all systems installed.
- Schedules of all fixed and variable equipment settings established during commissioning.
- Procedures for seasonal change-overs and/or precautions necessary for the care of apparatus subject to seasonal disuse.
- Detailed recommendations for the preventative maintenance frequency and procedures which should be adopted by the Employer to ensure the most efficient operation of the systems.
- Details of lubrication for lubricated items including schedules of lubricant type, frequency, etc.
- Details of regular tests to be carried out (e.g. water analysis for pseudonomas.)
- Details of procedures to maintain plant in safe working conditions.
- Details of the disposal requirements for all items in the works.
- A list of normal consumable items.
- A list of recommended spares to be kept in stock by the Employer, being those items subject to wear or deterioration and which may involve the Employer in extended deliveries when replacements are required at some future date.
- A list of any special tools needed for maintenance cross-referenced to the particular item for which required.
- Procedures for fault finding.
- Emergency procedures, including telephone numbers for emergency services.
- Hospital Operational Policy.
- Back-up copies of any system software.
- Documentation of the procedures for updating and/or modifying software operating systems and control programmes.
- Instructions for the creation of control procedure routines and graphic diagrams.
- Details of the software revision for all programs provided.
- Two back-up copies of all software items, as commissioned.
- Copies of relevant HSE/CIBSE/IEE Guidance notes etc.
- Contractual and legal information including but not limited to
 - details of local and public authority consents
- details of design team, consultants, installation contractors and associated subcontractors
- start date for installation, date of practical completion and expiry date for the defects liability period
- details of warranties for plant and systems including expiry dates, addresses and telephone numbers.
- As given in the Main Contract Preliminaries.

810.080 PROVISION OF INFORMATION:

- Co-operate with the specialist firm in the compilation of the manuals and provide them with copies of the following:
 - etc.
 - Record drawings, together with an index.
 - Plant room and switch room drawings, schedules and schematics, together with an index.
 - Legend for all colour-coded services.
 - the building, duties and performance figures.
 - All Test Certificates, Inspection and Test Records, Commissioning and Performance Test installations.
 - All manufacturer's guarantees or warranties.
 - Copies of insurance and inspecting Authority certificates and reports.
- Back-up copies of any system software. ٠
- Two back-up copies of all software items, as commissioned.
- As given in the Main Contract Preliminaries.

900.000 COMPLETION AND HANDOVER

900.010 GENERAL:

This section details the requirements and procedures for completion and handover.

900.020 HANDOVER REQUIREMENTS:

As a pre-requisite to Practical Completion in respect of the contract works or part thereof, demonstrate to the satisfaction of the CA that:

- All the contract works are complete.
 - With the exception of minor snags or limited defects as agreed with the CA that could be reasonably completed within an agreed programme without causing disruption to the Employer's use of the building or part thereof.
- All spares, keys, tools and other consumables as stated elsewhere have been supplied and handed over to the Employer.
- The instruction of the Employer's staff in the use and correct operation of the installation has been completed satisfactorily. In particular, safety devices and controls demonstration.
- All commissioning and testing completed
- A complete demonstration of the contract works with fully functional operational controls tested
- has been undertaken in the presence and to the satisfaction of the CA.
- All necessary certification by the Employer's insurers has been completed. All approved record documentation including record drawings, operation and maintenance manuals, etc is issued
- All information required for the health and safety file is issued to the satisfaction of the Planning Supervisor.
- All necessary Statutory Authority approvals have been undertaken and written confirmation • established
- Completion and issue of log books in accordance with Building Regulations.
- As given in the Main Contract Preliminaries.

900.030 READING OF METERS: Record readings of all water, gas, and electricity meters immediately on completion of the Works and forward to the CA.

900.040 RECOMMENDED SPARE PARTS:

Diagrammatic drawings of each system indicating principal items of plant, equipment, valves

Schedules (system by system) of plant, equipment, valves etc, stating their locations within

Records (including, but not limited to, electrical circuit tests, corrosion tests, type tests, start and commissioning tests) for the installations and plant, equipment, valves, etc., used in the

Schedules of all fixed and variable equipment settings established during commissioning.

including the issue of a final commissioning report signed by an approved competent person

in accordance with CIBSE TM31 Building Log Book Toolkit (standard templates)

Before Practical Completion submit to the CA a schedule of spare parts as stated elsewhere and recommend any that should be obtained and kept in stock by the Employer for maintenance of the installations included in the Works.

Time scale

weeks before (no) 12

As given in the Main Contract Preliminaries.

State against each item the manufacturer's current price, including packaging and delivery to site. Identify those items that are additional to those specified for inclusion as stated elsewhere.

900.050 INITIAL SUPPLY OF ADDITIONAL SPARE PARTS:

Submit to the CA a quotation, priced in detail, for the initial supply to the Employer of the additional spare parts identified elsewhere and including for:

- Checking that each spare part is suitable for the replacement of the corresponding part supplied with the item of plant or equipment.
- Checking receipt, marking and numbering in accordance with the schedule of spare parts. •
- Referencing to the plant and equipment list in the operation and maintenance manual.
- Painting, greasing, etc. and packing to prevent deterioration during storage.
- Time scale •
 - within weeks of request (no) 4
 - As given in the Main Contract Preliminaries.

900.060 RECOMMENDED TOOLS:

Prior to Practical Completion submit to the CA a schedule of tools and portable instruments as stated elsewhere and recommend any that should be obtained and kept in stock by the Employer for maintenance of the installations included in the Works.

Time scale

- weeks before Practical Completion (no) 12
- As given in the Main Contract Preliminaries.
- State against each item the manufacturer's current price, including packaging and delivery to site. Identify those items that are additional to those specified for inclusion as stated elsewhere.
- Submit to the CA a quotation, priced in detail, for the initial supply to the Employer of the additional tools identified under the clause headed 'recommended tools'.
 - Include for the following.
 - Checking that each item is suitable for the intended application.
 - Checking receipt, marking and identifying.
 - Referencing, where appropriate, to the plant and equipment list in the Operation and Maintenance Manual.
 - Protecting, greasing, etc. and packing to prevent deterioration.
 - Providing a suitable means of storing and securing same.
- Time scale
 - Within number of weeks of request 4
 - As given in the Main Contract Preliminaries.

900.070 SUPPLY OF TOOLS:

Provide all tools, keys and portable instruments as detailed elsewhere prior to practical completion and additional items if so instructed by the CA. Time scale

Weeks before Practical Completion (no) 4

900.080 INSPECTION BY EMPLOYER'S INSURERS:

Where indicated elsewhere installations, equipment, plant or materials are to be inspected by a representative acting for the Employer's insurers.

The installations, equipment, plant or materials shall satisfy the insurance company's requirements in all respects.

- Inform the CA when the installation or equipment is ready for examination •
- Provide a programme for the inspection and certification by the Employer's insurers.
- All necessary information shall be provided to enable the insurers to approve the design before manufacture.

- Arrange for the attendance of the insurance company's representative at agreed stages of manufacturer and installation.
- All necessary attendance, access and facilities for inspecting and testing as is required shall be provided.
- Certification shall have been received from the insurers before equipment or installations subject to inspection and certification will be accepted on behalf of the Employer.
- The order with the insurance company
 - will be placed by the Employer
- As given in the Main Contract Preliminaries.
- All insurance company charges will be
 - paid for by the employer
 - As given in the Main Contract Preliminaries.

900.090 TRAINING OF EMPLOYER'S STAFF:

Prior to Practical Completion explain and demonstrate the purpose, function and operation of the installations including all items and procedures listed in the operation and maintenance manual

- to the Employer's maintenance staff.
- to the operational staff. •

 As given in the Main Contract Preliminaries. Submit to the CA for approval a detailed programme for the training of the Employer's staff. Time scale

- Weeks before commencement of training (no) 4
- Employ the services of relevant specialists and suppliers for the purpose of training and • instruction.
- Provide each person with a comprehensive set of teaching notes and diagrams.
- instruction.
- All costs associated with the instruction of the Employer's personnel and required attendance following practical completion shall be included in the contract price.
- assist the Employer's personnel in the operation of the various systems together with the
 - controls specialist
 - commissioning specialist •

As given in the Main Contract Preliminaries. Training

- Number of persons to be included for training is 4.
- safe day to day running and maintenance of all systems, plant and equipment. • 5
- Carry out initial training at the works of the controls supplier.
- •
- Include instruction on the procedures for testing and routine inspection of sensors and • required.
- Provide all appropriate reference and training manuals.
- Complete initial instruction prior to commissioning of the installed system.
- Provide site instruction on the installed system.
- Include for training operating staff (no) 4
- the safe day to day running and maintenance of all systems, plant and equipment.
- 5
- As given in the Main Contract Preliminaries.

910.000 MAINTENANCE

910.020 PROPOSALS FOR ANNUAL MAINTENANCE CONTRACT:

A64

GENERAL CONDITIONS (SELF CONTAINED SPECIFICATION)

Be responsible for the correct operation and maintenance of the installation during such periods of

Following practical completion and occupation be available for a period as agreed with the CA to

Include for not less than indicated number of operating days for this purpose and demonstrate the

Provide training for the operation of the controls, monitoring or BMS installations as follows.

Include hands on experience of equipment and software similar to the installation.

actuators to enable the operator to assess the nature of faults and extent of remedial action

Include for not less than indicated number of operating days for this purpose and demonstrate

A64

N20 SPECIAL PURPOSE FIXTURES, FURNISHINGS AND EQUIPMENT

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES Provide equipment as detailed in the equipment schedules.

100.030 SYSTEM DESCRIPTION

Equipment listed within the equipment schedules shall be supplied by the contractor for inclusion within the mechanical services systems.

The following equipment shall be supplied as part of the contract:-

•Fume Cupboards.

- Microbiological Safety Cabinets
- •Extract Canopies
- Autoclaves
- •Glass washers
- Standalone Ducted Solvent Cabinets
- •Flexible Extract Arms

Before the contractor makes his final selection he shall make a technical presentation to the MRC, MRC H&S and the Design Team. Factory witness testing of the selected fume cupboard and microbiological safety cabinets shall be included within the contract. Prior to the technical presentation the manufacturers shall forward the following information for the engineers to check conformity with the design:-

- All BS & EU equipment testing results and certificates.
- Detailed acoustic data with sashes opened and closed.
- Air flow and pressure drop information.
- Unit drawings including the integral flow damper.

FUME CUPBOARDS

The basis of design fume cupboard has been listed in the equipment schedules, however this does not preclude the contractor from offering to the client and design team equipment which in his opinion will equal. The fume cupboards shall come complete with the following:-

•Frame to be constructed of fully weld box section steel, powder coat painted to an approved colour. •Epoxy resin liner complete with scaffold supports (to be confirmed by MRC).

- •Ceramic work surface (to be confirmed by MRC).
- •Electrical junction box with RCD.
- •Light fittings and on-off switch.
- •Visible flow indication damper at the top of the unit Service connections as detailed in the schedules. •Broan gas taps.
- •MK Logic Plus socket outlets.
- •Vulcathene or Giberit HDPE (to suit system VE M009) drip cups and traps. •Full width ventilated solvent cupboards complete with intumescent door seals and ductwork connections.
- •Infill panels above the FC to the ceiling line.
- •Digital airflow monitor and control panel with interface to the BMS as required. •On completion of the fume cupboard exhaust systems the contractor shall employ a specialist
- laboratory testing contractor Crowthorne Hi-Tec Services to carry out full compliance testing.

- Submit within one week of request a supplementary proposal for an annual maintenance contract • for the following:
- All systems.
- The proposal should include for
 - Planned preventative maintenance to maintain the installations in efficient working order including routine checks, adjustments, lubrication and replacement of consumable spares, etc
 - Preparation of work schedules and recording activities
 - Providing breakdown and emergency cover ٠
 - Planning and undertaking shut-downs for maintenance works ٠
 - Employing of all necessary specialist maintenance •
 - Attendance on and supervision of specialist maintenance ٠
 - Carrying out all necessary safety checks ٠
 - Carrying out system proving of the works to include the measuring, recording, evaluating and reporting on the seasonal performance of the systems against their design values
 - Water sampling including laboratory analysis and monitoring of heating, chilled, domestic ٠ water systems
 - Liaison with the employer
 - As given in the Main Contract Preliminaries.

The proposal should set out the terms of the offer, the work to be carried out, the guarantees of performance and the price of the first 12 months after Practical Completion of the contract works or section thereof.

The proposal will not necessarily be considered as part of the tender for the contract works and the Employer does not undertake to accept it.

N20

MICROBIOLOGICAL SAFETY CABINETS

The basis of design MSC's has been listed in the equipment schedules, however this does not preclude the contractor from offering to the client and design team equipment which in his opinion will equal.- The MSC's shall come complete with the following:-

- •Frame to be constructed of fully weld box section steel, powder coat painted to an approved colour.
- Stainless steel work surface.
- •Integral visible flow indication damper at the top of the unit
- •Electrical junction box with RCD.
- •Light fittings and on-off switch.
- •Service connections as detailed in the schedules.
- •Broan gas taps.
- •MK Logic Plus socket outlets.
- •HEPA Filter 99.997% @ 0.3 micron
- •Infill panels above the MRC's to the ceiling line.
- •Digital airflow monitor and control panel with interface to the BMS as required.
- •On completion of the fume cupboard exhaust systems the contractor shall employ a specialist
- laboratory testing contractor Crowthorne Hi-Tec Services to carry out full compliance testing.

AUTOCLAVES

The equipment schedules provide three steam or electric powered autoclaves for selection. The autoclaves shall come complete with the following:-

- •Autoclaves and pressure vessels to be fully CE marked and PED approved.
- •Stainless steel steam control valve as required.
- •Microprocessor control system.
- •Fully interlocked door safety system, including a thermal safety lock.
- •Low water level safety system.
- Vacuum assisted cooling.
- •Automatic timed free steaming.
- •Air intake filter system.
- •Stainless steel shelves
- •Stainless steel mesh baskets + additional set for each autoclave.
- •Stainless steel loading trolley for each autoclave.

The autoclaves shall be fully commissioned by the manufacturer after installation.

GLASS WASHERS

The equipment schedules provide three steam or electric powered glass washers for selection. The glass washers shall come complete with the following:-

- •Glass washers and pressure vessels to be fully CE marked and PED approved.
- •Stainless steel steam control valve as required.
- •Microprocessor control system.
- •Fully interlocked door safety system, including a thermal safety lock.
- •Low water level safety system.
- •Filtered hot air drying system.
- •Break tank sized to accommodate a single fill cycle.
- •Stainless steel shelves
- •Stainless steel mesh baskets + additional set for each autoclave.
- •Stainless steel loading trolley for each autoclave.

Solvent storage cabinets, extract canopies and flexible extract arms shall be as scheduled.

100.040 CONTROL REQUIREMENTS

100.050 SYSTEM SCHEMATICS Refer to RMF - KJ Tait Engineers drawings 2053-Z-(59) 701, 702, 703 & 710

100.060 SYSTEM DRAWINGS

PART 3 CLAUSES SPECIFIC TO N20

300.000 PRODUCTS/MATERIALS

300.010 HOSPITAL EQUIPMENT SCHEDULES:

- Supply Hospital equipment as schedule refere Location
 - At end of this work section.

300.020 EQUIPMENT:

- Type
- Application
- Manufacturer and reference
- Or approved equivalent Equipment description

310.000 WORKMANSHIP

310.010 INSTALLATION:

Install hospital equipment in accordance with manufacturer's recommendations.

R10

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **RAINWATER PIPEWORK/GUTTERS**

R10 RAINWATER PIPEWORK/GUTTERS

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES

The Rainwater system shall drain all Roofs and shall facilitate the removal of rainwater from the roof area through the building to below ground drainage outlets provided by others.

100.020 DESIGN PARAMETERS

The design of the systems shall be in accordance with BS EN 12056-3:2000 Gravity drainage systems inside buildings Part 3:

100.030 SYSTEM DESCRIPTION

Rainwater drainage will be provided to remove rainwater from roofs and terraced areas, to prevent ponding and damage to the building from water ingress. The rainwater falling on the roofs, terraces and balconies will be collected and removed by a system of rainwater outlets, gutters and drainage pipework.

Surface water will be transferred down through the laboratory building by means of vertical drainage pipes located throughout the building and. A majority of this drainage system will discharge by gravity to the rainwater harvest system in the basement east tunnel with any overflow discharging to the local stormwater sewer. Rainwater drainage that cannot drain to the harvest system without penetrating the basement tunnel system will be discharged to site gravity drainage. Rainwater harvesting omitted

Roof drainage outlets and vertical drainage pipes require careful coordination with the interstitial ceiling void. Horizontal drainage runs within the ceiling void must be routed along either the exterior or atrium side walls to avoid conflicts with other services in the interstitial.

All areas as described above that are exposed to rainfall will be laid to falls allowing precipitation to flow easily to the gutters/rainwater outlets located at low points.

All rainwater outlets and drainage channels will be supplied by the mechanical contractor and fitted by the roofing contractor for connection by the mechanical contractor.

All horizontal and vertical rainwater pipework shall be insulated against condensation and noise by 25mm vapour sealed insulation.

Energy Centre roof drainage will be served by horizontal gutters or roof/overflow drains. All rainwater will connect to site stormwater drainage.

Contractors shall take due cognisance of the specification clause 520.030 Design Responsibilities.

Under the above clause the pipework and ductwork support system is a contractor's design responsibility, therefore the 2053-Z-(59)-500 series drawings shall be used as generic design intent drawings. VE M 006.

Please refer to Appendix A for the Preferred Manufacturers List and Appendix B for the Pipework Specification

100.050 SYSTEM SCHEMATICS Refer to RMF - KJ Tait drawings 2053 Z 408, 409 & 411

100.060 SYSTEM DRAWINGS Refer to RMF - KJ Tait drawings 2053 Z (53) Series for notional routes within the buildings.

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

KJ TAIT ENGINEERS

210.010 GENERAL:

Comply with work section general clauses reference Y10.1000 and those detailed below. • Supply pipes and fittings as specified in work section R10 Supply pipes and fittings as schedule reference Refer to the pipework schedule

210.015 SANITARY FITTINGS:

Comply with work section general clauses reference Y10.1000 and those detailed below.

Supply pipes and fittings as specified in work section R10

210.020 STEEL PIPES AND FITTINGS:

- Application Rainwater •
- Stainless steel push-fit fittings reference Y10.2257 •
- Compression couplings to BS EN ISO 8434-1
- Stainless steel reference Y10.2215B
- Austenitic stainless steel to BS 3605
 - Reference Y10.2250A
 - Reference Y10.2250#
- Stainless steel, grooved for mechanical joints
 - Reference Y10.2255A
- Reference Y10.2255#
- Special materials
- Stainless steel to BS EN 10312 reference Y10.2220

210.040 CAST/DUCTILE IRON PIPES AND FITTINGS:

- Application Rainwater •
- Manufacturer Saint Gobain Ensign •
- Or approved equivalent • Cast iron pipes and fittings to BS EN 877
 - Red epoxy finish reference Y10.2390A
 - Grey epoxy finish reference Y10.2390B •
 - Reference Y10.2390#
- Jointing materials
 - Couplings for cast iron pipes to BS EN 877
 - Stainless steel reference Y10.3105A
 - Red ductile iron reference Y10.3105B
 - Grey ductile iron reference Y10.3105C

210.080 GENERAL WORKMANSHIP

- Appearance reference Y10.4010 •
- Spacing reference Y10.4020 •
- Gradients reference Y10.4030 •
- Expansion and contraction reference Y10.4060
- Acoustic insulation of pipework reference Y10.4105Z
- Pipes through walls and floors reference Y10.4110 •
- Pipe sleeves •
 - Reference Y10.4120A
 - Insulation carried through reference Y10.4120B
- Pipe sleeves through fire barriers reference Y10.4125 All pipework greater than 40mm diameter penetrating fire barrier shall incorporate a fire collar.Firesleeves

Firesleeves shall comply with BS 476 : Part 20 : 1987 to give a 2 Hour fire protection period. Abesco Firesleeves or approved equivalent shall be fitted on MUPVC, UPVC, Vulcathene and Polypropylene pipes passing through walls and floors between Fire Zones. Pipes passing through walls shall be fitted with Abesco type FBC firesleeve. The Contractor should note that Filler Rings must be fitted. Pipes passing through floors shall be fitted with Abesco type FBC firesleeve. The Contractor should note that Filler Rings must be fitted.

R10

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **RAINWATER PIPEWORK/GUTTERS**

Reference Y50.3230A

- Liquid vapour barriers reference Y50.3260
- Integrity of vapour barriers reference Y50.3270

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below.

251.030 STATIC TESTING:

- Application Rainwater
- Pressure testing •
 - General reference Y51.2010
 - Soil, waste, ventilation, anti-syphon and rainwater pipework reference Y51.2080
- Vacuum testing reference Y51.2100
- Testing records reference Y51.2110
 - Distribution As A64

251.050 PERFORMANCE TESTING:

- Application Rainwater •
- System performance testing reference Y51.4010
- Environmental tests
 - Artificial loads reference Y51.4020A
- Testing to specified conditions
- Rainwater Systems reference Y51.4040A
- Performance test records - reference Y51.4050
 - Distribution As A64

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL: Comply with work section general clauses reference Y54.1000 and those detailed below.

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL: Comply with work section general clauses reference Y90.1000 and those detailed below.

290.020 FIXINGS:

- Shot fired fixings reference Y90.2050
- Proprietary channel inserts reference Y90.2070

290.030 WORKMANSHIP:

- Drilling reference Y90.3010
- Proprietary fixings reference Y90.3020
- Fixing to reinforced concrete reference Y90.3030 •
- Fixing to timber rails reference Y90.3050 •
- Fixing to hollow stud/tile/block wall Reference Y90.3060A
- Fixing to concrete, brickwork or blockwork
- Reference Y90.3070A
- Fixing to metalwork Reference Y90.3080A
 - Fixing to structural steelwork and concrete structures
 - Reference Y90.3090A

Where the inside diameter of the Firesleeve is larger than the outside diameter of pipe, Abesco Interdens Paste or equal and approved shall be used to fill the space the full length of the Firesleeve

- Connections to equipment reference Y10.4130
- Temporary plugs, caps and flanges
- Reference Y10.4150A.
- Pipe supports reference Y10.4210
- Support spacing reference Y10.4220
- Isolation and regulation
- Reference Y10.4230A
- Maintenance and renewal reference Y10.4240
- Cleaning reference Y10.4250
- Non-ferrous components reference Y10.4260

210.120 WORKMANSHIP, PLASTICS PIPES:

- Application Gravity Rainwater
- Solvent welded joints, PVC reference Y10.8010
- -Fusion joints, PE reference Y10.8020 Anchors, PVC reference Y10.8040

250.000 THERMAL INSULATION

250.010 GENERAL:

Comply with work section general clauses reference Y50.1000 and those detailed below.

250.020 INSTALLER SELECTION:

- Use a contractor specialising in the supply and installation of thermal insulation.
- Use thermal insulation materials supplied by a manufacturer assessed and registered in • accordance with BS ISO 9000-2.

250.030 MINERAL FIBRE THERMAL INSULATION - PIPEWORK:

- Application Rainwater •
- European Classification for Reaction to Fire Performance
- Class A1 reference Y50.1035A
- CFC's and HCFC's reference Y50.1040Z
- Spread of flame as BS 476-7
- Reference Y50.1050A
- Smoke emission characteristics
- Reference Y50.1055A
- Inspection and testing reference Y50.1090
- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy •
- For plant design life reference Y50.2015A
- Restrictions on use of materials reference Y50.2020
- Mineral fibre pipe insulation
- Foil faced reference Y50.2030A
- Vapour barrier permeance
 - Reference Y50.2170A
- Adhesives reference Y50.2190
- Protection
 - Laminated foil/film reference Y50.2200J
- Thickness table
 - Insulation thickness calculation methods reference Y50.2285

250.090 WORKMANSHIP PIPEWORK INSULATION:

- General reference Y50.3010
- Installation of foil faced mineral wool insulation reference Y50.3020
- Installation where insulation is carried through pipeline support

Comply with work section general clauses reference Y91.1000 and those detailed below.

291.000 OFF-SITE PAINTING AND ANTI-CORROSION TREATMENT

291.010 GENERAL

291.020 PAINT MATERIALS:

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **RAINWATER PIPEWORK/GUTTERS**

fabric. Ensure any specific painting of surfaces which will be concealed or otherwise inaccessible, is completed.

310.030 GUTTERS:

Set out to a true line and even gradient to ensure no ponding or backfall. Position high points of gutters as close as practical to roof and low points not more than 50mm below roof. Position outlets to align with connections to below ground drainage, unless otherwise indicated on drawings.

Overlap joints in direction of fall and seal as specified to make watertight. Ensure that roofing underlay is dressed into gutter.

310.040 GUTTER BRACKETS:

Fix securely at specified centres and at all joints in gutters, with additional brackets near angles and outlets.

310.050 SEALING JOINTS IN GUTTERS:

Spread jointing compound evenly over surface of socket. Tighten fixings to squeeze out some compound, but do not over-compress. Remove surplus squeezed out compound and neatly clean off.

310.060 RAINWATER HEADS AND OUTLET PIPES FROM GUTTERS: Fix suitable domical cages.

310.070 CONNECTION TO EXISTING GUTTERS: Provide and fix all necessary and proper fittings for the purpose of connecting to existing gutters. Make good and leave the work in a watertight condition.

310.080 GUTTER TEST: Block all outlets, fill gutters to overflow level and closely inspect for leakage.

310.090 STORAGE - PIPES, GUTTERS AND FITTINGS: Store pipes, gutters and fittings under cover and clear of the ground.

310.100 STACKING PIPES AND GUTTERS: Stack pipes and gutters on level surface. Do not rest pipes on their sockets. Securely stake end pipes in bottom row to prevent collapse of stack. Comply with manufacturer's recommendations.

310.110 STORAGE - ELASTOMERIC JOINTING RINGS: Store elastomeric jointing rings in their delivery bags or protective containers. Do not expose to sunlight.

310.120 MAKING GOOD: Make good damage to coatings or recoat.

310.130 ACCESS POINTS: Provide rodding and access points at all changes of direction to enable whole system to be maintained.

Provide square door type access points as indicated on drawings at foot of all rainwater stacks. Fit covers, caps, etc. as work proceeds to prevent ingress of dirt and building materials.

310.140 RAINWATER OUTLETS: Fix a grating or cage to restrict entry of solids to system.

310.150 ROOF AND BALCONY OUTLETS: Ensure that outlets are securely fixed before connecting pipework. Ensure junctions between outlets and pipework can accommodate all movement in roof decking and pipework.

310.160 FOOT OF PIPE STACKS: Fix cast iron rest bends supported on brick-work or concrete bases where indicated on drawings.

KJ TAIT ENGINEERS

Paint materials Reference Y91.2010A Paint quality - reference Y91.2020 291.030 WORKMANSHIP General - reference Y91.3010 Weather and other conditions - reference Y91.3020 • Cleaning and preparing for painting Steel surfaces - reference Y91.3030A Surfaces - reference Y91.3030B Application off-site - reference Y91.3040 Application - reference Y91.3050 Cold galvanizing - reference Y91.3060 **PART 3 SPECIFICATION CLAUSES SPECIFIC TO R10** 300.000 PRODUCTS/MATERIALS 300.090 ROOF OUTLETS: Application Rainwater Material Plastic. Gratings Flat. 300.120 DOMICAL GRATING: Material • Plastic, removable. 300.140 COPPER ALLOY OVAL ACCESS COVERS: Inner face of cover to conform to internal surface shape of pipe. 300.150 THIMBLES AND SLEEVES: Provide thimbles and sleeves of copper alloy, for use with lead. 310.000 WORKMANSHIP 310.010 INSTALLATION GENERALLY: Install in accordance with BS 8000-13 and manufacturer's recommendations to ensure complete discharge of rainwater from building without leaking. Handle, store and securely fix all products and accessories in accordance with manufacturer's recommendations. Obtain all components for each type of pipework and guttering from same manufacturer, unless otherwise indicated. Inspect components before fixing and reject any which are defective. Ensure cut ends are clean and square with burrs removed. Where not indicated otherwise use plated, sherardized, galvanized or non-ferrous fastenings, suitable for purpose and background, and compatible with material being fixed. Allow for thermal and building movement when fixing and jointing. 310.020 BEFORE COMMENCING WORK: Before commencing work ensure that below ground drainage is ready to receive rainwater or that the discharge can be dispersed by approved means to prevent damage or disfigurement of the building

KJ TAIT ENGINEERS

R10/65

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **RAINWATER PIPEWORK/GUTTERS**

310.170 CAULKED LEAD JOINTS:

Ensure that materials are tightly caulked into jointing space to eliminate all cavities. Finish off lead joint to a neat fillet at mouth of socket.

310.180 CONNECTIONS BETWEEN PIPES OF DIFFERENT MATERIALS:

- Plastic
 - Connect plastics pipework to pipework of other materials using approved connectors and methods in accordance with manufacturer's recommendations, to form a watertight joint.
- Cast iron •
 - Connect cast iron pipework to clay/concrete sockets with bitumenised yarn and 1:3 • cement:sand mortar, neatly finished, to form a watertight joint.
 - Connect cast iron pipework to clay pipework using supersleeve adapters.
- Copper
 - . Connect copper pipework to clay/concrete sockets using a caulking bush (brazed on), bitumenised yarn and 1:3 cement:sand mortar, neatly finished, to form a watertight join
 - Connect copper pipework to cast iron sockets using a caulking bush (brazed on), bitumenised yarn and an approved caulking compound, neatly finished, to form a watertight joint.
 - Connect copper pipework to cast iron using purpose made copper to iron connectors.
- Galvanized steel
 - Connect galvanized steel pipework to cast iron sockets with bitumenised yarn and molten lead. lead wool or an approved cold caulking compound.
 - Connect galvanized steel pipework to clay/concrete sockets with bitumenised yarn and 1:3 cement:sand mortar, neatly finished, to form a watertight joint.

320.090 CONNECTIONS TO UNDERGROUND DRAINAGE:

Use an elastomeric flexible coupling to BS EN 681-1 or BS EN 681-2, fitted with stainless steel clamping bands to connect the syphonic roof drainage system to a below ground gravity drainage system with a watertight seal.

Connect the syphonic roof drainage system to below ground gravity drainage system at finished floor level.

320.100 WORKMANSHIP:

Fittings

Install eccentric reducers in horizontal flows so that the crown of the pipe is retained. Use T pieces with branches at 45° in direction of flow.

Joints

• Ensure joints are capable of resisting longitudinal forces without sliding apart.

Jointing

Make joints in accordance with manufacturer's recommendations

Outlets

Ensure that outlets are fixed before connecting pipework. Position outlets to align with high level collection pipes. Connect the outlet spigot to the pipework in accordance with manufacturer's instructions using a proprietary connection.

320.110 PIPEWORK INSTALLATION:

Fix high level collector pipes and downpipes in accordance with manufacturer's recommendations.

• Install polyethylene pipework using rail system to constrain thermal movement. Support horizontal or near-horizontal sections of rainwater outlet tail pipe greater than 1.5 metres long. Use additional supports on pipe collars, particularly at changes in direction.

Do not make changes in direction in pipe runs unless they are shown on the drawing or otherwise approved.

Provide rodding eves as indicated.

Ensure all pipe hangers, beam clamps, bolts, nuts and fittings used in the pipe support system are either hot dip galvanised or bright zinc phosphate finish. Fit an isolation strip within all supports to separate dissimilar metals.

320.120 TESTING:

Inform CA in advance to give a reasonable opportunity to observe tests. Check all sections of installation are free from obstruction and debris before testing.

KJ TAIT ENGINEERS

Provide assistance and apparatus for testing. Carry out tests in accordance with BS EN 12056.

- Air test
- Water test

Remedy all defects without delay and re-test as instructed.

BS APPENDIX

BS EN 12056-3:2000

Gravity drainage systems inside buildings. Part 3 Roof drainage, layout and calculation
210.015 SANITARY FITTINGS:

Comply with work section general clauses reference Y10.1000 and those detailed below. Supply pipes and fittings as specified in work section Refer to pipework schedule

210.020 STEEL PIPES AND FITTINGS:

- Application Rainwater
- Jointing materials
 - Use press fitting jointing system for stainless steel pipe to BS 3605.
 - Jointing equipment for press fitting jointing system reference Y10.3125
 - Press fittings for stainless steel pipe reference Y10.3130#

210.040 CAST/DUCTILE IRON PIPES AND FITTINGS:

- Application Soil and Waste Systems
- Manufacturer Saint Gobain Ensign
 - Or approved equivalent
- Cast iron pipes and fittings to BS EN 877
 - Red epoxy finish reference Y10.2390A
 - Grey epoxy finish reference Y10.2390B
 - Reference Y10.2390#
- Jointing materials
 - Couplings for cast iron pipes to BS EN 877
 - Stainless steel reference Y10.3105A
 - Red ductile iron reference Y10.3105B
 - Grey ductile iron reference Y10.3105C
 - Reference Y10.3105#

210.050 PLASTICS PIPES AND FITTINGS:

- Application Sanitary Pipework Installation
 - or serving Laboratory Outlets.
- Manufacturer Marley
- PVC-U to BS 4514
- Reference Y10.2480A
- - Pipes to BS EN 1451-1 reference Y10.2545A

 - PVC-U pipes to BS EN 1329-1 reference Y10.2580A

 - PVC-U fittings to BS EN 1329-1 reference Y10.2585A
- ABS fittings to BS EN 1455-1 reference Y10.2585B
- Jointing materials
 - Jointing materials for plastics pipes to BS 7291
 - Pushfit reference Y10.3095B
 - Use push-fit joints for plastic pipe.
 - Jointing equipment for push-fit system reference Y10.3102

210.080 GENERAL WORKMANSHIP

- Appearance reference Y10.4010
- Spacing reference Y10.4020
- **KJ TAIT ENGINEERS**

R11 FOUL DRAINAGE ABOVE GROUND

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES

All sanitary appliances, laboratory hand wash equipment, kitchen equipment and vending equipment as defined by the Architect to have suitable drainage installed to connect the appliance via gravity to below ground drainage provided by others.

100.020 DESIGN PARAMETERS

Refer to BS EN 12056-2 Gravity drainage systems inside buildings. Sanitary pipework, layout and calculation, for the design of sanitary pipework.

100.030 SYSTEM DESCRIPTION

The above ground soil waste and ventilation pipework system will be a two pipe fully ventilated system provided in various risers throughout the building and will connect to sanitary fittings and waste water fittings including kitchen equipment. Each toilet group and the kitchen will be provided with separate risers to avoid long horizontal runs in the interstitial ceiling void.

The system will incorporate anti-siphon pipes to prevent excessive movement and loss of water seal from the sanitary fitting traps.

The contractor shall allow for supplying, receiving, storing and installation of free issue toilet sanitary ware, provided by others. The contractor shall also allow for all equipment connections to equipment indicated on the drawings whether supplied by him or others i.e. lab sinks (by others) glass dishwashers (by mechanical contractor). The pipework will drain through the building connecting with below-grade basement pipework and slope to external manholes. All vent pipes will terminate at the highest level with air admittance valves.

Basement sanitary fittings will connect to various drainage points at grade level. The below ground drainage serving the tunnels will discharge into sump pump chambers where it will be pumped to mains at grade. Vent stacks from the basement fittings will rise to roof level and connect to associated foul drainage vent systems where practicable and terminate with air admittance valves per BS-12380.Transformer rooms in the Energy Centre will be provided with trench drains.

Contractors shall take due cognisance of the specification clause 520. 030 Design Responsibilities.

Under the above clause the pipework and ductwork support system is a contractor's design responsibility, therefore the 2053-Z-(59)-500 series drawings shall be used as generic design intent drawings. VE M 006.

Please refer to Appendix A for the Preferred Manufacturers List and Appendix B for the Pipework Specification

100.050 SYSTEM SCHEMATICS

Refer to RMF - KJ Tait Engineers schematic drawings 2053-Z-(59) 401, 402, 403, 404, 405, 406, 407 & 408.

100.060 SYSTEM DRAWINGS Refer to RMF - KJ Tait Engineers Series (53) drawings.

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.010 GENERAL:

Comply with work section general clauses reference Y10.1000 and those detailed below.

- Laboratory Drainage shall be covered under Section R14.
- Or approved equivalent

- PVC-U fittings to BS 4514
- Reference Y10.2490A
- Plastics piping systems with structured-wall pipes for soil and waste discharge within the building structure
 - Pipes to BS EN 1453 reference Y10.2495A
 - Fittings to BS EN 1329-1 reference Y10.2496A
- Plastics piping systems for soil and waste discharge within the building structure

 - Fittings to BS EN 1451-1 reference Y10.2555A
 - •

 - ABS pipes to BS EN 1455-1 reference Y10.2580B

All Pipework less than 75mm diameter shall be MUPVC solvent welded, unless otherwise noted.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE FOUL DRAINAGE ABOVE GROUND

- Gradients reference Y10.4030 •
- Expansion and contraction reference Y10.4060
- Pipe fittings
- Bends/swept tees reference Y10.4070A
- Acoustic insulation of pipework reference Y10.4105Y
- Pipes through walls and floors reference Y10.4110
- Pipe sleeves
 - Reference Y10.4120A
- Insulation carried through reference Y10.4120B
- Pipe sleeves through fire barriers reference Y10.4125

All pipework greater than 40mm diameter penetrating fire barrier shall incorporate a fire collar.Firesleeves

Firesleeves shall comply with BS 476 : Part 20 : 1987 to give a 2 Hour fire protection period. Abesco Firesleeves or approved equivalent shall be fitted on MUPVC, UPVC, Vulcathene and Polypropylene pipes passing through walls and floors between Fire Zones.

Pipes passing through walls shall be fitted with Abesco type FBC firesleeve. The Contractor should note that Filler Rings must be fitted.

Pipes passing through floors shall be fitted with Abesco type FBC firesleeve. The Contractor should note that Filler Rings must be fitted.

Where the inside diameter of the Firesleeve is larger than the outside diameter of pipe, Abesco Interdens Paste or equal and approved shall be used to fill the space the full length of the Firesleeve

- Connections to equipment reference Y10.4130
- Temporary plugs, caps and flanges
- Reference Y10.4150A.
- Pipe supports reference Y10.4210
- Support spacing reference Y10.4220
- Isolation and regulation
- Reference Y10.4230A
- Maintenance and renewal reference Y10.4240
- Cleaning reference Y10.4250
- Non-ferrous components reference Y10.4260

210.120 WORKMANSHIP, PLASTICS PIPES:

- Solvent welded joints, PVC reference Y10.8010
- Anchors, PVC reference Y10.8040

210.130 WORKMANSHIP:

- Flexible couplings and flange adapters, sleeve type reference Y10.9010
- Protection of pipes in screed
- Wrap with two protective tapes before laying.
- Sheath with PVC
- Corrosion protective tape reference Y10.9100
- Mechanical protective tape reference Y10.9110

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below.

251.030 STATIC TESTING:

- Pressure testing
- General reference Y51.2010
- Soil, waste, ventilation, anti-syphon and rainwater pipework reference Y51.2080
- Vacuum testing reference Y51.2100
- Testing records reference Y51.2110
- Distribution As A64

R11/71

251.050 PERFORMANCE TESTING:

- System performance testing reference Y51.4010
- Testing to specified conditions
- Sanitary Systems reference Y51.4040B Performance test records - reference Y51.4050
 - Distribution As A64

254,000 IDENTIFICATION - MECHANICAL

254.010 GENERAL: Comply with work section general clauses reference Y54.1000 and those detailed below.

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL:

Comply with work section general clauses reference Y90.1000 and those detailed below.

290.020 FIXINGS:

- Screws reference Y90.2030
- Cast-in fixings reference Y90.2040
- Shot fired fixings reference Y90.2050
- Proprietary channel inserts reference Y90.2070

290.030 WORKMANSHIP:

- Drilling reference Y90.3010
- Proprietary fixings reference Y90.3020
- Fixing to reinforced concrete reference Y90.3030
- Fixing to brickwork reference Y90.3040
- Fixing to timber rails reference Y90.3050 •
- Fixing to hollow stud/tile/block wall •
 - Reference Y90.3060A
- Fixing to concrete, brickwork or blockwork Reference Y90.3070A
- Fixing to metalwork
- Reference Y90.3080A
- Fixing to structural steelwork and concrete structures Reference Y90.3090A

291.000 OFF-SITE PAINTING AND ANTI-CORROSION TREATMENT

291.010 GENERAL

Comply with work section general clauses reference Y91.1000 and those detailed below.

291.020 PAINT MATERIALS:

- Paint materials
- Reference Y91.2010A
- Paint quality reference Y91.2020
- Heat resistant paint reference Y91.2030

291.030 WORKMANSHIP

- General reference Y91.3010
- Weather and other conditions reference Y91.3020
- Cleaning and preparing for painting
- Surfaces reference Y91.3030B
- Application off-site reference Y91.3040
- Application reference Y91.3050

KJ TAIT ENGINEERS

- FOUL DRAINAGE ABOVE GROUND Cold galvanizing - reference Y91.3060 • Plastic to BS EN 274-1, BS EN 274-2, BS EN 274-3. • • Protection of bright machine parts - reference Y91.3070 Characteristics Size 40mm PART 3 SPECIFICATION CLAUSES SPECIFIC TO R11 300.030C TRAPS: 300.000 PRODUCTS/MATERIALS Appliance • Wash basin 300.020 FLOOR OUTLETS: Form • Application Plantrooms • S. Manufacturer and reference Wade Products Ltd Incorporating; Standard • Plastic to BS EN 274-1, BS EN 274-2, BS EN 274-3. Plant Room floor gullies - cast iron with galvanised finish. . • Characteristics Cast iron trapped drain bodies - G or H series. • Size 32mm c) Extension piece • Kitchen floor gullies - Stainless Steel anti-slip mesh finish. . 300.030D TRAPS: • Cast iron trapped drain bodies - G or H series. Appliance • Plant room linear drainage outlets - sheradized cast iron finish channel & grating • ٠ Bath Kitchen linear/tee drainage outlets - stainless steel channel & anti-slip mesh finish grating • Type • Tubular. • Form Or approved equivalent. • S. To suit sup-slab drainage systems layout Standard • Standard • Plastic to BS EN 274-1, BS EN 274-2, BS EN 274-3. BS EN 1253-1 • Characteristics • Material Size 40mm ٠ Cast iron. To be coordinated with below ground drainage connections, and incorporate Trap. ٠ 300.030E TRAPS: Appliance • 300.030 TRAPS: Shower unit Appliance • • Type • W.C. pan Tubular. • Type Form • Integral with appliance. • P. • Form • Standard • P. Plastic to BS EN 274-1, BS EN 274-2, BS EN 274-3. Characteristics Characteristics Size 110mm Size 40mm 300.030A TRAPS: 300.030F TRAPS: Appliance • • Appliance Urinal Water cooler Type • •
 - Resealing.
- Form • • S.
- Standard •
- Plastic to BS EN 274-1, BS EN 274-2, BS EN 274-3.
- Characteristics
- Size 40mm

300.030B TRAPS:

- Appliance •
- Sink
- Type
- Tubular.
- Form
- S.
- Standard

KJ TAIT ENGINEERS

Material

300.110 DOMICAL GRATINGS:

- Туре
- Tubular •
- Form

•

- S.
- Standard
 - Plastic to BS EN 274-1, BS EN 274-2, BS EN 274-3.
- Characteristics Size 32mm

300.090 COPPER ALLOY OVAL ACCESS PIECE: Ensure inner face conforms to internal surface shape of pipes

300.100 THIMBLES AND SLEEVES: Provide copper alloy thimbles and sleeves for use with lead.

FOUL DRAINAGE ABOVE GROUND

Plastic, (removable).

300.120 COVER PLATES:

- Type
- Snap on.
- Material
- Plastics.

300.130 PLASTICS WC PAN CONNECTOR:

- For horizontal outlet and shrouded pans. •
- BS 5627 for pans to BS EN 33, BS EN 37, BS EN 997.
 - Figure 1 'S' or turned 'P' traps.
 - Figure 2 'P' traps new installations.
 - Figure 3 'P' traps replacements.

300.140 GRATINGS:

- Material
 - ٠ Plastics.

300.150 SINGLE STACK PLUMBING:

Ensure that there is a change of gradient at stack connections. Use swept branches on small diameter pipes. Use swept inlet or 45 degree branch connections for pipe 75mm diameter or over.

310.000 WORKMANSHIP

310.010 PERFORMANCE CRITERIA:

Install pipework fittings and accessories to ensure that:-

- appliances drain quickly, quietly and completely at all times without nuisance or risk to health.
- discharge is conveyed without crossflow, backfall, leakage or blockage.
- air from drainage system does not enter building.
- pressure fluctuations in pipework do not vary by more than plus or minus 38mm water gauge and traps retain a water seal of not less than 25mm.
- system can be adequately tested, cleaned and maintained.

310.020 ROUTES:

Ensure pipe routes are shortest practicable, with as few bends as possible and no bends in wet portion of soil stacks, unless indicated otherwise on drawings.

310.030 COATED PIPES:

Make good damaged coatings and cut ends, or recoat, as recommended by manufacturer.

310.040 INSTALLATION GENERALLY:

Install pipes, fittings and accessories in accordance with BS 8000-13, BS EN 12056-2 and manufacturer's recommendations.

Obtain all components for each type of pipework from the same manufacturer, unless otherwise indicated.

Inspect components carefully before fixing and reject any which are defective.

Ensure cut ends of pipes to be clean and square with burrs removed.

Allow for thermal and building movement when jointing and fixing.

Form junctions using fittings intended for the purpose, ensuring that jointing material does not project into bore of pipes, fittings and appliances.

Avoid contact between dissimilar metals and other materials which would result in electrolytic corrosion.

Provide access covers and cleaning eyes as necessary in convenient locations, to permit adequate testing and cleaning of pipework.

Prevent entry of foreign matter into any part of system by sealing openings during construction. Fit all access covers and cleaning eyes as work proceeds.

310.050 CONNECTIONS BETWEEN PIPES OF DIFFERENT MATERIALS:

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE

• Plastic

Connect plastics pipework to pipework of other materials using approved connectors and watertight joint.

310.070 WASTES:

310.080 WASTE CONNECTORS:

Join to traps as manufacturer's recommendations.

310.090 WC PANS:

- Plastic
 - Connect all soil pipe spigots with plastic connectors in accordance with manufacturer's recommendations.

310.100 TRAP TEST REQUIREMENTS: Ensure there is a retention of 25mm water seal in every trap, and that no air is blown through the trap seal when performance is tested.

310.110 ACCESS POINTS:

Provide rodding and access points at all changes of direction to enable whole system to be maintained.

Provide square door type access points as indicated on drawings at foot of all soil and ventilation pipes. Where practicable, locate access points and horizontal anti-syphon pipes above fitment flood level.

In general make WC connections to drain points and soil pipes via flexible connectors.

BS APPENDIX

BS 4514:2001 Unplasticized PVC soil and ventilating pipes of 82.4mm minimum mean outside diameter, and fittings and accessories of 82.4mm and of other sizes. Specification

BS EN 12056-2:2000 Gravity drainage systems inside buildings. Part 2 Sanitary pipework, layout and calculation

methods in accordance with plastics pipework manufacturer's recommendations, to form a

Bed in waterproof jointing compound and fix with resilient washer between appliance and backnut.

R14 LABORATORY/INDUSTRIAL WASTE DRAINAGE

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES

All laboratory appliances to have suitable drainage installed to connect the appliance via gravity to below ground drainage provided by others. Drainage for Laboratory areas to be installed in chemical resistant pipework (from outlets to below ground drainage) to avoid deterioration.

100.020 DESIGN PARAMETERS

General Laboratory Drainage - BS-12056, Part 2

100.030 SYSTEM DESCRIPTION

A separate system of drainage from the foul water drainage system will be provided within the building to collect the laboratory or acid waste and radioactive waste discharges from the-laboratory areas. This will be maintained as a separate system and will connect to the external foul drainage system as a separate connection from the foul water drainage building connection. Radioactive waste will be a low grade type and will connect to acid waste piping. The waste outlets from all laboratory fixtures will discharge into vertical stacks.

All laboratory waste stacks and run outs shall be installed using the Vulcathene or Giberit (VE M009) enfusion method of pipework jointing. Final connection to basinh and sinks shall be made with mechanical joints only. The contractor shall allow for sufficient stress relief units to be installed to the manufacturers recommendations.

Vulcathene bBottle traps shall be installed unless stated that dilution traps are required at for specific areas. The vertical stacks will be located throughout the building and be coordinated with the foul and rainwater stacks. The module lab blocks will have drainage flowing in two directions to minimise the slope and resulting height of the lines in the interstitial ceiling void.

All vent pipes will terminate above roof level.

All pipework and fittings shall be manufactured by Durapipe UK or Geberit, and shall be the Vulcathene or Geberit MDPE system.

Vulcathene is a chemical waste system manufactured from black co-polymer polypropylene, injection moulded from virgin material. The system shall be manufactured to conform with the requirements of British Board of Agreement (BBA) certificate number 92/2805.

The Geberit system is made from high density polyethylene. The system shall be manufactured to conform with the requirements of British Board of Agreement (BBA) certificate number 92/2796.

Contractors shall take due cognisance of the specification clause 520. 030 Design Responsibilities.

Under the above clause the pipework and ductwork support system is a contractor's design responsibility, therefore the 2053-Z-(59)-500 series drawings shall be used as generic design intent drawings. VE M 006.

100.050 SYSTEM SCHEMATICS

Refer to RMF - KJ Tait Engineers Schematic drawings 2053 - Z (59) 401, 402 & 406

100.060 SYSTEM DRAWINGS Refer to RMF - KJ Tait Engineers (53) Series Drawings for Pipework design.

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

KJ TAIT ENGINEERS

210.000 PIPELINES

210.010 GENERAL:

Comply with work section general clauses reference Y10.1000 and those detailed below.

210.015 SANITARY FITTINGS:

Comply with work section general clauses reference Y10.1000 and those detailed below.

210.050 PLASTICS PIPES AND FITTINGS:

- Application Laboratory Drainage
- Manufacturer Vulcathene
- Or approved equivalent
- Polypropylene to BS 5254 reference Y10.2540
- Polypropylene fittings to BS 5254 •
- Reference Y10.2550A
- Special materials
 - Vulcathene reference Y10.2710Z
 - Vulcathene fittings reference Y10.2720Z

210.070 PIPEWORK ACCESSORIES:

- Wall, floor and ceiling masking plates Plastic - reference Y10.3190B
- 210.080 GENERAL WORKMANSHIP
- Appearance reference Y10.4010
- Spacing reference Y10.4020
- Gradients reference Y10.4030
- Expansion and contraction reference Y10.4060 •
- Pipe fittings •
- Bends/swept tees reference Y10.4070A
- Fabricated junctions reference Y10.4080
- Fabricated fittings •
 - Non-ferrous reference Y10.4100
- Acoustic insulation of pipework reference Y10.4105Z
- Pipes through walls and floors reference Y10.4110 •
- Pipe sleeves
- Reference Y10.4120A
- Insulation carried through reference Y10.4120B
- Pipe sleeves through fire barriers reference Y10.4125
- Connections to equipment reference Y10.4130 •
- Temporary plugs, caps and flanges •
- Reference Y10.4150A.
- Pipe rings and clips reference Y10.4180
- Pipe supports reference Y10.4210 •
- Support spacing reference Y10.4220 •
- Isolation and regulation •
- Reference Y10.4230A
- Maintenance and renewal reference Y10.4240
- Cleaning reference Y10.4250
- Non-ferrous components reference Y10.4260

210.120 WORKMANSHIP, PLASTICS PIPES:

- Fusion joints, PE reference Y10.8020
- Mechanical fittings, PE reference Y10.8030
- Anchors, PVC reference Y10.8040
- Jointing polybutylene pipes and fittings reference Y10.8050

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE LABORATORY/INDUSTRIAL WASTE DRAINAGE

Fixing to structural steelwork and concrete structures • Reference Y90.3090A

291.000 OFF-SITE PAINTING AND ANTI-CORROSION TREATMENT

291.010 GENERAL

Comply with work section general clauses reference Y91,1000 and those detailed below

291.020 PAINT MATERIALS:

- Paint materials
 - Reference Y91.2010A
- Paint quality reference Y91.2020
- Heat resistant paint reference Y91.2030

291.030 WORKMANSHIP

- General reference Y91.3010
- Weather and other conditions reference Y91.3020
- Cleaning and preparing for painting
- Surfaces reference Y91.3030B Application off-site - reference Y91.3040
- Application reference Y91.3050
- Cold galvanizing reference Y91.3060
 Protection of bright machine parts reference Y91.3070

PART 3 SPECIFICATION CLAUSES SPECIFIC TO R14

300.000 GENERAL

300.010 SPECIALIST: Use a specialist to supply, install and commission the laboratory or industrial waste drainage system.

310.000 PRODUCTS/MATERIALS

310.080 GULLEYS:

- Standard
 - BS EN 1253-1

310.100 TRAPS:

- Application Chemical Sinks and Fume cupboards
- Manufacturer and reference Vulcathene
- Or approved equivalent.
- Size To suit connection to appliance
- Details Recovery Dilution Trap

310.100A TRAPS:

- Application Rooms Where Clat is Used
- Manufacturer and reference Vulcathene • Or approved equivalent.
- Size To suit Line Size
- Details Clay Trap

320.000 WORKMANSHIP

320.010 INSTALLATION: Install laboratory and industrial waste drainage equipment in accordance with manufacturer's recommendations.

BS APPENDIX

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below.

251.030 STATIC TESTING:

Pressure testing

•

- General reference Y51.2010
- Soil, waste, ventilation, anti-syphon and rainwater pipework reference Y51.2080
- Vacuum testing reference Y51.2100
- Testing records reference Y51.2110
 - Distribution As A64

251.050 PERFORMANCE TESTING:

- System performance testing reference Y51.4010 •
- Testing to specified conditions
- Sanitary Systems reference Y51.4040B
- Performance test records reference Y51.4050

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL: Comply with work section general clauses reference Y54.1000 and those detailed below.

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

254.045 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416: Reference Y54.2035

254.070 LABORATORY OUTLETS: To BS 1710 - reference Y54.2060A

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL: Comply with work section general clauses reference Y90.1000 and those detailed below.

290.020 FIXINGS:

- Standards reference Y90.2010 •
- Plugs reference Y90.2020
- Screws reference Y90.2030 •
- Cast-in fixings reference Y90.2040
- Shot fired fixings reference Y90.2050
- Self adhesive fixings reference Y90.2060
- Proprietary channel inserts reference Y90.2070

290.030 WORKMANSHIP:

- Drilling reference Y90.3010 •
- Proprietary fixings reference Y90.3020
- Fixing to reinforced concrete reference Y90.3030
- Fixing to brickwork reference Y90.3040 •
- Fixing to timber rails reference Y90.3050 •
- Fixing to hollow stud/tile/block wall •
- Reference Y90.3060A
- Fixing to concrete, brickwork or blockwork
- Reference Y90.3070A
- Fixing to metalwork
 - Reference Y90.3080A

S10 COLD WATER

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES Provision of separate Domestic, Industrial and Mains Cold Water storage and distribution systems serving all appliances and equipment throughout the building.

100.020 DESIGN PARAMETERS Domestic water installations shall be in accordance with: Water Supply Byelaws BS 6700: 2006 CIBSE Guide G. CIBSE TM13. Institute of Plumbing Design Guide HSE Approved Code of Practice HS (G) 70 and Guidance L8.

100.030 SYSTEM DESCRIPTION

Incoming Water Main - The incoming water service will draw water from the diverted town main which runs along the northern boundary of the site. A 150 mm service main will be extended from the town main connection to the water service entrance point in the southern part of the Energy Centre mechanical room. The incoming supply will be valved and will incorporate a backflow device and water meter, with maintenance by-pass. The meter will be linked to the BMS for independent readout. Current water demand will be 16.5 litres per second with a future demand of 19.0 litres per second.

Drinking Water Service - A separate metered drinking water supply will be taken from the incoming water service before any other connection. The drinking water system within the building will supply drinking water to drinking points, such as, coffee/meeting rooms, breakout/coffee rooms, drinking fountains and kitchen equipment providing drinking fluid services.

De-ionised Water Service - A separate metered drinking water supply will be taken from the incoming Cat 5 pressurised water main prior to the softeners to serve the RO/DO water system. See Section S 20 for further details

Mains Water as indicated on the drawings will be distributed to the two three-separate water service tank systems in the basement tank room. The basement tank room is located in the east service tunnel, and shall have tanks for the following systems:-

•Domestic Water
 •Industrial Water (Category 5)
 •Rainwater Harvesting Water.

Domestic Cold Water Service - The domestic cold water service is a pressurised water system that is draws its water from a domestic cold water storage tank situated in the east tunnel. The service will supply fixtures and fittings to all toilet areas, tea points, laboratory wash hand basins and the kitchen area. The system also feds the domestic hot water generators, deionised water systems and water softener systems.

Domestic cold water will connect to hose union bibs taps in the plant towers and Energy Centre mechanical room.

Industrial Cold Water Service - The laboratory cold water is a is a pressurised Category 5 water system that is draws its water from a domestic cold water storage tank situated in the east tunnel. The service will be used to supply laboratory sinks, laboratory equipment and the industrial water hot water generators.

BS 5254:1976

Specification for polypropylene waste pipe and fittings (external diameter 34.6 mm, 41.0 mm and 54.1 mm).

Replaced by BS EN 1451-1:2000 but remains current.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE COLD WATER

Rainwater Harvesting System - The rainwater harvesting system collects rainwater for toilet and urinal flushing throughout the building, See Section S17 for further details.Omitted under VE M017

Water Storage - Separate water storage tanks will be provided for each of the water service systems. Domestic cold water will be stored in two 22,800 22000 litre tank. Industrial water will be stored in two Category 5 45,600 22000 litre tanks. Rainwater will be stored in two 34,200 litre tanks.

Tanks located in the basement tank room will be sized to ensure operation of the facilities for 24 hours in the event of failure of the mains. High and low water level alarms will be fitted to all tanks.

Water level will be controlled by Keraflo Aylesbury Type KA float control valves on the domestic and industrial tanks, and Type KB delayed action on the rainwater harvesting tanks.

Each tank shall be fully insulated externally flanged mounted on concrete piers, complete with raised valve chamber, access ladders, handrails and access manholes. All tanks shall be fitted with screened overflows and an overflow warning system to comply with water bylaw 38. Given the reduced headroom within the tank room the contractor may consider using an internally flanged tank base tank.

Drainage and overflow of tanks will be handled by floor trenches in the tank room which will connect the 16.2 cubic metre sump pit. Water will be discharged by means of a 6.3 litres per second duplex sump pump and will connect to foul water site drainage. Sump pumps will have essential power supplies.

Rainwater will have twin or duplex 40 mesh bucket strainers in the pipe system prior to entering the rainwater harvesting storage tanks to catch debris in the water system. All water systems shall have twin 100 mesh bucket strainers in the pipe system on the discharge side of the storage tanks prior to intake side of respective water booster pumps to catch debris from the water system.

Water Distribution - Domestic Waterand, Industrial Cat 5 Water and the Rain Water Harvesting make-up systems shall have separate inverter controlled water booster pump sets, comprised of two (2) duty and one (1) stand-by pumps, will generate the system pressure to satisfy the duty requirement of the most hydraulically remote fitting of the water systems. All pipework will be insulated to maintain the temperature of the contents within the pipework system and prevent the possibility of condensation. Frost protection will be provided to any exposed elements of the system. There are no exposed sections of the system requiring trace heating.

The distribution pipework will be sized to provide the system demands based upon the number of fittings and equipment connected to it. Diversified volumes will be applied to ensure economy of pipework whilst giving due consideration to later modifications of the system.

Water hammer arrestors shall be installed at the top of all pressurised water system risers. Where quick-closing valves on equipment, quarter-turn elbow/wrist action taps or 15 mm bore taps are installed water hammer arrestors will be provided at the ends of branches serving them. The cold water systems will also be separated from the hot services to prevent the temperature of water being raised by heat radiation, during static conditions. This is in order to guard against the growth of Legionella.

Eye-wash and emergency shower facilities as indicated on the drawings will be provided as required throughout the building.

Water Softener System - Domestic water and industrial water systems will be treated by a salt softening system. Drinking water systems will not be softened.

The water softening systems are located in the Energy Centre.

Calculations are based on incoming water total hardness of 300 PPM and operating at 24 hours per day. Each system will be provided with duplex softener tanks and a brine tank.

Domestic water usage is calculated at an average load of 4.3 5.6 cubic metres per hour and a peak flow of 276 44,000 litres per minute over an 8 hour period. Salt usage will be 16.8 KG per 20,000 litres of water treated.

Industrial water usage is calculated at an average load of 14.3 5.6 cubic metres per hour. and a peak flow of 363 44,000 litres per minute over an 8 hour period. Salt usage will be 70 KG per 83,500 litres of water treated.

Salt saturator calculations shall be undertaken by the saturator manufacturer are based on a daily salt consumption of approximately 500 KG. Salt saturator tank will have a capacity of 21,000 KG of storage. Due to the height of the tank, a pit will be provided.

The contractor to take due cognisance of Legionella Bacteria guidelines set out with CIBSE TM13 and HSE's Approved Code of Practice and Guidance L8 - Legionnaires Disease: The control of legionella bacteria in water systems. The contractor shall employ a specialist contractor to undertake all flushing, cleaning, and sterilization of the domestic water system pipework. After completion all water systems shall be tested and a certificate of system compliance shall be issued.

Contractors shall take due cognisance of the specification clause 520. 030 Design Responsibilities.

Under the above clause the pipework and ductwork support system is a contractor's design responsibility, therefore the 2053-Z-(59)-500 series drawings shall be used as generic design intent drawings. VE M 006.

Contractors shall note that under VE M 018 aluminium protection within plant room areas is limited to 2.2 metres above finished floor level.

Please refer to Appendix A for the Preferred Manufacturers List, and Appendix B for the Pipework Specification and Appendix C for the Valve Schedule.

100.040 CONTROL REQUIREMENTS

The three cold water systems water booster sets will be fed from a permanent supply derived from the main switchboard and installed by the electrical contractor.

Pump run and trip indication along with a common fault for each booster set (3 pumps per set), will be derived from the booster package control panel for indication back at the BMS. This wiring along with the float switch interlocks shall be carried out by the controls specialist.

Water meters will be provided by the controls specialist for the following areas:-

 Mains Incoming Water •Drinking Water Supply •RO/DI Water Supply

•Mains Water to Rain Water Harvester Softener Mains Water to Industrial Water Softener

Mains Water to Domestic Water Softener

These meters will provide water consumption indication to the BMS, and also alarm indication if a large change in water consumption is detected in the cold water tank feeds.

100.050 SYSTEM SCHEMATICS Refer to RMF - KJ Tait Engineers drawings 2053-Z-(59) 410, 411, 412, 413, 414, 415, 416, 417

100.060 SYSTEM DRAWINGS Refer to RMF - KJ Tait Engineers drawings 2053-Z-(55) series.

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.010 GENERAL:

Comply with work section general clauses reference Y10.1000 and those detailed below.

Supply pipes and fittings as specified in work section See Pipework and Valve Schedules

210.050 PLASTICS PIPES AND FITTINGS:

- Application Domestic Cold Water Supply •
- Manufacturer See Pipework Schedule
- Or approved equivalent
- Layered pipe and fittings for hot and cold water reference Y10.2430 •
- PVC-U to BS 3505
 - Reference Y10.2450A
 - Reference Y10.2450#
- PVC-U fittings, solvent welding to BS 4346-1 reference Y10.2470
- Polyethylene fusion fittings to BS EN 1555 reference Y10.2538
- Polyethylene to BS 6572
- Reference Y10.2660A
- Special materials
 - PVC-U to BS 3506 reference Y10.2460#
 - PVC-U fittings to BS 4346-2 reference Y10.2620# •
 - ABS to BS 5391-1 reference Y10.2630#
 - ABS fittings to BS 5392-1 reference Y10.2640#
 - Polyethylene fittings to BS EN 13244-3 reference Y10.2654#
- Jointing materials
 - Jointing materials for plastics pipes to BS 7291
 - Solvent cement reference Y10.3095C
 - Thermal fusion reference Y10.3095D
 - Compression to BS 864-2 reference Y10.3095E

210.070 PIPEWORK ACCESSORIES:

- Wall, floor and ceiling masking plates
- Chromium plated reference Y10.3190A.
- Pipe rings and clips
 - Copper pipework
 - Brass clips reference Y10.3200C

210.080 GENERAL WORKMANSHIP

- Appearance reference Y10.4010
- Spacing reference Y10.4020
- Gradients reference Y10.4030
- Drain requirements reference Y10.4050
- Expansion and contraction reference Y10.4060
- Fabricated junctions reference Y10.4080
- Fabricated fittings
 - Ferrous reference Y10.4090
 - Non-ferrous reference Y10.4100
- Pipes through walls and floors reference Y10.4110
- Pipe sleeves •
 - Reference Y10.4120A
 - Insulation carried through reference Y10.4120B
- Pipe sleeves through fire barriers reference Y10.4125
- Proprietary pipe sleeves through fire barriers reference Y10.4125#
- Connections to equipment reference Y10.4130
- Distribution headers reference Y10.4140
- Temporary plugs, caps and flanges
- Reference Y10.4150A.

S10 / 85

- Flanged joints general reference Y10.4160 •
- Dissimilar metals - reference Y10.4170
- Pipe rings and clips reference Y10.4180
- Pipe supports reference Y10.4210 Pipe supports for all main pipework runs shall comprise Flamco Support Rail, Rail Support Nuts, Washers, Backnut, Drop Rods, Rubber Caps, MUPRO rubber ring and metal pipe rings.

All concealed pipework and pipework within plant rooms shall be supported by means of Murpo or Flamcotype clamps complete with fixing rods and mounting rails.

All exposed pipework shall be supported using a split ring type mild steel pipe clip, complete with wall fixing bracket, incorporating MUPRO rubber rings. The upper half of the pipe clip shall be detachable without disturbing the fixing. Where pipework is insulated allowance shall be made in pipe fixtures to ensure a clearance of 32mm from building fabric.

An effective vapour seal shall be installed on low temperature water pipework.

The contractor shall be responsible for marking-off the exact position where pipe brackets are to be built in and for checking the accuracy, levelled and alignments of supports. Where pipes are run along a wall, sufficient space shall be allowed for insulating the pipes.

Supports shall be provided adjacent to all valves and other heavy equipment installed in pipelines to prevent undue strain on the adjoining piping and in order that the component may be removed for maintenance.

Structural steel work or structural concrete shall not be drilled to take supports, unless approved by the Structural Engineer. Steelwork clamps shall be used where possible. Pipes slung from other pipes and double type hangers shall not be used

Plantroom pipework supports shall not be attached directly to any connected wall to the offices, so as to reduce noise flanking. In such instances a 'Goal Post' arrangement shall be used which shall be fixed to the floor

- Support spacing reference Y10.4220 •
- Isolation and regulation
- Reference Y10.4230A
- Maintenance and renewal reference Y10.4240
- Cleaning reference Y10.4250
- Non-ferrous components reference Y10.4260 •

210.100 WORKMANSHIP, COPPER PIPEWORK:

- Compression joints reference Y10.6030
- Capillary joints reference Y10.6040

210.120 WORKMANSHIP, PLASTICS PIPES:

- Fusion joints, PE reference Y10.8020
- Anchors, PVC reference Y10.8040

210.130 WORKMANSHIP:

- Protection of underground pipework reference Y10.9030 • Location
- Protection of buried pipes
- Unmarked reference Y10.9040A
- Thermally insulated underground pipelines To BS 4508-1 - reference Y10.9060B
- Corrosion protective tape reference Y10.9100
- Mechanical protective tape reference Y10.9110

211.000 PIPELINE ANCILLARIES

211.010 GENERAL:

Comply with work section general clauses reference Y11.1000 and those detailed below.

211.030 STOP VALVES:

- Manufacturer and reference See Valve Schedule. •
- Or approved equivalent
- WRAS approved.
- Kitemark certified.
- Pipe material •
- To suit copper tube.
- Stop valves to BS EN 1213 for potable water supplies
- Compression ends for copper reference Y11.2015A ٠
- Threaded reference Y11.2015D

211.080 TEST PLUGS:

- Manufacturer and reference Binder
- Or approved equivalent ٠
- Self sealing test points reference Y11.2670A
- Valve controlled test points reference Y11.2670B

211.120 TUNDISHES:

Copper - reference Y11.2690A

211.130 FLOAT OPERATED VALVES:

- Type Delayed Action to tanks within plantroom.
- Application Cold water storage tanks. •
- Manufacturer and reference Kerflo Aylesbury "KB" type.
- Or approved equivalent
- Service fluid

•

- Water
- WRAS approved.
- Kitemark certified.
- WRc approved.
- To BS 1212 •
 - Piston type 1
 - Copper float reference Y11.2280A
- Delayed action type reference Y11.2300Z

211.140 GAUGES:

- General reference Y11.2700A
 - 100mm finish black stone enamel
 - Direct mounting reference Y11.2700F
 - Flange mounting reference Y11.2700G

211.160 LOOSE ITEMS:

For drain cocks - reference Y11.3010B •

211.170 CHECK VALVES:

- Application Domestic Cold Water
- Manufacturer and reference See Valve Schedule
- Or approved equivalent
- WRAS approved.
- Kitemark certified.
- Pipe material •
- To suit copper tube.
- Swing check type to BS 5154

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE COLD WATER

Device to prevent contamination of water by backflow to BS 6282 •

211.180 WORKMANSHIP:

S10

- Installation reference Y11.4010 •
- Location reference Y11.4020
- Vent cocks reference Y11.4060

211.190 PRESSURE REDUCING AND CONTROL VALVES:

- Application Domestic Cold water
- Manufacturer and reference See Valve Schedule • Or approved equivalent
- Kitemark certified.

211.200 DIRECT ACTING SAFETY VALVES TO BS 6759:

- Application Domestic Cold Water
- Copper alloy
 - Single spring reference Y11.2430A
 - Double spring reference Y11.2430B

211.210 DRAIN COCKS:

- WRAS approved. •
- Kitemark certified.
- Throughway gland cock type
- Reference Y11.2440A
- Screwdown to BS 2879, type 1 reference Y11.2450
- Ball type reference Y11.2460

221.000 WATER TANKS/CISTERNS

221.010 GENERAL

- Comply with work section general clauses reference Y21.1000 and those detailed below.
- Provide tanks and cisterns as schedule reference Y21-Water tanks

221.040 GLASS REINFORCED PLASTICS SECTIONAL TANK TO BS EN 13280:

- Application Domestic Cold Water
- Cold water storage for domestic.
- Manufacturer and reference Balmoral, Brimar or Braithwaite Or approved equivalent
- Sectional A1 reference Y21.2020A
- Division plate •
- Baffle and weir plates •
- Access ladders •
- Manholes or access hatches
- 600mm diameter.
 - 600mm square.
- Raised level control valve chamber.
- Type and weight of float operated valve •
- Limiting conditions
 - Height above ground 2m
 - Exposed to weather.
- Type of foundation

221.100 WORKMANSHIP:

KJ TAIT ENGINEERS

- Snow loading as BS 6399-3
- Special requirements
- Level switches for Booster Set

Temperature probes 1 Per side

Alarm facilities Low Level and High Level •

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE COLD WATER

- Protection and cleaning reference Y21.4020 •
- Inspection and access reference Y21.4030
- Install glass reinforced plastics cisterns Reference Y21.4060

224.000 TRACE HEATING

224.010 GENERAL:

Comply with work section general clauses reference Y24.1000 and those detailed below.

• As schedule reference Section T31, Clause 224.000 Location

225.000 CLEANING AND CHEMICAL TREATMENT

225.010 GENERAL:

Comply with work section general clauses reference Y25.1000 and those detailed below.

225.020 CLEANING AND CHEMICAL TREATMENT SPECIALIST:

• Reference Y25.2010

225.030 MAINS WATER ANALYSIS:

Reference Y25.2020A

225.040 PRELIMINARY CHECKS:

Reference Y25.2030A

225.050 PROCEDURAL PRECAUTIONS:

- Reference Y25.2040A
- Including taking samples reference Y25.2040B

225.070 MONITORING AND SAMPLING:

- Sampling reference Y25.2070B
- Sampling kits reference Y25.2070C

225.090 FLUSHING:

- BSRIA Application Guide 1/2001 reference Y25.3010A •
 - System filling
 - Temporary connection from mains in compliance with the Water Supply (Water Fittings) Regulations 1999, and the Water Supply (Water Fittings) (Amendment) Regulations 1999.
 - Temporary connection from fire hydrant pipework.
 - By installation of temporary tank and pump arrangement.
- Flushing reference Y25.3010B •

225.110 CHEMICAL CLEANING AND SOLIDS REMOVAL:

- BSRIA Application Guide 1/2001
- Inhibited acid reference Y25.3030A
- Formulated products reference Y25.3030B

225.120 STERILIZATION:

- General reference Y25.3040
- Mains water system reference Y25.3050
- Water storage systems reference Y25.3060

225.150 DOCUMENTATION: Reference Y25.3090

250.000 THERMAL INSULATION

250.010 GENERAL:

KJ TAIT ENGINEERS

Comply with work section general clauses reference Y50.1000 and those detailed below. • Supply thermal insulation as specified in section Section T31 Clause 250.000

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below.

251.030 STATIC TESTING:

- Pressure testing
 - General reference Y51.2010

 - Underground pipework •
 - 1 hour reference Y51.2030A
 - 4 hours reference Y51.2030B
 - Water mains reference Y51.2040
- Testing records reference Y51.2110

251.040 COMMISSIONING:

- Commissioning codes reference Y51.3020
- Commissioning
- Water distribution
 - Including BSRIA pre-commissioning check list Reference Y51.3030A
- Instruments and gauges
 - Reference Y51.3090A
- Pre-commissioning reference Y51.3120
- Plant ready for control system commissioning •
- Reference Y51.3130A
- Commissioning reference Y51.3150

251.050 PERFORMANCE TESTING:

- System performance testing reference Y51.4010 •
 - Environmental tests
 - Artificial loads reference Y51.4020A
- Testing to specified conditions
 - Sanitary Systems reference Y51.4040B
- Cold Water Systems reference Y51.4040C
- Performance test records reference Y51.4050

252.000 VIBRATION ISOLATION MOUNTINGS

252.010 GENERAL:

Comply with work section general clauses reference Y52.1000 and those detailed below. Supply plant and pipework vibration isolation as schedule reference Section T31

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL:

Comply with work section general clauses reference Y54.1000 and those detailed below. Services Identification drawings - reference Y54.2015

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

254.040 PLANT AND EQUIPMENT IDENTIFICATION:

- Letterina
 - Engraved plates filled with paint reference Y54.2030A

Water circulating and supply systems and steam and condense lines - reference Y51.2020

254.045 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416: Reference Y54.2035

254.050 VALVE AND COCK IDENTIFICATION: Reference Y54.2040

254.090 INSTRUMENT IDENTIFICATION: Reference Y54.2080

254,100 DANGER AND WARNING NOTICES: Reference Y54.2090

254.110 SYSTEM IDENTIFICATION INSTALLATION CHARTS:

Plastic encapsulated chart - reference Y54.2100C

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL: Comply with work section general clauses reference Y90.1000 and those detailed below.

290.020 FIXINGS:

- Standards reference Y90.2010
- Plugs reference Y90.2020
- Screws reference Y90.2030
- Cast-in fixings reference Y90.2040
- Shot fired fixings reference Y90.2050
- Proprietary channel inserts reference Y90.2070 •

290.030 WORKMANSHIP:

- Drilling reference Y90.3010 •
- Proprietary fixings reference Y90.3020
- Fixing to reinforced concrete reference Y90.3030
- Fixing to brickwork reference Y90.3040
- Fixing to timber rails reference Y90.3050
- Fixing to hollow stud/tile/block wall •
 - Reference Y90.3060A
- Fixing to concrete, brickwork or blockwork
- Reference Y90.3070A
- Fixing to metalwork
 - Reference Y90.3080A
- Fixing to structural steelwork and concrete structures
- Reference Y90.3090A

291.000 OFF-SITE PAINTING AND ANTI-CORROSION TREATMENT

291.010 GENERAL

- Comply with work section general clauses reference Y91.1000 and those detailed below.
- Carry-out off-site painting and anti-corrosion treatment as work section Section T31

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S10

300.000 PRODUCTS/MATERIALS

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies.

KJ TAIT ENGINEERS

Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.005 APPROVALS:

Ensure all water fittings and materials are listed in the Water Fittings and Materials Directory published by WRAS.

300.010 WATER METERS:

- Manufacturer and reference Reliance Water Controls Ltd, Type MTK-i Multi-Jet Water Meter with Pulse Output
 - Or approved equivalent

Install a water meter to the incoming mains supply. Locate the meter to allow for easy access for meter reading by the building's occupants.

300.012 TAP PIPE INTERRUPTER

Application back flow prevention to laboratory taps and fume cupboards

Manufacturer and refernace Spout with pipe interrupter (15 279 309) and vaccum breaker (15 279 329) manufactured by Broen or approved equal

Pipe interrupter to incorporate permanent atmospheric vent.

WRAS approved.

Outlet of tap shall be not less than 300mm above free discharge point or spill over level of applinace.

300.015 DRENCH SHOWERS Application Laboratory

Manufacturer and Referance Redline modular floor standing body shower (no. 17 957.009) c/w eye/face shower and bowl. or approved equal

Body shower modualr to be in brass and SS with chemical resistant red polycoat, and self draining head. Shower shall be manually operated via a rod system supplied by the manufacturer. Eve wash to include built-in regulation. Bowl to be in stainless steel with integrated outlet.

Shower shall be installed to Manufacturers recommendations.

Shower to comply with DIN 12899 standard section 1.

Shower to be self draining and provide anti-lime scale.

300.030 FLUSH WATER CONSERVATION EQUIPMENT:

- Application Urinals
- Manufacturer and reference Cistermiser sized for application
- Or approved equivalent

300.060 PRESSURE BOOSTER SETS:

- Application Cold Water booster
- schedules

Or approved equivalent

Provide pressure booster set complete with duplicate pump, pre-wired control panel and interconnecting pipework.

 Use plant/pipework arrangement with re-circulating circuits to avoid stagnant water in pressurisation unit expansion vessel.

• Manufacturer and reference See RMF - KJ Tait Engineers drawing 2053-Z(59)-707 for equipment

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE HOT WATER

S11 HOT WATER

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES Provision of separate domestic and Industrial (Lab Grade) hot water storage and distribution systems serving all appliances and equipment throughout the building.

100.020 DESIGN PARAMETERS Domestic hot water installations shall be in accordance with: Water Supply Byelaws BS 6700: 2006 CIBSE Guide G. CIBSE TM13. Institute of Plumbing Design Guide HSE Approved Code of Practice HS (G) 70 and Guidance L8.

100.030 SYSTEM DESCRIPTION

Domestic Hot Water Service - The domestic hot water service is a pressurised system that will supply fixtures and fittings, to all toilet areas, tea points, laboratory wash hand basins and the kitchen area. The domestic hot water will be generated by three two gas fired condensing package water heaters.

Industrial hot water service - The laboratory hot water is a pressurised Category 5 clean water system that will be used to supply laboratory sinks and equipment. The laboratory hot water will be generated by three two gas fired condensing packaged water heaters.

Distribution - The distribution pipework will be sized to provide the system demands based upon the number of fittings and equipment connected to it.

Diversified volumes will be applied to ensure economy of pipework whilst giving due consideration to later modifications of the system.

Water hammer arrestors shall be installed at the top of all pressurised water system risers. Where quick-closing valves on equipment, quarter-turn elbow/wrist action taps or 15 mm bore taps are installed water hammer arrestors will be provided at the ends of branches serving them. The cold water systems will also be separated from the hot services to prevent the temperature of water being raised by heat radiation, during static conditions in order to guard against the growth of legionella bacteria.

Eye-wash and emergency shower facilities as indicated on the drawings will be provided as required throughout the building.

The gas fired hot water generators shall be CE marked and WRAS approved fully packaged units complete with control system, circulation pump, expansion vessel and stainless steel storage vessel for each system. The heaters shall be low NOx units with multistage proportional gas firing controller. Each hot water generator will be provided with an integral re-circulation pump, each system pipework connects to an associated storage vessel.

The storage vessels are sized to hold approximately 5685 3750 litres, and shall be fitted with a packaged anti-stratification pump and controller.

The exhaust flues shall from the heaters be run in a 50mm thick insulated twin wall stainless steel packaged flue system. The heater flues shall be connected into the same flue system that serves the steam boilers. The flue shall be constructed from stainless steel grade 304/316 inner / outer skins. The flue contractor shall be responsible for all system expansion devices, brackets, anchors and guides.

The heater control system management shall keep the pumps running to prevent heater stratification, and eliminate the groth of Legionella bacteria build up.

Facilities within the control system will allow the hot water generator to be manually elevated in temperature during out of hours use, to eliminate Legionella bacteria build up. The hot water generator will be fitted with thermal stress/temperature safety valves, anti vacuum valves, temperature and pressure gauges (primary and secondary), access doors, etc.

The system pressure and flow will be maintained by the cold water booster set for the associated system. The systems will be pressurised and un-vented.

The hot water will be maintained at a temperature of $60 \,^{\circ}$ C for general use. Equipment requiring greater temperatures, such as glass wash machines, will have integral heaters to elevate the water to its required temperature.

All pipework will be insulated to reduce energy levels, thus reducing heat loss/system operating costs. Each hot water return system will be provided with duplex inline circulating pumps to continuously circulate hot water to offset the system heat loss and to provide for a minimum wait time for hot water at each plumbing fixture.

The contractor is to take due cognisance of Legionella Bacteria guidelines set out within CIBSE TM13 and HSE's Approved Code of Practice and Guidance L8 - Legionnaires Disease:

The contractor shall employ a specialist contractor to undertake all flushing, cleaning, and sterilization of the domestic water system pipework. After completion all water systems shall be tested and a certificate of system/sectional compliance shall be issued.

All services within the plant tower and energy centre shall be on spring vibration hangers to avoid structural borne vibration.

Contractors shall take due cognisance of the specification clause 520. 030 Design Responsibilities.

Under the above clause the pipework and ductwork support system is a contractor's design responsibility, therefore the 2053-Z-(59)-500 series drawings shall be used as generic design intent drawings. VE M 006.

Contractors shall note that under VE M 018 aluminium protection within plant room areas is limited to 2.2 metres above finished floor level.

Please refer to Appendix A for the Preferred Manufacturers List and Appendix B for the Pipework Specification and Appendix C for the Valve Schedule.

100.040 CONTROL REQUIREMENTS

Each of the direct fired gas water heaters shall have a domestic hot water pump to circulate water within the heater. The units will have the pump and water temperature controlled via the unit packaged controllers, these controllers shall have pump fault, high limit trip and a remote time start signal for interfacing with the BMS.

The water heaters will be powered and wired by the controls specialist from the associated HVAC control panel.

Remote temperature control of each water heater via the BMS system shall be allowed.

Each storage vessel will be provided a packed anti stratification pump controller and shall be complete with suitable connections for a temperature sensor. In addition the common secondary flow and return temperature sensors will provide temperature monitoring and high/low temperature alarms to the BMS.

Duplex DHW secondary pump will be installed for each system will be powered and wired by the

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE HOT WATER

controls specialist from the relevant HVAC control panel. Positive monitoring of each pump will be carried out by a differential pressure switch mounted across each pump.

All control and monitoring items associated with the domestic hot water system will be supplied and wired by the controls specialist.

100.050 SYSTEM SCHEMATICS

Please refer to RMF - KJ Tait Engineers drawings 2053-Z-(59)-410, 411, 412, 413, 414, 415, 416, 417 & 422.

100.060 SYSTEM DRAWINGS Please refer to RMF - KJ Tait Engineers Drawing Series 2053-Z-(53

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.010 GENERAL:

Comply with work section general clauses reference Y10.1000 and those detailed below.

• Supply pipes and fittings as specified in work section S10

210.050 PLASTICS PIPES AND FITTINGS:

- Application Domestic Hot water
- Manufacturer refer to Pipework Schedule
 - Or approved equivalent
- Layered pipe and fittings for hot and cold water reference Y10.2430
- PVC-U to BS 3505
 - Reference Y10.2450A
 - Reference Y10.2450#
- PVC-U fittings, solvent welding to BS 4346-1 reference Y10.2470
- Polyethylene to BS 6730
- Reference Y10.2500A
- Reference Y10.2500#
- Compression fittings for polyethylene
 - Reference Y10.2510A
 - Reference Y10.2510#
- Polyethylene pipe reference Y10.2520
- Polyethylene pipe to BS 7281 reference Y10.2525
- Polyethylene pipe to BS EN 1555 reference Y10.2528
- Polyethylene fittings reference Y10.2530
- Polyethylene fusion fittings to BS 7336 reference Y10.2535
- Polyethylene fusion fittings to BS EN 1555 reference Y10.2538
- Special materials
 - PVC-U to BS 3506 reference Y10.2460#
 - PVC-U ancillary fittings to BS 4660 reference Y10.2590#
 - PVC-U fittings to BS 4346-2 reference Y10.2620# ٠
 - ABS to BS 5391-1 reference Y10.2630#
 - ABS fittings to BS 5392-1 reference Y10.2640#

211.000 PIPELINE ANCILLARIES

211.010 GENERAL:

Comply with work section general clauses reference Y11.1000 and those detailed below.

• Supply valves as specified in work section S10

211.030 STOP VALVES:

- Application Domestic Water Services
- Manufacturer and reference Refer To Valve Schedule
 - Or approved equivalent

S11

S11/95

- Kitemark certified.
- Pipe material
 - To suit copper tube.
 - To suit plastic tube.
- Stop valves to BS EN 1213 for potable water supplies
- Compression ends for copper reference Y11.2015A
- Compression ends for plastics reference Y11.2015B
- Threaded reference Y11.2015D
- Gate valves to BS 5154
 - Screwed to BS 21 reference Y11.2020A
 - Flanged to BS EN 1092-3 reference Y11.2020C
- Reference Y11.2020#
- Gate valves to BS EN 1171
 - Flanged to BS EN 1092-2 reference Y11.2030A
 - Grooved ends reference Y11.2030B
 - Reference Y11.2030#
- Ball type, copper alloy to BS EN 13828.
 - Lever operated
 - Screwed to BS 21 reference Y11.2080C
 - Compression to BS EN 1254-2 reference Y11.2080D
 - Lockshield
 - Screwed to BS 21 reference Y11.2080E
 - Compression to BS EN 1254-2 reference Y11.2080F
- Reference Y11.2080#
- Sluice type to BS 5163
- Key operated type A reference Y11.2110A • Flanged to BS EN 1092-2, PN
- Grooved ends.
- Key operated type B reference Y11.2110B
 - Flanged to BS EN 1092-2, PN Grooved ends.
- Reference Y11.2110#
- To BS 5433 reference Y11.2120#
- Polyethylene valves to BS EN 13244-5 reference Y11.2125#
- Polyethylene valves to BS EN 1555-4 reference Y11.2128#

211.080 TEST PLUGS:

- Type
- Application Domestic Water services
- Manufacturer and reference Binder
- Or approved equivalent
- Self sealing test points reference Y11.2670A
- Valve controlled test points reference Y11.2670B •
- Reference Y11.2670# •

211.140 GAUGES:

- General reference Y11.2700A
- 100mm finish
 - Flush panel mounting reference Y11.2700E
 - Direct mounting reference Y11.2700F
 - Flange mounting reference Y11.2700G
- Reference Y11.2700#

KJ TAIT ENGINEERS

- Temperature gauges general reference Y11.2710A
- Mercury in steel reference Y11.2710B
- Reference Y11.2710# • Pressure and altitude gauges - reference Y11.2720

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE HOT WATER

250.010 GENERAL:

Comply with work section general clauses reference Y50.1000 and those detailed below. Supply thermal insulation as specified in section T31

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below. • Carry out testing and commissioning as specified in section S10

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL:

Comply with work section general clauses reference Y54.1000 and those detailed below. • Provide identification - mechanical as specified in work section S10 Services Identification drawings - reference Y54.2015

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL:

Comply with work section general clauses reference Y90.1000 and those detailed below.

• Carry out fixing to building fabric as specified in work section S10

291.000 OFF-SITE PAINTING AND ANTI-CORROSION TREATMENT

291.010 GENERAL

Comply with work section general clauses reference Y91.1000 and those detailed below. Carry-out off-site painting and anti-corrosion treatment as work section S10

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S11

300.000 PRODUCTS/MATERIALS

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.005 APPROVALS:

Ensure all water fittings and materials are listed in the Water Fittings and Materials Directory published by WRAS.

300.050 THERMOSTATIC MIXING VALVES:

- Application All showers, sinks and WHB's unless specifically specified on the drawings. Valves shall have a fail-safe to ensure the temperature does not exceed 43degC under any circumstances. There shall be one thermostatic mixing/anti-scald valve per appliance served.
- Manufacturer and reference Please refer to Valve Schedule Or approved equivalent
- Standard
 - BS EN 1111

300.060 MECHANICAL MIXING VALVES:

- Manufacturer and reference
- Or approved equivalent
- Standard
- BS EN 1286

211.170 CHECK VALVES:

- Application Domestic Hot Water
- Manufacturer and reference refer to Valve Schedule
- Or approved equivalent WRAS approved.
- Kitemark certified.
- Pipe material
- To suit copper tube.
- To suit plastic tube.
- Swing check type to BS 5154
 - Screwed to BS 21 reference Y11.2320A
 - Flanged to BS EN 1092-3 reference Y11.2320B
 - Reference Y11.2320#
- Check valve to BS EN 12334
 - Swing check
 - Flanged reference Y11.2330A
- Device to prevent contamination of water by backflow to BS 6282
- Combined check and anti-vacuum reference Y11.2385A
- Reference Y11.2385#
- Anti-back syphonage valve, combined check and anti-vacuum type
 - Reference Y11.2390A
 - Reference Y11.2390#

220.000 PUMPS

220.010 GENERAL:

Comply with work section general clauses reference Y20,1000 and those detailed below.

Provide pumps as schedule reference Refer to RMF - KJ Tait Engineers drawing 2053-Z-(59)-709

222.000 HEAT EXCHANGERS

222.010 GENERAL:

Comply with work section general clauses reference Y22.1000 and those detailed below.

 Supply gas fired heat exchangers and storage vessels, Refer to RMF - KJ Tait Engineers drawing 2053-Z-(59)-709

222.050 WORKMANSHIP

- General reference Y22.4010
- Flange drillings reference Y22.4020
- Protection and cleaning reference Y22.4030
- Inspection reference Y22.4040 •
- Rust protection reference Y22.4050

224,000 TRACE HEATING

224.010 GENERAL:

Comply with work section general clauses reference Y24.1000 and those detailed below.

As schedule reference T31 Location

225.000 CLEANING AND CHEMICAL TREATMENT

225.010 GENERAL:

- Comply with work section general clauses reference Y25.1000 and those detailed below.
- Supply cleaning and chemical treatment as specified in section S10

250.000 THERMAL INSULATION

KJ TAIT ENGINEERS

310.000 WORKMANSHIP

310.020 CONNECTIONS TO TAPS AND APPLIANCES:

Make final connections to taps and appliances with the exception of the kitchen equipment - refer to drawings and Specialist Kitchen Drawings.

310.030 WATER HEATER INSTALLATION:

Comply with manufacturer's instructions and recommendations for the installation of heater. Locate heater with adequate surrounding space for service and maintenance.

310.040 INSTALLATION OF MIXING VALVES:

Install thermostatic mixing valves and mechanical mixing valves in accordance with manufacturer's recommendations.

S17 WATER RECLAMATION SYSTEM

PART 1 SYSTEM OBJECTIVES

SECTION Omitted, water reclamation system was omitted under VE M017

100.010 PERFORMANCE OBJECTIVES: Rainwater collection and use for toilet and urinal flushing throughout the building

100.020 DESIGN PARAMETERS: Rainwater Drainage BS-12056, Part 3 Water Supply Byelaws BS 6700: 2006 **CIBSE Guide G.** CIBSE TM13. Institute of Plumbing Design Guide HSE Approved Code of Practice HS (G) 70 and Guidance L8.

100.030 SYSTEM DESCRIPTION:

Rainwater harvesting equipment for collection and use for toilet and urinal flushing throughout the building, will be installed and located in the service tunnel. Collection and distribution of harvested rainwater will include separate storage tanks, filtration and sterilisation, pressurisation equipment and clearly marked pipework. Tanks, filters, sterilisation, booster set and mains top up control valves to be provided as a manufacturers packaged set.

Rainwater Harvesting System - The rainwater harvesting system collects rainwater for toilet and urinal flushing throughout the building, See Section S17 for further details.

Water Storage - Rainwater will be stored in two 34,200 litre tanks. The tanks are located in the basement tank room will be sized to ensure operation of the facilities for 24 hours in the event of failure of the mains.

High and low water level alarms will be fitted to all tanks.

Water level will be controlled by Keraflo Aylesbury Type KB delayed action float control valves. Each tank shall be fully insulated externally flanged mounted on concrete piers, complete with raised valve chamber, access ladders, handrails and access manholes.

All tanks shall be fitted with screened overflows and an overflow warning system to comply with water bylaw 38.

Drainage and overflow of tanks will be handled by floor trenches in the tank room which will connect the 16.2 cubic metre sump pit. Water will be discharged by means of a 6.3 litres per second duplex sump pump and will connect to foul water site drainage.

Sump pumps will have essential power supplies.

Rainwater tank intakes shall have triple 20 mesh bucket strainers in the pipe system prior to entering the rainwater harvesting storage tanks to catch debris in the water system.

All water systems shall have twin 100 mesh bucket strainers in the pipe system on the discharge side of the storage tanks prior to intake side of respective water booster pumps to catch debris from the water system.

Water Distribution - The Rain Water Harvesting make-up systems shall have inverter controlled water booster pump sets, comprised of two (2) duty and one (1) stand-by pumps, these will generate the system pressure to satisfy the duty requirement of the most hydraulically remote fitting of the water systems. All pipework will be insulated to maintain the temperature of the contents within the of the water

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE WATER RECLAMATION SYSTEM

pipework system and prevent the possibility of condensation. Frost protection will be provided to any exposed elements of the system.

The distribution pipework will be sized to provide the system demands based upon the number of fittings and equipment connected to it. Diversified volumes will be applied to ensure economy of pipework whilst giving due consideration to later modifications of the system.

Water hammer arrestors shall be installed at the top of all pressurised water system risers. Where quick-closing valves on equipment are installed water hammer arrestors will be provided at the ends of branches serving them. The cold water systems will also be separated from the hot services to prevent the temperature of water being raised by heat radiation, during static conditions. This is in order to guard against the growth of Legionella.

The contractor to take due cognisance of Legionella Bacteria guidelines set out with CIBSE TM13 and HSE's Approved Code of Practice and Guidance L8 - Legionnaires Disease: The control of legionella bacteria in water systems. The contractor shall employ a specialist contractor to undertake all flushing, cleaning, and sterilization of the domestic water system pipework. After completion all water systems shall be tested and a certificate of system compliance shall be issued.

Please refer to Appendix A for the Preferred Manufacturers List and Appendix B for the Pipework Specification.

100.040 CONTROL REQUIREMENTS:

The rainwater harvesting water systems water booster set will be fed from a permanent supply derived from the main switchboard and installed by the electrical contractor.

Pump run and trip indication along with a common fault for each booster set (3 pumps per set), will be derived from the booster package control panel for indication back at the BMS. This wiring along with the float switch interlocks and top up valve controls shall be carried out by the controls specialist.

100 050 SYSTEM SCHEMATICS Please refer to RMF - KJ Tait Engineers drawings 2053-Z-(59)-409, 410 & 411.

100.060 SYSTEM DRAWINGS: Please refer to RMF - KJ Tait Engineers Drawing Series 2053-Z-(53)

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.010 GENERAL: Comply with work section general clauses reference Y10.1000 and those detailed below.

210.015 SANITARY FITTINGS: Comply with work section general clauses reference Y10.1000 and those detailed below.

210.040 CAST/DUCTILE IRON PIPES AND FITTINGS:

- Type
- Application Rainwater Reclaimation System
- Manufacturer Saint Gobian Ensign
- Or approved equivalent
- Cast iron pipes and fittings to BS EN 877
- Red epoxy finish reference Y10.2390A
- Grey epoxy finish reference Y10.2390B
 Reference Y10.2390#
- Jointing materials
- **KJ TAIT ENGINEERS**

 Couplings for cast iron pipes to BS EN 877 Stainless steel - reference Y10.3105A

- Red ductile iron reference Y10.3105B Grey ductile iron - reference Y10.3105C
- Reference Y10.3105#

210.080 GENERAL WORKMANSHIP

- Appearance reference Y10.4010
- Spacing reference Y10.4020
- Gradients reference Y10.4030
- Air venting requirements
 Drain requirements reference Y10.4050
- Expansion and contraction reference Y10.4060 Pipe fittings
- Bends/swept tees reference Y10.4070A
- Elbows/square tees reference Y10.4070B
- Pipes through walls and floors reference Y10.4110
- Pipes through walls and floors fire stopping reference Y10.4110#
 - Pipe sleeves
 - Reference Y10.4120A
- Pipe sleeves through fire barriers reference Y10.4125
- Connections to equipment reference Y10.4130
- Distribution headers reference Y10.4140
- Temporary plugs, caps and flanges Reference Y10.4150A.
- Pipe rings and clips reference Y10.4180
- Pipe supports reference Y10.4205 •
- Support spacing reference Y10.4220
- Maintenance and renewal reference Y10.4240
- Cleaning reference Y10.4250
- Non-ferrous components reference Y10.4260

210.110 WORKMANSHIP. CAST/DUCTILE IRON:

- Type
- Application
- Flanged joints reference Y10.7010
- Flexible joints reference Y10.7030

211.000 PIPELINE ANCILLARIES

211.010 GENERAL:

- Comply with work section general clauses reference Y11.1000 and those detailed below.

 Supply valves as specified in work section Refer to Valve Schedule
- 221.000 WATER TANKS/CISTERNS

221.010 GENERAL

- Comply with work section general clauses reference Y21.1000 and those detailed below.
- Provide tanks and cisterns as schedule reference Refer to RMF KJ Tait Engineers Drawing 2053-7-(59)- 709

- 221.040 GLASS REINFORCED PLASTICS SECTIONAL TANK TO BS EN 13280:
- Type
- Application
- Cold water storage for domestic.
- Manufacturer and reference
- Or approved equivalent
- Sectional A1 reference Y21.2020A

KJ TAIT ENGINEERS

Sectional A2 - reference Y21.2020B	
Connections	225.150 DOCUMENTATION:
 Positions and sizes on drawing number 2053-Z-(59)-709 	 Reference Y25.3090
Division plate	
Access ladders	251.000 TESTING AND COMMISSIONING OF MECH
Manholes or access hatches	
600mm diameter.	251.010 GENERAL:
<u>600mm square</u>	Comply with work section general clauses reference
Baised level control valve chamber	 Carry out testing and commissioning as specified
Type and weight of float operated value See Value Schedule	
Type of foundation Concrete	251.020 SPECIALIST:
Special requirements	Use one of the following specialist commissioning eng
Defor to RME K Toit Schematic Drawing 2052 7 (50) 411	 Or approved equivalent
	251.030 STATIC TESTING:
ZZI. TUU WUMAWAMATIF.	• Type
General - reference Y21.4010	Application
 Protection and cleaning - reference Y21.4020 	Pressure testing
 Inspection and access - reference Y21.4030 	 General - reference Y51.2010
 Install glass reinforced plastics cisterns - Reference Y21.4060 	Soil waste ventilation anti-syphon and rainw
	Provide an air compressor and subject the pipow
225.000 CLEANING AND CHEMICAL TREATMENT	- Flowloe an air compressor and subject the pipewo
	exceeding .5 bars) before commencing any nushi
225.010 GENERAL:	 On completion of all cleaning, flushing and air test
Comply with work section general clauses reference Y25.1000 and those detailed below.	water and subject them to sectional hydraulic test
 Supply cleaning and chemical treatment as specified in section 	 There is to be no loss of pressure for a period of r
Provide water treatment in accordance with schedule reference	 Testing records - reference Y51.2110
Location	Distribution
225.040 PRELIMINARY CHECKS	251.050 PERFORMANCE TESTING:
	• Type
	Application
	 System performance testing - reference Y51.4010
	Testing to specified conditions
225.050 PROCEDURAL PRECAUTIONS:	Bainwater Systems - reference V51 4040A
Application	Porformanae test records reference V51 4050
Reference Y25.2040A	- Distribution
 Including taking samples - reference Y25.2040B 	
225.070 MONITORING AND SAMPLING:	254.000 IDENTIFICATION - MECHANICAL
Monitoring - reference Y25.2070A	
Remote location	254.010 GENERAL:
Sampling - reference Y25.2070B	Comply with work section general clauses reference
	 Provide identification - mechanical as specified in
225.090 FLUSHING:	
Application	254.020 PIPEWORK IDENTIFICATION:
 BSRIA Application Guide 1/2001 - reference V25 3010A 	Reference Y54.2010
System filling	
Tomporary connection from mains in compliance with the Water Supply (Water Eittings)	290.000 FIXING TO BUILDING FABRIC
 Temporary connection non-mains in compliance with the water Supply (water Fittings) Destulations 1000, and the Water Supply (Water Fittings) (Amondment) Destulations 1000. 	
Terregulations 1999, and the water Supply (water Fittings) (Amenument) Regulations 1999.	290.010 GENERAL:
	Comply with work section general clauses reference
● Flushing - reference Y25.3010B	 Carry out fixing to building fabric as specified in w
 Flush system until discharge water is clear and free from stones or other rubble. 	
	290.020 FIXINGS:
225.120 STERILIZATION:	 Standards - reference Y90.2010
Application	Plugs reference Y90 2020
General - reference Y25.3040	Scrows - reference V90.2020
 Mains water system - reference Y25.3050 	Cast in fivings reference V00 2040
System standing time	- Cast-III HXIIIgs - ICICICIICC 190.2040
	A SNOT TIRE TIXINGS - RETERENCE Y9U.2050

Water storage systems - reference Y25.3060

KJ TAIT ENGINEERS

Proprietary channel inserts - reference Y90.2070

HANICAL SERVICES

Y51.1000 and those detailed below. in section

aineers

vater pipework - reference Y51.2080 ork to sectional testing by air at low pressure (not ing or testing with water. sting operations, recharge each system with clean its of one and a half times the working pressure. not less than 30 minutes for each test.

θ

Y54.1000 and those detailed below. work section

Y90.1000 and those detailed below. vork section

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE WATER RECLAMATION SYSTEM	S17 C0605LMB Revised Stage E Mechanical Spo WATER REC
	Three phase.
Drilling - reference V90 3010	310 020 PHYSICAL TREATMENT SYSTEM:
Propriotary fivings - reference V90 3020	
Fixing to reinforced concrete - reference Y90 3030	Application
Eixing to brickwork - reference Y90 3040	Manufacturer/supplier and reference
Fixing to concrete, brickwork or blockwork	Or approved equivalent
Reference Y90.3070A	Duty
Fixing to metalwork	Standard
Reference Y90.3080A	The Water Supply (Water Fittings) Rec
Fixing to structural steelwork and concrete structures	The Water Supply (Water Fittings) (Arr
Reference Y90.3090A	Supply physical treatment system complete with
 Non-penetrative support systems for roof mounted equipment - reference Y90.3100# 	sensors, control panel, pumps, tanks and wate
PART 3 SPECIFICATION CLAUSES SPECIFIC TO S17	Controls and sensors Control panel
300.000 GENERAL:	 Control parts Pumps
	Hanks
All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED)	 Power supply in accordance with BS 7697 Of a basis of the second se
97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested	Single phase. Three release
by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be	• Inree phase.
evidenced by displaying the appropriate CE Mark on the equipment and assemblies.	310 030 CHEMICAL TREATMENT SYSTEM
Only relevant equipment and assemblies certified as compliant will be permitted under this	
specification, and any substitution put forward must also be compliant with the Directive.	- Application
	Manufacturer/supplier and reference
300.010 STANDARDS:	Or approved equivalent
 BSRIA TN 7/02 Water Reclamation Standard Laboratory Testing of Systems Using Grey Water. 	
 The Water Supply (Water Fittings) Regulations 1999. 	Standard
 The Water Supply (Water Fittings) (Amendment) Regulations 1999. 	The Water Supply (Water Eittings) Rec
 Select materials that comply with 	The Water Supply (Water Fittings) (Ar
WRAS Water Regulations Guide	HSG 193 Index To The Control Guidar
WRAS Water Fittings and Materials Directory	Supply chemical treatment system complete w
Collection	sensors, control panel, pumps, tanks and wate
	 Controls and sensors
300.020 APPROVALS:	Control panel
Ensure all water multigs and materials are listed in the water Fittings and waterials Directory published	Pumps
	• Tanks
310 000 PRODUCTS/MATERIALS:	Power supply in accordance with BS 7697
	Single phase.
310.010 BIOLOGICAL TREATMENT SYSTEM:	Three phase.
• Type	
Application	310.050 CONNECTION TO FOUL DRAIN OR
Manufacturer/supplier and reference	Provide the system with a sewage backflow pr
Or approved equivalent	Ensure device can only be reset by manual interest
Duty	 BSRIA TN 7/2002 Water Reclamation Star
Standard	Water.
 The Water Supply (Water Fittings) Regulations 1999. 	BSRIA TN 6/2002 Water Reclamation Guid
The Water Supply (Water Fittings) (Amendment) Regulations 1999.	Water.
Supply biological treatment system complete with collection system, treatment system, controls and	
sensors, control panel, pumps, tanks and water meter.	
Controls and sensors	
Control panel	Install water reclamation equipment in accorda
Pumps	
Tanks	BS APPENDIX

- Power supply in accordance with BS 7697
- Single phase.

KJ TAIT ENGINEERS

BS EN 877:1999

equilations 1999 wendment) Regulations 1999. with collection system, treatment system, controls and ter meter.

equilations 1999 mendment) Regulations 1999 ance Sheets Parts 1 and 2 with collection system, treatment system, controls and ter meter.

R SEWER: prevention device with a visible indicator. ntervention. andard. Laboratory Testing of Systems Using Grey

idance. Design and Construction of Systems Using Grey

MATION SYSTEM: lance with manufacturer's instructions. Cast iron pipes and fittings, their joints and accessories for the evacuation of water from buildings Requirements, test methods and quality assurance

S20 TREATED/DEIONISED/DISTILLED WATER

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES Production and circulation of De-Ionised water to all lab areas with a target conductivity of 18 megaohms and a minimum conductivity of 1915 megaohms

100.030 SYSTEM DESCRIPTION

The services contractor shall employ a specialist company to supply and install the water purification system as described on the schematic layouts. The specialist shall be responsible for all elements of the water purification system and shall validate and handover the systems to the end user.

The Central water purification plant shall produce water to provide a target conductivity at the outlets of 18 megaohms.

The system water is re-circulated through two (2) ring mains serving each half of the building. The plant will be complete with all sensing devices and controls. The plant will have 100% stand-by in order to maintain the required quality and quantity of RO water during downtime and maintenance periods.

As scheduled and detailed on the drawings, local polishers shall be fitted within the lab areas.

The polishers are client specified as Millipore Milli-Q Advantage A10 water purification unit. Each unit shall come complete with a single Q-Pod dispensing unit. The water polishers, dispensing arms and interconnecting pipework shall be installed and commissioned by the manufacturer.

Volt free contacts for connection to the BMS will be provided to monitor the plant status. This will indicate the failure of any item of plant. Resistivity meters will also register the quality of the water to ensure the required quality of water is maintained at all times. The plant will feed the treated water tank through a solenoid valve. The use of this type of fitting will ensure that the design flow rate of the plant will be achieved frequently thus ensuring that channelisation in the ionising resins does not take place.

Consideration shall be given to the anticipated permanent plumbed in items (polishing machines etc), and the level of dependence on these water systems. Based on the extent of connected equipment, a risk assessment shall be carried out, which should allow for the manufacturers mean time between failures (MTBF), and anticipated mean time for repair (MTFR) in the event of a fault.

A valved connection from each RO storage tank will feed a system of flow and return pipework which is boosted and reticulated through the building supplying a designated RO tap at each pair of laboratory sinks. The distribution will follow the same route as the other main services from the Energy Centre, connecting three (3) risers in the east and west buildings and distributing at the interstitial level before dropping down to each area served.

Dead legs will be limited to 3 pipe diameters in length to give greater control and inhibit degradation of water quality within the system. Physical pipework fitting sizes will not allow a 3 pipe diameter dead leg length in all cases

A specialist contractor has presented the client with a continuous electrodeionisation option which is being considered by the client and Client Advisory Team (CAT). Separate costings for this option should be prepared and submitted alongside the tender sum for analysis.

As indicated on the schematic drawings the following areas also require water treatment and water softening systems:-

Aquatics water treatment systems

Contractors shall take due cognisance of the specification clause 520. 030 Design Responsibilities.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE TREATED/DEIONISED/DISTILLED WATER

S20

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE TREATED/DEIONISED/DISTILLED WATER

- Pipe sleeves through fire barriers reference Y10.4125 •
- Connections to equipment - reference Y10.4130
- Distribution headers reference Y10.4140
- Temporary plugs, caps and flanges • Reference Y10.4150A.
- Pipe rings and clips reference Y10.4180
- Anchors reference Y10.4190 Location
 - As drawing numbers
- Slide guides reference Y10.4200 Location
- As drawing numbers
- Pipe supports reference Y10.4205
- Support spacing reference Y10.4220 •
- Isolation and regulation •
- Reference Y10.4230A
- Maintenance and renewal reference Y10.4240
- Cleaning reference Y10.4250
- Non-ferrous components reference Y10.4260

210.120 WORKMANSHIP, PLASTICS PIPES:

- Type
- Application •
- Solvent welded joints, PVC - reference Y10.8010
- Fusion joints, PE reference Y10.8020 •
- Mechanical fittings, PE reference Y10.8030
- Anchors, PVC reference Y10.8040 •
- Jointing polybutylene pipes and fittings reference Y10.8050

211.000 PIPELINE ANCILLARIES

211.010 GENERAL:

Comply with work section general clauses reference Y11.1000 and those detailed below.

- Supply valves as specified in work section
- Supply valves as schedule reference Y11-valves
- Location
- Supply valves as schedule reference
 - Location
 - At end of this work section.
- Supply local controls as schedule reference
 - Location
 - At end of this work section.

211.030 STOP VALVES:

- Type
- Application •
- Manufacturer and reference
- Or approved equivalent
- Service fluid
 - Water
- Operating temperature (°C) •
- PN rating •
- WRAS approved.
- Kitemark certified.
- Pipe material
- To suit plastic tube.
- Stop valves to BS EN 1213 for potable water supplies Compression ends for plastics - reference Y11.2015B

Under the above clause the pipework and ductwork support system is a contractor's design responsibility, therefore the 2053-Z-(59)-500 series drawings shall be used as generic design intent drawings. VE M 006.

Contractors shall note that under VE M 018 aluminium protection within plant room areas is limited to 2.2 metres above finished floor level.

Please refer to Appendix A for the Preferred Manufacturers List and Appendix B for the Pipework Specification

100.050 SYSTEM SCHEMATICS

Refer to RMF - KJ Tait Engineers Schematic drawings 2053 - Z (59) 410, 422, 423 & 454 & 710

100.060 SYSTEM DRAWINGS Refer to RMF - KJ Tait Engineers (53) Series Drawings

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.050 PLASTICS PIPES AND FITTINGS:

- Manufacturer Refer to pipework specification
 - Or approved equivalent
- Fluid conveyed Treated Water
- Plastics piping systems for hot and cold water systems within buildings
- Special materials
 - ABS to BS 5391-1 reference Y10.2630#
 - ABS fittings to BS 5392-1 reference Y10.2640#
- Jointing materials
 - Jointing materials for plastics pipes to BS 7291
 - Reference Y10.3095#

210.070 PIPEWORK ACCESSORIES:

- Type
- Application •
- Wall, floor and ceiling masking plates
- Chromium plated reference Y10.3190A.
- Pipe rings and clips
- Reference Y10.3200#
- Pipework support reference Y10.4210

210.080 GENERAL WORKMANSHIP

- Type •
- Application
- Appearance reference Y10.4010
- Spacing reference Y10.4020
- Gradients reference Y10.4030
- Drain requirements reference Y10.4050
- Expansion and contraction reference Y10.4060 •
- Pipe fittings •
 - Bends/swept tees reference Y10.4070A
 - Elbows/square tees reference Y10.4070B
- Pipes through walls and floors reference Y10.4110
- Pipes through walls and floors fire stopping reference Y10.4110#
- Pipe sleeves
 - Reference Y10.4120A
 - Insulation carried through reference Y10.4120B

211.070 FLOW REGULATOR:

- Type •
- Application
- Manufacturer and reference
- Or approved equivalent.
- Service fluid
- Water
- Operating temperature (°C) •
- PN Rating
- WRAS approved.
- Kitemark certified.
- Pipe material
- To suit plastic tube.

211.170 CHECK VALVES:

- Manufacturer and reference Refer to valve schedule • Or approved equivalent
- WRAS approved.
- Kitemark certified.
- Service fluid
- Water.
- Pipe material
- To suit plastic tube.
- Swing check type to BS 5154
- Screwed to BS 21 and BS EN 10226-1 reference Y11.2320A
- Flanged to BS EN 1092-3 reference Y11.2320B
- Check valve to BS EN 12334 ٠
- Swing check
 - Flanged reference Y11.2330A
 - Wafer body reference Y11.2330B
- Device to prevent contamination of water by backflow to BS 6282
- Combined check and anti-vacuum reference Y11.2385A
- Anti-back syphonage valve, combined check and anti-vacuum type •
 - Reference Y11.2390A

211.175 VERIFIABLE BACKFLOW PREVENTER WITH REDUCED PRESSURE ZONE (RPZ VALVE):

- Manufacturer and reference Refer to valve schedule •
 - Or approved equivalent
- WRAS approved.
- Kitemark certified.
- General requirements reference Y11.2395A.
- Service fluid
- Water.
- Assembly complete with
 - Isolating valves ٠
 - Strainers ٠
 - Pressure reducing valves •
 - Non-return valves •
 - ٠ Test points
 - Tamper free housing or secure cabinet
- Mounting
 - Vertical.
 - Horizontal.
- Installation reference Y11.2395B.
- On-site inspection and testing reference Y11.2395C.

S20

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE TREATED/DEIONISED/DISTILLED WATER

- Record of installation and test data reference Y11.2395D. •
- 211.180 WORKMANSHIP:
- Installation reference Y11.4010 •
- Positioning of components
 - Flow/pressure measurement valves reference Y11.4030
 - Double regulating variable orifice valves reference Y11.4040
 - Control ball valves reference Y11.4045
 - Control components •
 - Reference Y11.4050#
- Expansion devices reference Y11.4090 •
- Expansion compensators reference Y11.4100 •
- Flexible connections installation reference Y11.4110

211.190 PRESSURE REDUCING AND CONTROL VALVES:

- Type
- Application
- Manufacturer and reference
- Or approved equivalent
- Kitemark certified.
- Pressure reducing valve
- Integral sensor type reference Y11.2400#
- Pressure control valve direct acting Reference Y11.2420#
- Differential pressure control valve directing acting type •
 - In line type reference Y11.2422# Bypass type - reference Y11.2424#

211.210 DRAIN COCKS:

- Manufacturer and reference refer to valve schedule • Or approved equivalent
- WRAS approved.
- Kitemark certified. •
- Throughway gland cock type
- Reference Y11.2440A
- Screwdown to BS 2879, type 1 reference Y11.2450
- Ball type reference Y11.2460

225.000 CLEANING AND CHEMICAL TREATMENT

225.010 GENERAL:

Comply with work section general clauses reference Y25.1000 and those detailed below. • Supply cleaning and chemical treatment as specified in section Provide water treatment in accordance with schedule reference

- Location •

225.020 CLEANING AND CHEMICAL TREATMENT SPECIALIST:

- Use one of the following specialists Refer to prefered manufacturers list
 - Or approved equivalent

225.030 MAINS WATER ANALYSIS:

Application •

pН

KJ TAIT ENGINEERS

•

- Reference Y25.2020A
- The following is an analysis of mains water taken from site supply point:-
- Conductivity (uS/cm)

• Chloride Cl (mg/l)

Total Dissolved Solids (mg/l)

- Calcium Ca (mg/l) •
- ٠ Magnesium Mg (mg/l)
- Sodium Na (mg/l) ٠
- Potassium K (mg/l) ٠
- Total Hardness CaC0₃
- Alkalinity CaC0₃
- Total Iron Fe (ug/l)
- Copper Cu (ug/l)

225.040 PRELIMINARY CHECKS:

- Application
- Reference Y25.2030A

225.050 PROCEDURAL PRECAUTIONS:

- Application
- Reference Y25.2040A
- Including taking samples reference Y25.2040B

225.060 CHEMICAL INJECTION AND DOSING METHODS:

- Type •
- Application
- Manufacturer and reference
- Or approved equivalent
- System details
 - System capacity (litres)
 - System pressure (kPa)
- Method of introducing chemicals into closed systems reference Y25.2060A
- Method of introducing chemicals into open recirculating systems reference Y25.2060B
- Packaged plant reference Y25.2060C
- Dosing for closed systems reference Y25.2060D
- Dosing for open systems reference Y25.2060E
- Dosing chemicals reference Y25.2065

225.070 MONITORING AND SAMPLING:

- Type
- Application •
- Manufacturer and reference •
- Or approved equivalent
- Monitoring reference Y25.2070A
- Remote location
- Sampling reference Y25.2070B
- Sampling kits reference Y25.2070C

225.080 CHEMICAL PROVISION:

- Type •
- Application
- Standard arrangement reference Y25.2080A

225.085 AVOIDANCE OF STAGNANT WATER IN PRESSURISATION UNIT EXPANSION VESSELS:

Reference Y25.2090

225.090 FLUSHING:

- Application •
- BSRIA Application Guide 1/2001 reference Y25.3010A
- System filling
 - Temporary connection from mains in compliance with the Water Supply (Water Fittings) Regulations 1999, and the Water Supply (Water Fittings) (Amendment) Regulations 1999.
 - Temporary connection from fire hydrant pipework.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE TREATED/DEIONISED/DISTILLED WATER

- By installation of temporary tank and pump arrangement.
- Flushing - reference Y25.3010B
- Flush system until discharge water is clear and free from stones or other rubble.

225.100 PURGING:

Application •

S20

- Testing and purging gas pipework
- Industrial and commercial installation reference Y25.3020A
- Small low pressure industrial and commercial installations reference Y25.3020B
- Testing gas pipework to BS EN 12327 reference Y25.3020C • Purge each system using either Nitrogen or CO₂.
 - This operation is to prove the continuity of the pipework, remove any cutting fluid and ensure that the nozzles are clear.
 - completion of the purge.

225.110 CHEMICAL CLEANING AND SOLIDS REMOVAL:

- Application •
- System capacity (litres)
- System pressure (kPa)
- Water quality required after final flushing.
 - pН
 - Suspended solids
 - Iron levels
 - Magnetite levels
- BSRIA Application Guide 1/2001 •
 - Inhibited acid reference Y25.3030A
 - Formulated products reference Y25.3030B
- Cleaning and chemical treatment regime reference Y25.3035#

225.120 STERILIZATION:

- Application
- General reference Y25.3040
- Mains water system reference Y25.3050 • System standing time
- Water storage systems reference Y25.3060

225.130 WATER TREATMENT FOR STEAM BOILERS:

225.135 WATER TREATMENT:

Reference Y25.3075#

225.140 SERVICE VISITS:

- Reference Y25.3080
- Special requirements
 - At 6 monthly intervals carry out chlorination of the cooling tower circuit, and the cold and hot water domestic services.
 - Adopt procedures as indicated in HSE L8.
 - Include for 6 visits during the first 2 months commissioning
 - Provide one annual review of system.
 - analysis.
 - Include for carrying out all necessary maintenance and inspections during the first twelve months following the agreed date of practical completion.
 - Use only fully qualified operatives for any maintenance carried out.

225.150 DOCUMENTATION:

Reference Y25.3090

Flimsy paper bags are to be attached to all nozzles during the purge and removed upon

Four times per annum send samples to independent laboratory for differential micro-biological

S20 / 115

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE TREATED/DEIONISED/DISTILLED WATER

- Solvent polymers- reference Y50.2180C
- Bitumen emulsion- reference Y50.2180D
- Adhesives reference Y50.2190
- Protection
 - Application
 - Polyisobutylene- reference Y50.2200A
 - Roofing felt reference Y50.2200B
 - Flat aluminium-zinc coated steel reference Y50.2200C
 - Ribbed aluminium-zinc coated steel reference Y50.2200D
 - Aluminium sheeting reference Y50.2200E
 - Galvanized sheet steel reference Y50.2200F
 - Canvas reference Y50.2200G
 - Canvas with aluminium bands reference Y50.2200H
 - PVC reference Y50.22001
 - Laminated foil/film reference Y50.2200J
 - Reinforcement
 - Aluminium bands
 - 300mm centres reference Y50.2210A
 - 450mm centres reference Y50.2210B
 - Wire netting
- Valve and flange insulation
 - Application
- Thickness table
 - Insulation thickness calculation methods reference Y50.2285
- Non-domestic hot water service areas reference Y50.2300
- Non-domestic heating installations reference Y50.2320
- Chilled and cold water supplies to prevent condensation
 - High emissivity reference Y50.2360
 - Low emissivity reference Y50.2380
- Chilled water services
 - Phenolic foam reference Y50.2400
 - Nitrile rubber reference Y50.2410
- Protection against freezing
 - Phenolic foam reference Y50.2430
- Nitrile rubber reference Y50.2440
- Thickness of insulation

250.070 CLOSED CELL MATERIALS THERMAL INSULATION - DUCTWORK:

- Type
- Application
- Manufacturer and reference
- Or approved equivalent
- Temperature of fluid in ducts (°C)
- European Classification for Reaction to Fire Performance
 - Class A1 reference Y50.1035A
 - Class A2 reference Y50.1035B
 - Class B reference Y50.1035C
 - Class C reference Y50.1035D
- CFC's and HCFC's reference Y50.1040#
- Spread of flame as BS 476-7
- Reference Y50,1050A
- Smoke emission characteristics
- Reference Y50.1055A
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Materials •
- Thermal conductivity reference Y50.2010

250.000 THERMAL INSULATION

250.010 GENERAL:

Comply with work section general clauses reference Y50.1000 and those detailed below. Supply thermal insulation as specified in section

- Supply thermal insulation as schedule reference Y50-Insulation
 - Location

250.015 ZERO GLOBAL WARMING POTENTIAL (GWP): Use insulating materials with a Global Warming Potential (GWP) of zero.

250.017 ZERO OZONE DEPLETION POTENTIAL (ODP): Use insulating materials with an Ozone Depletion Potential (ODP) of zero.

250.020 INSTALLER SELECTION:

- Use a contractor specialising in the supply and installation of thermal insulation.
- Use one of the specialist companies listed below
- Or approved equivalent
- Use thermal insulation materials supplied by a manufacturer assessed and registered in accordance with BS ISO 9000-2.

250.040 CLOSED CELL MATERIALS THERMAL INSULATION - PIPEWORK:

- Type •
- Application
- Manufacturer and reference
- Or approved equivalent
- Temperature of fluid in pipes (°C)
- European Classification for Reaction to Fire Performance
 - Class A1 reference Y50.1035A ٠
 - Class A2 reference Y50.1035B •
 - Class B reference Y50,1035C
 - Class C reference Y50.1035D
- CFC's and HCFC's reference Y50.1040#
- Spread of flame as BS 476-7
- Reference Y50.1050A
- Smoke emission characteristics
- Reference Y50.1055A
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Materials
- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy
- For plant design life reference Y50.2015A
- Details reference Y50.2015B
- Restrictions on use of materials reference Y50.2020
- Closed cell rigid phenolic foam (PF) preformed sections

Closed cell nitrile rubber preformed flexible sections

Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.

Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.

Foil faced - reference Y50.2110A ٠

Bitumen - reference Y50.2180A

• Vinyl - reference Y50.2180B

Reference Y50.2110B High density phenolic pipe and duct support foam - Reference Y50.2130A

Reference Y50.2140A

Vapour barrier permeance

Vapour barrier coatings

KJ TAIT ENGINEERS

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE TREATED/DEIONISED/DISTILLED WATER

S20

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE TREATED/DEIONISED/DISTILLED WATER

- Thermal performance life expectancy •
 - For plant design life reference Y50.2015A
 - Details reference Y50.2015B
- Restrictions on use of materials reference Y50.2020
- Closed cell rigid phenolic foam (PF) slab
 - Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
 - Foil faced reference Y50.2120A
 - Reference Y50.2120B
- High density phenolic pipe and duct support foam Reference Y50.2130A
 - Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Closed cell nitrile rubber elastomeric sheet
- Reference Y50.2140A
- Vapour barrier coatings
 - Bitumen reference Y50.2180A
 - Vinyl reference Y50.2180B
 - Solvent polymers- reference Y50.2180C
 - Bitumen emulsion- reference Y50.2180D
- Adhesives reference Y50.2190
- Protection •
 - Application ٠
 - Polyisobutylene- reference Y50.2200A
 - Roofing felt reference Y50.2200B
 - Flat aluminium-zinc coated steel reference Y50.2200C
 - Ribbed aluminium-zinc coated steel reference Y50.2200D
 - Aluminium sheeting reference Y50.2200E ٠
 - Galvanized sheet steel reference Y50.2200F
 - Canvas reference Y50.2200G
 - Canvas with aluminium bands reference Y50.2200H
 - PVC reference Y50.22001
 - Laminated foil/film reference Y50.2200J
- Reinforcement
 - Aluminium bands
 - 300mm centres reference Y50.2210A
 - 450mm centres reference Y50.2210B
- Wire netting
- Thickness table
 - Environmental thickness on warm air ductwork reference Y50.2450
 - Condensation control on chilled air ductwork phenolic foam reference Y50.2470
 - Condensation control on chilled air ductwork closed cell pvc nitrile foam reference
 - Y50.2475
- Thickness of insulation
- Insulation thickness calculation methods reference Y50.2285

250.090 WORKMANSHIP PIPEWORK INSULATION:

- General reference Y50.3010 •
- Installation of foil faced mineral wool insulation reference Y50.3020
- Installation of foil faced phenolic foam insulation reference Y50.3030 •
- Installation of insulation with canvas finish reference Y50.3040
- Installation of closed cell nitrile rubber insulation reference Y50.3050
- Installation of protection
- Polyisobutylene (PIB) reference Y50.3120
- Sheet metal finish ٠
- Reference Y50.3130A
- Canvas reference Y50.3150
- Roofing felt reference Y50.3160
- Aluminium sheeting reference Y50.3170

S20 / 117

- Aluminium-zinc coated steel reference Y50.3180
- Rigid PVC - reference Y50.3190
- Laminated foil/film reference Y50.3195
- Flanges and valves reference Y50.3210
- Liners reference Y50.3220
- Installation where insulation is carried through pipeline support Reference Y50.3230A
- Closed cell insulation reference Y50.3230B
- Installation where insulation is not carried through pipeline support reference Y50.3240
- Liquid vapour barriers reference Y50.3260 •
- Integrity of vapour barriers reference Y50.3270

250,100 WORKMANSHIP DUCTWORK INSULATION:

- General - reference Y50.3010
- Installation of foil faced semi-rigid slab insulation reference Y50.3060
- Installation of foil faced flexible insulation reference Y50.3070
- Installation of foil faced lamella insulation reference Y50.3080
- Installation of protection
 - Polyisobutylene (PIB) reference Y50.3120
 - Sheet metal finish
 - Reference Y50.3140A
 - Reference Y50.3140#
 - Canvas reference Y50.3150
 - Roofing felt reference Y50.3160
 - Aluminium sheeting reference Y50.3170
 - Aluminium-zinc coated steel reference Y50.3180
 - Rigid PVC reference Y50.3190
 - Laminated foil/film reference Y50.3195
 - Installation of ductwork fire protection insulation reference Y50.3200
- Installation where insulation is not carried through ductline support reference Y50.3240
- Installation where insulation is carried through ductwork support reference Y50.3250
- Liquid vapour barriers reference Y50.3260 •
- Integrity of vapour barriers reference Y50.3270 •

250.110 WORKMANSHIP EQUIPMENT INSULATION:

- General reference Y50.3010
- Installation of insulation on tanks reference Y50.3090
- Installation of mineral wool insulation on vessels reference Y50.3100
- Installation of phenolic foam insulation on vessels reference Y50.3110 •
- Installation of protection •

•

251.010 GENERAL:

KJ TAIT ENGINEERS

Polyisobutylene (PIB) - reference Y50.3120

Aluminium sheeting - reference Y50.3170

- Sheet metal finish
- Reference Y50.3140A Reference Y50.3140#

Canvas - reference Y50.3150

Water tanks - reference Y50.3280

Roofing felt - reference Y50.3160

Rigid PVC - reference Y50.3190

Laminated foil/film - reference Y50.3195

Integrity of vapour barriers - reference Y50.3270

Liquid vapour barriers - reference Y50.3260

Aluminium-zinc coated steel - reference Y50.3180

251,000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

Comply with work section general clauses reference Y51.1000 and those detailed below.

Carry out testing and commissioning as specified in section

251.020 SPECIALIST:

Use one of the following specialist commissioning engineers

• Or approved equivalent

251.030 STATIC TESTING:

- Type •
- Application
- Pressure testing
 - General reference Y51.2010 ٠
 - Water circulating and supply systems and steam and condense lines reference Y51.2020
 - Underground pipework
 - 1 hour reference Y51.2030A
 - 4 hours reference Y51.2030B
 - Water mains reference Y51.2040 •
 - Fire risers reference Y51.2050
 - Refrigerant pipework ٠
 - Strength pressure test reference Y51.2055A
 - Leak test reference Y51.2055B
 - Deep vacuum test reference Y51.2055C
 - Gas pipework
 - HVCA Guide TR6 reference Y51.2060A
 - To BS EN 12327 reference Y51.2060B
 - To IGE/UP/1 reference Y51.2060C
 - To IGE/UP/1A reference Y51.2060D
 - Piped medical gases reference Y51.2070
 - Soil, waste, ventilation, anti-syphon and rainwater pipework reference Y51.2080
 - Underslab drainage reference Y51.2090
- Vacuum testing reference Y51.2100
- Provide an air compressor and subject the pipework to sectional testing by air at low pressure (not exceeding .5 bars) before commencing any flushing or testing with water.
- On completion of all cleaning, flushing and air testing operations, recharge each system with clean water and subject them to sectional hydraulic tests of one and a half times the working pressure.
- There is to be no loss of pressure for a period of not less than 30 minutes for each test.
- Testing records reference Y51.2110 •
 - Distribution

251.040 COMMISSIONING:

- Type
- Application
- Cleaning ductwork systems reference Y51.3010
- Commissioning codes reference Y51.3020
- Commissioning
 - Water distribution
 - Including BSRIA pre-commissioning check list
 - Reference Y51.3030A
 - Air distribution
 - Including BSRIA pre-commissioning check list
 - Reference Y51.3040A
 - VAV systems including BSRIA pre-commissioning checklist reference Y51.3040B
 - Boiler plant reference Y51.3050
 - Gas plant and systems reference Y51.3055
 - Refrigerating systems reference Y51.3060
 - Automatic control systems reference Y51.3070
- Plant items reference Y51.3080
- Instruments and gauges
- Reference Y51.3090A

S20 / 119

KJ TAIT ENGINEERS

- Commissioning records • Distribution
 - For air systems •
 - To BSRIA Application Guide 3/89.3 reference Y51.3100A For water systems
 - To BSRIA Application Guide 2/89.3 reference Y51.3100B
- BMS commissioning
- Control system specification details required for commissioning reference Y51.3110 •
- Pre-commissioning reference Y51.3120 •
- Plant ready for control system commissioning • Reference Y51.3130A
- Control system requirements for plant commissioning reference Y51.3140
- Commissioning reference Y51.3150 •

251.050 PERFORMANCE TESTING:

- Type
- Application
- System performance testing reference Y51.4010
- Testing of residential ventilation systems reference Y51.4015
- Environmental tests
 - Artificial loads reference Y51.4020A
 - Ambient Air Quality reference Y51.4020B
 - Reference Y51.4020#
- Recorders reference Y51.4030 •
 - Seven day space temperature recorders Number
 - For (weeks)
 - Relative humidity recorders
 - Number
 - For (weeks)
- Testing to specified conditions
 - Rainwater Systems reference Y51.4040A
 - Sanitary Systems reference Y51.4040B
 - Cold Water Systems reference Y51.4040C ٠
 - Fire Fighting Systems reference Y51.4040D Hydraulic Systems - reference Y51.4040E
 - Requirements Medical Gas and Air Systems - reference Y51.4040F
 - Laboratory and Industrial Systems
 - Reference Y51.4040G Requirements
 - Gas Systems reference Y51.4040H
 - Silencers and Acoustic Treatment Reference Y51.4040I Noise criteria
 - Acoustic Enclosures reference Y51.4040J
 - Reference Y51.4040#
 - On completion of all static testing carry out a pressure/flow to demonstrate that each system pressure of 4.5 bar measured at the highest outlet.
 - be investigated and any remedial work required carried out.
 - Testing to be carried out.
 - After obtaining and recording the approval of the Fire Officer and the Contract • Administrator to the systems, drain down each riser and leave ready for use.

will provide an effective fire fighting jet of 500 litres/min through a 65mm diameter nozzle at a

Any inability to sustain this requirement, or any undue pressure loss in the system must

Provide temporary pumps and if required, a storage tank to enable all Performance

All performance testing will be witnessed by the Contract Administrator and will consist of

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE TREATED/DEIONISED/DISTILLED WATER

- 290.010 GENERAL:
- Comply with work section general clauses reference Y90.1000 and those detailed below. Carry out fixing to building fabric as specified in work section

290.020 FIXINGS:

- Type
- Application
- Standards reference Y90.2010
- Plugs reference Y90.2020
- Screws reference Y90.2030 •
- Cast-in fixings reference Y90.2040
- Shot fired fixings reference Y90.2050
- Self adhesive fixings reference Y90.2060
- Proprietary channel inserts reference Y90.2070
- Non-penetrative support systems reference Y90.2080
- Manufacturer and reference
 - Or approved equivalent

290.030 WORKMANSHIP:

- Type •
- Application
- Drilling reference Y90.3010
- Proprietary fixings reference Y90.3020 •
- Fixing to reinforced concrete reference Y90.3030 •
- Fixing to brickwork reference Y90.3040
- Fixing to timber rails reference Y90.3050
- Fixing to hollow stud/tile/block wall
- Reference Y90.3060A
- Fixing to concrete, brickwork or blockwork •
 - Reference Y90.3070A
- Fixing to metalwork
- Reference Y90.3080A Fixing to structural steelwork and concrete structures
- Reference Y90.3090A
- Non-penetrative support systems for roof mounted equipment reference Y90.3100#

291.000 OFF-SITE PAINTING AND ANTI-CORROSION TREATMENT

291.010 GENERAL

- Comply with work section general clauses reference Y91.1000 and those detailed below.
- · Carry-out off-site painting and anti-corrosion treatment as work section

291.020 PAINT MATERIALS:

- Paint materials
- Heat resistant paint reference Y91.2030

291.030 WORKMANSHIP

- General reference Y91.3010
- Weather and other conditions reference Y91.3020 •
- Cleaning and preparing for painting •
 - Steel surfaces reference Y91.3030A
- Surfaces reference Y91.3030B
- Application off-site reference Y91.3040
- Application reference Y91.3050

- Localised smoke puff tests on selected detectors in all zones to ensure all aspects of the electrical installation, plunger actuation and fire damper operation react as required.
- The gas bottles will be disconnected during all performance testing.
- Performance test records reference Y51.4050
 - Distribution

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL:

Comply with work section general clauses reference Y54.1000 and those detailed below.

· Provide identification - mechanical as specified in work section

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

254.030 DUCTWORK IDENTIFICATION: Reference Y54.2020

254.040 PLANT AND EQUIPMENT IDENTIFICATION:

- Type
- Application •
- Lettering
 - Laminated plates, multi-coloured with outer layer removed for lettering reference Y54.2030B

254.045 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416: Reference Y54.2035

254.050 VALVE AND COCK IDENTIFICATION: Reference Y54.2040

254.060 MEDICAL GAS TERMINAL UNITS:

- Type
- Application
- To HTM 2022 reference Y54.2050A
- Cylinders to BS EN ISO 407 reference Y54.2050B

254.070 LABORATORY OUTLETS:

- Type
- Application
- To BS 1710 reference Y54.2060A
- To BS EN 13792 reference Y54.2060B

254.080 AIR VOLUME REGULATING AND CONTROL DAMPER IDENTIFICATION: Reference Y54.2070

254.090 INSTRUMENT IDENTIFICATION: Reference Y54.2080

254.100 DANGER AND WARNING NOTICES: Reference Y54.2090

254.110 SYSTEM IDENTIFICATION INSTALLATION CHARTS:

- Type
- Application
- Perspex sheet glazing with frame reference Y54.2100A

290.000 FIXING TO BUILDING FABRIC

- Type
- Application
- •
- Reference Y91.2010A
- Paint quality reference Y91.2020

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE TREATED/DEIONISED/DISTILLED WATER

S20

- Cold galvanizing reference Y91.3060
- Protection of bright machine parts reference Y91.3070
- Special protective finishes

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S20

300.000 GENERAL

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.010 SYSTEM REQUIREMENTS:

Select plant and equipment suitable to meet system objectives requirements.

300.020 TREATED/DEIONIZED/DISTILLED WATER SPECIALIST

- Application
- Use a specialist
- for analysis.
- to develop design, supply, install and commission plant for
- treating water.
- deionizing water.
- distilling water.

300.030 STATUTORY AUTHORITIES:

Ensure treatment complies with statutory authority and health and safety regulations.

300.040 MAINS WATER ANALYSIS:

- Type
- Application
- Obtain an analysis of mains water taken from site supply point. Check with local water authority to ensure analysis results are typical for site area and report variances for instruction.
- Submit a sample of water to water treatment specialist.
- The following is an analysis of mains water taken from site supply point:-
 - Conductivity (uS/cm)
 - Total Dissolved Solids (mg/1)
 - pH
 - Chloride Cl (mg/1)
 - Calcium Ca (mg/1)
 - Magnesium Mg (mg/1)
 - Sodium Na (mg/1)
 - Potassium K (mg/1)
 - Total Hardness CaC03 (mg/1)
 - Alkalinity CaC03 (mg/1)
 - Total Iron Fe (ug/1)
 - Copper Cu (ug/1)

300.050 WATER TREATMENT METHODS:

- Type
- Application
- System details
- System capacity (litres)
- System pressure (kPa)
- Scale control

PhysicalFiltration units.

Chemical

Control of microbiological fouling

• Twin bed.

Mixed bed.Reverse osmosis plant.

Corrosion control - Chemical

Control of general fouling

- Chemical
- Biocides.

• Pre-treatment

Chemical

- Biodispersants.
- Biocides and biodispersants.

Base exchange softening plant.

De-ionisation or demineralisation plant

- Physical
 - Ultraviolet disinfection units.
- Thermal techniques.
- Ionisation.

310.000 PRODUCTS/MATERIALS

310.010 DEIONIZER:

- Type
- Application
- Manufacturer and reference
- Or approved equivalent
- Duty
- Components
 - Battery operated conductivity meter.
 - Internal recycle kit.
 - Control monitor.
- Automatic control system.
- Mounting
- Wall mounted.
- Bench standing.
- Operation
- Single.
- In series.
- Accessories
- Remote alarm.

310.020 REVERSE OSMOSIS UNIT:

- Type
- Application
- Manufacturer and reference
 - Or approved equivalent
- Duty
- Component
 - High pressure pump.
 - Hollow fibre permeator.
 - Conductivity measurement.
 - Permeate and reject flow gauges.Adjustable alarm set point.
 - Adjustable alarm set poin

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE TREATED/DEIONISED/DISTILLED WATER

310.030 DISTILLATION EQUIPMENT:

- Type
- Application •
- Manufacturer and reference •
- Or approved equivalent
- Duty • Details •

310.040 OZONE GENERATION EQUIPMENT:

- Type
- Application •
- Manufacturer and reference •
- Or approved equivalent
- Duty •
- Details •

310.050 ELECTROLYTIC CHLORINE ION GENERATION EQUIPMENT:

- Type
- Application •
- Manufacturer and reference •
 - Or approved equivalent
- Duty •
- Details •

310.060 DEMINERALISATION PLANT:

- Type
- Application •
- Manufacturer and reference
- Or approved equivalent •
- Duty •
- Details

310.070 FILTRATION EQUIPMENT:

- Туре •
- Application •
- Manufacturer and reference •
- Or approved equivalent
- Duty •
- Details •

310.080 MAGNETIC EQUIPMENT:

- Type
- Application •
- Manufacturer and reference •
- Or approved equivalent ٠
- Duty
- Details •

310.090 ULTRA VIOLET DISINFECTION:

- Type •
- Application
- Manufacturer and reference •
- Or approved equivalent
- Duty •
- Details •

310.100 DEALKALISATION PLANT:

• Type

KJ TAIT ENGINEERS

threads (metric dimensions).

- Application •
- Manufacturer and reference Or approved equivalent
- Duty •
- Details •

310.110 WATER SOFTENER:

• Type

•

•

- Application •
- Manufacturer and reference
- Or approved equivalent
- Standard BS EN 14743
- Duty •
 - Peak flow (l/hr) •
 - Average flow (l/hr) ٠
 - Final water quality
 - Less than 10ppm.
 - Blend with mains water to ppm
 - Hours of operation
- Arrangement •
 - Single column.
 - Double column.
- Regeneration control
 - Time clock.
 - Water throughput (volume).
 - Conductivity control. •
 - Provide

•

- Inlet isolation valve. •
- Inlet water sample valve. •
- Softener inlet isolating valve.
- Softener outlet isolating valve.
- Softener bypass valve. •
- Soft water sample valve. ٠
- Brine storage tank.
- Storage water storage tank
- Capacity litres
- Provide
 - Delayed action ball valve. ٠
 - Sight glass. ٠
 - Level probes.
- Cold water break tank •
- Cold water transfer pump •

320.000 WORKMANSHIP

320.010 INSTALLATION OF PLANT: Install treated water plant in accordance with manufacturer's recommendations.

Partially superseded by BS EN 10226-1:2004

BS APPENDIX

BS 1710:1984

BS 21:1985

Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the

Specification for identification of pipelines and services

S32 NATURAL GAS

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES Installation of natural gas distribution system to serve boilers, water heaters, steam generators and kitchen appliances.

100.020 DESIGN PARAMETERS IGE design guides.

100.030 SYSTEM DESCRIPTION

The incoming service connection point will likely occur along the new spine road close to the intersection with Robinson Way.

The incoming supply will be a high pressure connected to the local HP gas infrastructure, shall be routed to the Energy Centre. Routing will follow the north access road which occurs between the diverted water main easement and future NMR site.

The incoming supply will have a pressure regulating station with a energy centre pressure of 13.8 Kpa and be locally metered within the Energy Centre. The gas service entrance is currently planned adjacent to the diesel tanks, but subject to review by the Authority Having Jurisdiction.

The meter will be linked to the BMS for independent readout. The building has a current projected natural gas demand of 7,011 7080 KW and a future gas demand of 9,062 9131 KW to handle the ultimate site development of 30,000 gross square metres.

Separate metered distribution mains will serve the boilers, domestic and industrial hot water generators and clean steam generators in the Energy Centre and the kitchen requirements in the main building.

A single gas riser is planned for the building and will extend up to serve the kitchen. This gas riser shall be installed within a builders work ventilated shaft.

Contractors shall take due cognisance of the specification clause 520. 030 Design Responsibilities.

Under the above clause the pipework and ductwork support system is a contractor's design responsibility, therefore the 2053-Z-(59)-500 series drawings shall be used as generic design intent drawings. VE M 006.

Please refer to Appendix A for the Preferred Manufacturers List Appendix B for the Pipework Specification and Appendix C for the Valve Schedule.

100.040 CONTROL REQUIREMENTS

An emergency gas shut down system shall be installed to the energy centre and kitchen areas

Water Gas meters will be provided by the controls specialist for the following areas:-

Mains Incoming Gas
Gas Supply to Heating Boilers
Gas Supply to Clean Steam Generators
Gas Supply to Industrial Water Heaters
Gas Supply to Domestic Water Heaters
Gas Supply to Building Systems
Gas Supply to Kitchen

BS 2879:1980 Specification for draining taps (screw-down pattern)

BS 5154:1991 Specification for copper alloy globe, globe stop and check, check and gate valves. Partially replaced by BS EN 12288:2003

BS 5391-1:1976 Specification for acrylonitrile-butadiene-styrene (ABS) pressure pipe. Part 1 Pipe for industrial uses

BS 5392-1:1976 Specification for acrylonitrile-butadiene-styrene (ABS) pressure pipe. Part 1 Fittings for use with pipe for industrial uses

BS EN 10226-1:2004 Pipe threads where pressure tight joints are made on the threads. Part 1 Taper external threads and parallel internal threads. Dimensions, tolerances and designation

BS EN 1092-3:2003 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Part 3 Copper alloy flanges

BS EN 1213:2000 Building valves. Copper alloy stopvalves for potable water supply in buildings. Tests and requirements

BS EN 12327:2000 Gas supply systems. Pressure testing, commissioning and decommissioning procedures. Functional requirements

BS EN 12334:2001 Industrial valves. Cast iron check valves

BS EN 13792:2002 Colour coding of taps and valves for use in laboratories

BS EN 14743:2005 Water conditioning equipment inside buildings. Softeners. Requirements for performance, safety and testing

BS ISO 9000-2:1997 Quality management and quality assurance standards. Generic guidelines for the application of ISO 9001, ISO 9002 and ISO 9003

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE NATURAL GAS

These meters will provide gas consumption indication to the BMS, and also alarm indication if a large change in gas consumption is detected in the system.

100.050 SYSTEM SCHEMATICS Refer to RMF - KJ Tait Engineers Schematic drawings 2053 - Z (59) 420 & 421

100.060 SYSTEM DRAWINGS Please refer to RMF - KJ Tait Engineers Drawing Series 2053-Z-(55)

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below.

251.030 STATIC TESTING:

- Application Gas Service
- Pressure testing •
 - General reference Y51.2010
 - Gas pipework
 - HVCA Guide TR6 reference Y51.2060A
 - To BS EN 12327 reference Y51.2060B
 - To IGE/UP/1 reference Y51.2060C
 - To IGE/UP/1A reference Y51.2060D

251.040 COMMISSIONING:

- Application Gas Service
- Commissioning codes reference Y51.3020
- Commissioning
 - Boiler plant reference Y51.3050 ٠
 - Gas plant and systems reference Y51.3055 ٠
 - Automatic control systems reference Y51.3070
 - Plant items reference Y51.3080
- Commissioning records
 - Distribution
 - For air systems •
 - To BSRIA Application Guide 3/89.3 reference Y51.3100A
 - For water systems To BSRIA Application Guide 2/89.3 - reference Y51.3100B
- BMS commissioning
- Control system specification details required for commissioning reference Y51.3110
- Pre-commissioning reference Y51.3120
- Plant ready for control system commissioning •
 - Reference Y51.3130A
- Control system requirements for plant commissioning reference Y51.3140
- Commissioning reference Y51.3150

251.050 PERFORMANCE TESTING:

- Type
- **Application Gas Service**
- System performance testing reference Y51.4010
- Testing to specified conditions
- Gas Systems reference Y51.4040H

254,000 IDENTIFICATION - MECHANICAL

KJ TAIT ENGINEERS

Comply with work section general clauses reference Y54.1000 and those detailed below. Provide identification - mechanical as specified in work section

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

254.010 GENEBAL:

254.045 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416: Reference Y54.2035

254.050 VALVE AND COCK IDENTIFICATION: Reference Y54,2040

254.100 DANGER AND WARNING NOTICES: Reference Y54,2090

254.110 SYSTEM IDENTIFICATION INSTALLATION CHARTS:

- Application Gas Service
- Perspex sheet glazing with frame reference Y54.2100A

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL:

290.020 FIXINGS:

- Standards reference Y90.2010
- Plugs reference Y90.2020
- Screws reference Y90.2030 •
- Cast-in fixings reference Y90.2040
- Proprietary channel inserts reference Y90.2070

290.030 WORKMANSHIP:

- Application Gas Service
- Drilling reference Y90.3010
- Proprietary fixings reference Y90.3020
- Fixing to reinforced concrete reference Y90.3030 •
- Fixing to brickwork reference Y90.3040
- Fixing to concrete, brickwork or blockwork
- Reference Y90.3070A
- Fixing to metalwork
 - Reference Y90.3080A
- Fixing to structural steelwork and concrete structures Reference Y90.3090A

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S32

300.000 GENERAL

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies (i.e. those with a maximum allowable) certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

Comply with work section general clauses reference Y90.1000 and those detailed below.

300.010 REGULATIONS:

Supply and install equipment in accordance with

HSE L56 - Safety in the installation and use of gas systems and appliances. Approved Code of Practice and Guidance. Gas Safety (Installation and Use) Regulations 1998. HSE L81 - Design, construction and installation of gas services pipes. Approved Code of Practice and Guidance. Pipelines Safety Regulations 1996.

300.020 STANDARDS:

- Install gas pipework in buildings in accordance with BS EN 1775. •
- Gas supply pipelines for maximum operating pressure up to and including 16 bar to BS EN 12007 Polvethylene - BS EN 12007-2.
- Steel BS EN 12007-3.
- Installation of gas fired catering appliances for use in all types of catering establishments to BS • 6173.
- Gas supply pipelines for maximum operating pressure over 16 bar to BS EN 1594.
- Gas pressure regulating installations on service lines to BS EN 12279.
- Safety and control devices for gas burners and gas-burning appliances general requirements to BS EN 13611.
- Gas Safety (Installation and Use) Regulations 1998 Safety in the installation and use of gas systems and appliances, L56.
- Pipelines Safety Regulations 1996 Design, construction and installation of gas service pipes, L81.
- IGE/TD/4 Gas services.
- IGE/UP/2 Gas installation pipework, boosters and compressors on industrial and commercial premises.
- IGE/UP/11 Gas in educational establishments.
- IGE/GM/4 Flow metering practice.
- IGE/GM/5 The installation and use of electronic gas meter conversion systems.
- IGE/GM/6 Specifications for low pressure diaphragm & rotary displacement meter installations.
- IGE/GM/7 Electrical connections to gas meters.

310.000 PRODUCTS/MATERIALS

310.010 LOCAL METERS:

- Application Gas energy metering
- Standard
 - Supply and install local meter with unions and adaptors in accordance with BS 746.
 - BS EN 12261. ٠
 - BS EN 12480.
 - BS EN 1359 Diaphragm.
 - Low pressure meter installations to IGE/GM/6
 - Diaphragm.
 - Rotary displacement.
 - Electrical connections to gas meters to IGE/GM/7.
- Accessories
 - Filtration to at least 200 micron.
 - ٠ Remote reading facility.
 - Liquid drain sump.
 - Provide pulsed output for BMS monitoring.

310.030 SOLENOID OPERATED VALVES:

- Application Gas Service
- Plant rooms:

Provide an automatic shut-off valve with 24hr battery back up to all plant rooms. The valve shall be installed downstream of the manual emergency control valve at gas entry to the plant room. The valve shall be hard wired and closure shall be by operation of either a thermal link located above each burner, or one of the push buttons located at each exit from the plant room. Operation of the valve shall raise an alarm. The valve shall be manual reset.

Catering establishments: • Standard - BS 6173

- the gas service can be opened by air flow switches). gas supply. The system shall be in accordance with BG IM/20. At all locations where either a manual gas isolation valve is fitted, or where an automatic gas valve system can be reset, a notice shall be affixed stating:
- ALL DOWNSTREAM BURNERS AND PILOT VALVES ON APPLIANCES MUST BE TURNED OFF PRIOR TO ATTEMPTING TO RESTORE THE GAS SUPPLY. AFTER EXTENDED SHUT-OFF. PURGE BEFORE RESTORING GAS SUPPLY. Educational establishments:
- to each teaching area shall be installed. This shall be in accordance with BG IM/20.
- Manufacturer and reference Or approved equivalent

310.090 GAS BOOSTERS:

- Application Gas Service
- Manufacturer and reference Or approved equivalent
- Standard
- Gas installation pipework, boosters and compressors as IGE/UP/2. Booster installation
- Run/standby boosters.
- Connections
- Flanged to BS EN 1092-3 PN
- Electrical supply
- Three phase.
- Accessories
- Pressure switch, manual reset, gas booster inlet.
- Pressure switch, gas booster outlet.
- Non-return valve for each booster in automatic duplex installations.
- Control panel
- Mounted on booster.
- Wall mounted.

320.000 WORKMANSHIP

320.010 INSTALLATION:

320.020 TESTING AND PURGING:

- Comply with IGE/UP/1 Strength and tightness testing and direct purging of industrial and commercial gas installations.
- Comply with IGE/UP/1A Strength and tightness testing and direct purging of small low pressure industrial and commercial Natural Gas installations.
- Carry out pressure testing in accordance with BS EN 12327.

320.030 COMMISSIONING:

KJ TAIT ENGINEERS

Provide an automatic shut-off valve with 24hr battery back up and shielded emergency stop button, installed in the gas supply to any catering equipment. The stop button shall be readily accessible, near to the exit from the catering area. The valve shall be interlocked with the ventilation to the kitchens (such that the ventilation system operation must be proved before

Where catering appliances are not fitted with full flame safeguards, the gas supply shall also be fitted with a system to prove closure of all valves prior to establishment or restoration of the

IN THE EVENT OF AN EMERGENCY THE GAS ISOLATION VALVE MUST BE CLOSED.

Where it is impractical to locate a manual gas isolation valve in a readily accessible position at the exit from a laboratory, than an automatic means of isolating and restoring the gas supply In the event of a shut-down occurring, the system shall require manual resetting such that an automatic check is performed to prove that all downstream gas isolation valves are closed.

Install equipment in accordance BS EN 1775 and with manufacturer's recommendations. Comply with IGE/UP/10 Installation of gas appliances in industrial and commercial premises.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE NATURAL GAS

S32

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE MEDICAL/LABORATORY GAS

Commission gas fired plant on industrial and commercial premises in accordance with IGE/UP/4. Commission gas supply systems in accordance with BS EN 12327.

BS APPENDIX

BS 746:2005 Fittings for installation of low pressure gas meters. Requirements and test methods

BS EN 1092-3:2003 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Part 3 Copper alloy flanges

BS EN 12007-2:2000 Gas supply systems. Pipelines for maximum operating pressure up to and including 16 bar. Part 2 Specific functional recommendations for polyethylene (MOP up to and including 10 bar)

BS EN 12007-3:2000 Gas supply systems. Pipelines for maximum operating pressure up to and including 16 bar. Part 3 Specific functional recommendations for steel

BS EN 12261:2002 Gas meters. Turbine gas meters

BS EN 12279:2000 Gas supply systems. Gas pressure regulating installations on service lines. Functional requirements

BS EN 12327:2000 Gas supply systems. Pressure testing, commissioning and decommissioning procedures. Functional requirements

BS EN 12480:2002 Gas meters. Rotary displacement gas meters

BS EN 1359:1999 Gas meters. Diaphragm gas meters

BS EN 13611:2000 Safety and control devices for gas burners and gas-burning appliances. General requirements

BS EN 1594:2000 Gas supply systems. Pipelines for maximum operating pressure over 16 bar. Functional requirements

BS EN 1775:1998 Gas supply. Gas pipework in buildings. Maximum operating pressure = 5 bar. Functional recommendations

S34 MEDICAL/LABORATORY GAS

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES To provide laboratory gas services at managed pressure to all outlets including bulk storage systems local change-over manifolds, low level alarms and associated systems

100.020 DESIGN PARAMETERS

Install the individual gas services as indicted on the drawings in accordance with:-

 British Compressed Gas Association code of practice CP4 •HSE latest directive on the safe storage and use of compressed gas cylinders. Pressure Systems Regulations 2000

100.030 SYSTEM DESCRIPTION

The following bulk gases shall be designed supplied and installed by BOC Ltd. These gases have been pre-designed by the BOC in conjunction with the client and the design team.

BULK GASES

LN₂ System -

Liquid Nitrogen will be stored in a bulk vessel located between 40 & 60 metres from the new facility (exact location to be finalised). Liquid will be piped via Super Vacuum Insulated Line (SIVL) to the facility via overhead support structure. Pipeline will deliver liquid to 3 x take off points located on the ground, 1st & 2nd floors. Liquid will be decanted from these units into pressurised vessels, which will then be moved to cold storage rooms for decanting direct into preservation units. The running of this system would create Gaseous Nitrogen, which would require a venting system to vent the gas safely to atmosphere. The vent pipe would run either to the roof or back to the vessel point.

In addition it is proposed to pipe liquid via an intermediate storage vessel to 2 x 40k (or 1 x 80k) Cryo preservation unit (s) (The exact number of preservation units is yet to be determined, but they will be located in the nitrogen dewar room on each floor that is closest to the pipeline and decant system.)

Liquid demand

Liquid demand is based on the following assumptions

Current usage = 1200 liquid litres per day 3 days per week

Expected growth = 50% on current usage

Estimated new demand = 5400 liquid litres per week

Estimated Liquid Losses = 1722 litres per week

Total weekly usage = 7122 litres per week

Spare vessel capacity = 40% of weekly usage

Estimated vessel capacity required = Minimum 9971 liquid litres

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE MEDICAL/LABORATORY GAS

Refer to RMF - KJ Tait Engineers (50) Series Drawings

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below. Carry out testing and commissioning as specified in section

251.020 SPECIALIST:

Use one of the following specialist commissioning engineers

• Or approved equivalent

251.030 STATIC TESTING:

- Type
- Application •
- Pressure testing
 - General reference Y51.2010
 - Piped medical gases reference Y51.2070

251.050 PERFORMANCE TESTING:

- Type
- Application •
- System performance testing reference Y51.4010
- Testing to specified conditions
 - Laboratory and Industrial Systems Reference Y51.4040G Requirements

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL:

Provide identification - mechanical as specified in work section

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

254.040 PLANT AND EQUIPMENT IDENTIFICATION:

- Type
- Application
- Lettering

254.045 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416:

Reference Y54.2035

254.050 VALVE AND COCK IDENTIFICATION: Reference Y54,2040

254.060 MEDICAL GAS TERMINAL UNITS:

- Type
- Application
- To HTM 2022 reference Y54.2050A
- Cylinders to BS EN ISO 407 reference Y54.2050B •

254.070 LABORATORY OUTLETS:

Operation of system -It is initially proposed that the pipeline system would be run "wet" (flooded) between normal day-time working hours (e.g. 8.00 am to 5.00 pm) and will then revert to a "dry" system overnight (e.g. 5.00pm to 8.00 am).

A docking station for pressurised vessels would be installed on the ground, 1st and 2nd floors. Approved pressurised vessels can be connected up and filled via the docking station.

The pipe system would also supply an intermediate storage vessel, which would supply a number of cryopreservation units. The storage vessel would be filled automatically via the main tank and would supply liquid to the preservation units on demand.

Emergency shut off valve -A pneumatically operated emergency shut off valve would be fitted at the vessel, which would be linked into the O₂ monitoring system. In the event of the system alarming, the shut off valve would stop liquid entering the pipeline from the vessel

CO₂ System –

A 5,450 KG CO₂ tank will be located within the same enclosure as the LN₂ tank. Piping from the tank will extend to three (3) distribution risers in the east and west buildings.

Valved branch connections complete with secondary regulation will connect the distribution mains on the interstitial level and extend to the laboratory areas.

Automatic isolation valves with manual turn-on capability will be provided to isolate individual laboratory zoned areas.

Local Area Lab Gases -

Local area gases shall be designed and installed by a specialist laboratory gas system installer. Local area bottled gas distribution systems shall be installed to serve the laboratory outlets indicated on the series (50) room data sheet drawings.

The systems shall be complete with all necessary oxygen depletion, gas level alarms, and gas level alarm indication systems, gas shut off valves, flash back arrestors. The necessary power and control wiring shall be allowed as a complete package system. Electrical supplies are available from local essential and non essentail services distribution boards being supplied by the BMS contractor.

A local area compressed air system shall be installed to serve the laboratory outlets indicated on the series (50) room data sheet drawings. The systems shall be complete with fully packaged compressed air plant complete with horizontal receiver, filtration to 0.01 micron heatless desiccant drier.

Each individual laboratory shall have secondary gas regulators for each service within the laboratory.

Contractors shall take due cognisance of the specification clause 520. 030 Design Responsibilities.

Under the above clause the pipework and ductwork support system is a contractor's design responsibility, therefore the 2053-Z-(59)-500 series drawings shall be used as generic design intent drawings. VE M 006.

100.050 SYSTEM SCHEMATICS Refer to RMF - KJ Tait Engineers Schematic drawings 2053 - Z (59) 420 & 421

100.060 SYSTEM DRAWINGS

KJ TAIT ENGINEERS

Comply with work section general clauses reference Y54.1000 and those detailed below.

Laminated plates, multi-coloured with outer layer removed for lettering - reference Y54.2030B

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE MEDICAL/LABORATORY GAS

- Type
- Application •
- To BS 1710 reference Y54.2060A
- To BS EN 13792 reference Y54.2060B

254.090 INSTRUMENT IDENTIFICATION: Reference Y54.2080

254,100 DANGER AND WARNING NOTICES: Reference Y54.2090

254.110 SYSTEM IDENTIFICATION INSTALLATION CHARTS:

- Type
- Application •
- Perspex sheet glazing with frame reference Y54.2100A •

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL:

Comply with work section general clauses reference Y90.1000 and those detailed below.

Carry out fixing to building fabric as specified in work section

290.020 FIXINGS:

- Type
- Application
- Standards reference Y90.2010
- Plugs reference Y90.2020
- Screws reference Y90.2030
- Cast-in fixings reference Y90.2040
- Proprietary channel inserts reference Y90.2070 •

290.030 WORKMANSHIP:

- Type
- Application •
- Drilling reference Y90.3010
- Proprietary fixings reference Y90.3020
- Fixing to reinforced concrete reference Y90.3030 •
- Fixing to brickwork reference Y90.3040
- Fixing to timber rails reference Y90.3050
- Fixing to hollow stud/tile/block wall
- Reference Y90.3060A
- Fixing to concrete, brickwork or blockwork
- Reference Y90.3070A
- Fixing to metalwork
- Reference Y90.3080A
- Fixing to structural steelwork and concrete structures
- Reference Y90.3090A
- Non-penetrative support systems for roof mounted equipment reference Y90.3100#

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S34

300.000 GENERAL

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE MEDICAL/LABORATORY GAS

Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.020 MEDICAL/LABORATORY GAS SPECIALIST:

- Employ a specialist to carry out the supply, installation and testing of the medical/laboratory gas system.
- Use one of the specialist companies listed below to carry out the supply, installation and testing of the medical/laboratory gas system. Refer to the preferred manufacturers list

320.000 WORKMANSHIP

320.010 LOCATION OF TERMINAL UNITS:

Locate terminal units in accordance with HTM 2022.

320.020 PIPEWORK INSTALLATION:

Install pipework in accordance with HTM 2022.

320.030 ISOLATING VALVES:

- Install shut-off valves and AVSUs in accordance with HTM 2022.
- Location

320.040 INSTALLATION OF ALARM SYSTEM:

Install the medical gas alarm system in accordance with HTM 2022.

S34

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES

Provision of clean steam distributed around the building for laboratory process and ventilation humidification requirements.

100.020 DESIGN PARAMETERS Refer to section T13

100.030 SYSTEM DESCRIPTION

Steam is being generated by three packaged steam generators within the energy centre at a minimum pressure of 100 psi (445 690 KPa). See section T13 for details of the steam generators.

From these generators the steam supply is pressure reduced at duplex pressure reducing stations to give the required pressure within each system. Each pressure reducing station shall comprise of the following:-

- •Separator.
- •Separator trap set.
- SG Iron bellows sealed stop valve with throttling plug.
- Strainer.
- •Pressure gauge.
- Pilot operated pressure reducing valve.
- Pressure gauge
- Safety valve with discharge line vented to atmosphere with vent head.
- •SG Iron bellows sealed stop valve with throttling plug.

From the pressure reducing stations the steam and condensate service supplies the following two systems:-

A Medium pressure steam (MPCS) at a pressure of 100 psi (445 690 KPA) will run from the energy centre and distribute within each service tunnel and rise as indicated to serve the autoclaves. glasswashers, humidifiers, fermentation vessels and other process equipment. All connections to equipment shall have pressure reducing stations before connection to any item of equipment.

•Low pressure steam (LPCS) at a pressure of 103KPA will run from the energy centre and distribute within each service tunnel and rise as indicated with the plant towers to serve the main air handling unit humidifiers.

All steam pipework services are distributed in welded steel pipework and copper condensate suitable for temperature and pressure of the service.

At all MPCS equipment connections the steam shall have a pressure reducing / filter station. Within this station the the pipework shall change to schedule 10 stainless steel.

The make-up of the pressure regulating/filter station shall comprise of the following:-

- Separator.
- •Separator trap set.
- •Double SG Iron bellows sealed stop valve with throttling plug.
- •Strainer.
- •Pressure gauge.
- •Pilot operated pressure reducing valve.
- •Pressure gauge

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CLEAN STEAM**

- •Safety valve with discharge line vented to atmosphere with vent head. Double Stainless steel bellows sealed stop valve with throttling plug. Change pipework specification to stainless steel at this point.
- •25 Micron steam filter
- •Filter trap set.
- •Filter steam air vent.
- •5 Micron steam filter.
- •Filter trap set.
- •Filter steam air vent.
- •Pressure Gauge
- Double Sstainless steel bellows sealed stop valve with throttling plug.

From this pressure filter station the steam connects to the equipment control valve which shall be manufactured from stainless steel, with a crevice free design.

At all LPCS equipment connections to humidifiers the steam shall have a filter station. Within this station the the pipework shall change to schedule 10 stainless steel.

The make-up of the filter station shall comprise of the following:-

•Separator.

•Separator trap set.

•SG Iron bellows sealed stop valve with throttling plug. •Strainer.

- Double Sstainless steel bellows sealed stop valve with throttling plug. •Change pipework specification to stainless steel at this point. •25 Micron steam filter
- •Filter trap set.
- •Filter steam air vent.
- Micron steam filter.
- •Filter trap set.
- Filter steam air vent.
- •Pressure Gauge
- Double Stainless steel bellows sealed stop valve with throttling plug.

From this filter station the steam connects to the humidifier control valve which shall be manufactured from stainless steel, with a crevice free design.

At all equipment and mains drainage points a fabricated stainless steel steam trapingtrapping set shall be installed, the trapping set shall comprise of the following:-

Isolating stop valve.

- Strainer
- •Float or thermodynamic trap with integral trap monitoring system.

•Non return valve. Isolating stop valve.

All steam/condensate trap sets shall have an integral steam trap monitoring system. Each trap shall be connected either directly or via an interface panel to the BMS system.

The LPR MPR condensate from each tunnel shall return to an electrically pumped condensate receiver situated at the end of within the service tunnel. The MPR condensate will return to the receiver via a steam flash vessel. The flash vessel The package condensate pumping set shall be complete with the following:-

•Vent discharge line vented to atmosphere with vent head. Receiver trapped overflow routed to a drain point
S52

Safety valve with discharge line vented to atmosphere with vent head.Trap set.

From the condensate receivers the condensate is then pumped returned to the packaged steam generators feed water system.

It should be clarified that where steam isolating valve positions are indicated these shall be two steam stop valves with a plugged drain point in the short connecting pipe section.

All steam and condensate pipework shall be fitted with appropriate expansion bellows, loops guides and anchors, as design by the contractor as noted in section A64 clause 520.030.

All services within the plant tower and energy centre shall be on spring vibration hangers to avoid structural borne vibration.

Contractors shall take due cognisance of the specification clause 520. 030 Design Responsibilities.

Under the above clause the pipework and ductwork support system is a contractor's design responsibility, therefore the 2053-Z-(59)-500 series drawings shall be used as generic design intent drawings. VE M 006.

Contractors shall note that under VE M 018 aluminium protection within plant room areas is limited to 2.2 metres above finished floor level.

Please refer to Appendix A for the Preferred Manufacturers List and Appendix B for the Pipework Specification and Appendix C for the Valve Schedule

100.040 CONTROL REQUIREMENTS Refer to Section T13

100.050 SYSTEM SCHEMATICS Refer to RMF - KJ Tait Engineers Schematic drawings 2053 - Z (59) 430, 431 & 432

100.060 SYSTEM DRAWINGS Refer to RMF - KJ Tait Engineers (55) Series Drawings

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.010 GENERAL: Comply with work section general clauses reference Y10.1000 and those detailed below.

210.020 STEEL PIPES AND FITTINGS:

- Fluid conveyed Clean Steam and Condensate
- Austenitic stainless steel tubes for pressure purposes
- Special materials
- Stainless steel to BS EN 10312 reference Y10.2220
- Jointing materials
 - Circular flanges
 - Welding flanges reference Y10.3010A
 - Screwed flanges reference Y10.3010B
 - Jointing rings for circular flanges
 - Non-metallic flat for flanges to BS EN 1092-1 reference Y10.3020A
 - Metallic for flanges to BS EN 1092-1 reference Y10.3020B
 - Screwed joints to BS 21and BS EN 10226-1.

- Union connections
 - Navy pattern reference Y10.3040B
- Welding rods
- Reference Y10.3050A

210.080 GENERAL WORKMANSHIP

- Application Steam & Condensate
- Appearance reference Y10.4010
- Spacing reference Y10.4020
- Gradients reference Y10.4030
- Air venting requirements
 - Automatic air vents reference Y10.4040B
- Drain requirements reference Y10.4050
- Expansion and contraction reference Y10.4060
 - Pipe fittings

•

- Bends/swept tees reference Y10.4070A
- Elbows/square tees reference Y10.4070B
- Pipes through walls and floors reference Y10.4110
- Pipes through walls and floors fire stopping reference Y10.4110#
- Pipe sleeves
 - Reference Y10.4120A
- Insulation carried through reference Y10.4120B
- Pipe sleeves through fire barriers reference Y10.4125
- Connections to equipment reference Y10.4130
 - Temporary plugs, caps and flanges
- Reference Y10.4150A.
- Flanged joints general reference Y10.4160
- Dissimilar metals reference Y10.4170
- Pipe rings and clips reference Y10.4180
- Anchors reference Y10.4190 Location
 - As drawing numbers
- Slide guides reference Y10.4200 Location
- As drawing numbers
- Pipe supports reference Y10.4205
- Support spacing reference Y10.4220
- Isolation and regulation
- Reference Y10.4230A
- Maintenance and renewal reference Y10.4240
- Cleaning reference Y10.4250
- Non-ferrous components reference Y10.4260

210.090 WORKMANSHIP, STEEL PIPEWORK:

- Type
- Application Clean Steam and Condensate
- Welding, general
- Class 1 reference Y10.5010A
- Welded joints reference Y10.5020
- Flanged joints reference Y10.5040
- Screwed joints reference Y10.5050
- Mechanical joints reference Y10.5060
 - Anchors
 - U-bolts reference Y10.5070A
 - Flanges reference Y10.5070B
- Installation of stainless steel pipework
- **KJ TAIT ENGINEERS**

el to BS EN 10312 - reference

110 ference Y10.4110#

20B).4125

- Application Clean Steam and condensate •
- Steam and condense mains
- Trap sets at low points reference Y10.9020A
- Trap sets at low points and at automatic control valves Reference Y10.9020B

211,000 PIPELINE ANCILLARIES

211.030 STOP VALVES:

- Type
- Application
- Manufacturer and reference Refer to valve schedule •
- Or approved equivalent
- Service fluid
- Steam & condensate
- WRAS approved.
- Kitemark certified.
- Pipe material
- To suit steel tube.
- Globe valves to BS 5154
 - Screwed to BS 21 and BS EN 10226-1 reference Y11.2040A
- Flanged to BS EN 1092-3 reference Y11.2040B
- Parallel slide to BS EN 1171
- Reference Y11.2060A

211.100 PIPELINE STRAINERS:

- Application Clean steam & condensate •
- Manufacturer and reference refer to the valve schedule
 - Or approved equivalent

211.140 GAUGES:

- Manufacturer and reference
- Or approved equivalent
- General reference Y11.2700A
 - 100mm finish
 - Direct mounting reference Y11.2700F
- Temperature gauges general reference Y11.2710A
 - Mercury in steel reference Y11.2710B
 - Vapour pressure to BS EN 13190
 - Direct mounting reference Y11.2710C
- Pressure and altitude gauges reference Y11.2720
- Vacuum gauges reference Y11.2730
- Differential pressure gauges
- Gauge mounting boards
 - Hardwood reference Y11.2750A

211.150 CONTROL VALVES:

- Type
- Application
- Manufacturer and reference Refer to valve schedule •
 - Or approved equivalent

211.170 CHECK VALVES:

- Type
- Application •
- Manufacturer and reference refer to valve schedule
- Or approved equivalent

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CLEAN STEAM**

211.180 WORKMANSHIP:

- Installation reference Y11.4010
- Location reference Y11.4020 •
- Positioning of components Control components
- Discharge connections

 - Safety and Relief valves reference Y11.4080A
- Expansion devices reference Y11.4090
- Expansion compensators reference Y11.4100

211.190 PRESSURE REDUCING AND CONTROL VALVES:

- Application Clean steam & condensate
- Manufacturer and reference refer to valve schedule

211.200 DIRECT ACTING SAFETY VALVES TO BS EN ISO 4126-1:

• Type

S52

- Application clean steam & condensate •
- Manufacturer and reference
- Or approved equivalent

211.240 DEAERATORS AND SEPARATORS

- Type
- Application •
- Manufacturer and reference refer to valve schedule • Or approved equivalent

211.260 EXPANSION ARRANGEMENTS/DEVICES:

- Application Clean Steam and Condensate
- Manufacturer and reference Refer to prefered manufactures list Or approved equivalent
- Expansion loops
 - Steel
 - Expansion compensators
- Axial bellows
 - Screwed to BS 21 and BS EN 10226-1 reference Y11.2630A
 - Flanged to BS EN 1092-1 reference Y11.2630B
- Articulated bellows
 - Screwed to BS 21 and BS EN 10226-1 reference Y11.2630D
 - Flanged to BS EN 1092-1 reference Y11.2630E
- Angular bellows

250,000 THERMAL INSULATION

250.010 GENERAL:

Comply with work section general clauses reference Y50.1000 and those detailed below.

- Supply thermal insulation as specified in section
- Supply thermal insulation as schedule reference Y50-Insulation
 - Location

250.015 ZERO GLOBAL WARMING POTENTIAL (GWP): Use insulating materials with a Global Warming Potential (GWP) of zero.

250.017 ZERO OZONE DEPLETION POTENTIAL (ODP): Use insulating materials with an Ozone Depletion Potential (ODP) of zero.

250.020 INSTALLER SELECTION:

Use a contractor specialising in the supply and installation of thermal insulation.

- Or approved equivalent
- Use thermal insulation materials supplied by a manufacturer assessed and registered in accordance with BS ISO 9000-2.

250.030 MINERAL FIBRE THERMAL INSULATION - PIPEWORK:

- Type •
- Application •
- Manufacturer and reference •
- Or approved equivalent
- Temperature of fluid in pipes (°C)
- European Classification for Reaction to Fire Performance
- Class A1 reference Y50.1035A
- Class A2 reference Y50.1035B
- Class B reference Y50.1035C
- Class C reference Y50.1035D
- CFC's and HCFC's reference Y50,1040#
- Spread of flame as BS 476-7
- Reference Y50.1050A
- Smoke emission characteristics
- Reference Y50.1055A
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Materials
- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy
 - For plant design life reference Y50.2015A
 - Details reference Y50.2015B
- Restrictions on use of materials reference Y50.2020
- Mineral fibre pipe insulation
 - Foil faced reference Y50.2030A
- Canvas covered reference Y50.2030B
- Vapour barrier permeance
- Vapour barrier coatings
 - Bitumen reference Y50.2180A
 - Vinyl reference Y50.2180B •
 - Solvent polymers- reference Y50.2180C
 - Bitumen emulsion- reference Y50.2180D
- Adhesives reference Y50.2190 •
- Protection
 - Application
 - Polyisobutylene- reference Y50.2200A •
 - Roofing felt reference Y50.2200B
 - Flat aluminium-zinc coated steel reference Y50.2200C
 - Ribbed aluminium-zinc coated steel reference Y50.2200D •
 - Aluminium sheeting reference Y50.2200E ٠
 - Galvanized sheet steel reference Y50.2200F ٠
 - Canvas - reference Y50.2200G
 - Canvas with aluminium bands reference Y50.2200H
 - PVC reference Y50.22001
 - Laminated foil/film reference Y50.2200J
- Reinforcement
 - Aluminium bands
 - 300mm centres reference Y50.2210A
 - 450mm centres reference Y50.2210B
 - Wire netting
- Valve and flange insulation

Application

S52

S52 / 145

- Thickness table
 - Insulation thickness calculation methods reference Y50.2285
 - Non-domestic hot water supply services reference Y50.2290
 - Non-domestic heating installations reference Y50.2310
- Domestic central heating and hot water systems reference Y50.2330
- Chilled and cold water supplies to prevent condensation
 - High emissivity reference Y50.2350
- Low emissivity reference Y50.2370
- Chilled water services reference Y50.2390
- Protection against freezing reference Y50.2420
- Thickness of insulation

250.040 CLOSED CELL MATERIALS THERMAL INSULATION - PIPEWORK:

- Type
- Application
- Manufacturer and reference
- Or approved equivalent
- Temperature of fluid in pipes (°C)
- European Classification for Reaction to Fire Performance
- Class A1 reference Y50.1035A
- Class A2 reference Y50.1035B
- Class B reference Y50.1035C
- Class C reference Y50.1035D
- CFC's and HCFC's reference Y50.1040#
- Spread of flame as BS 476-7
- Reference Y50.1050A
- Smoke emission characteristics
- Reference Y50.1055A
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Materials
- ٠ Thermal conductivity - reference Y50.2010
- Thermal performance life expectancy
 - For plant design life reference Y50.2015A
 - Details reference Y50.2015B
- Restrictions on use of materials reference Y50.2020
- Closed cell rigid phenolic foam (PF) preformed sections •

 - Foil faced reference Y50.2110A

Bitumen - reference Y50.2180A

• Vinyl - reference Y50.2180B

Adhesives - reference Y50,2190

Reference Y50.2110B

Vapour barrier permeance

Vapour barrier coatings

Protection

KJ TAIT ENGINEERS

Application

- High density phenolic pipe and duct support foam Reference Y50.2130A • Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Closed cell nitrile rubber preformed flexible sections • Reference Y50.2140A

Solvent polymers- reference Y50.2180C

Bitumen emulsion- reference Y50.2180D

Polyisobutylene- reference Y50.2200A

Roofing felt - reference Y50.2200B

Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.

Flat aluminium-zinc coated steel - reference Y50.2200C

S52

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CLEAN STEAM**

- Ribbed aluminium-zinc coated steel reference Y50.2200D
- Aluminium sheeting reference Y50.2200E ٠
- Galvanized sheet steel reference Y50.2200F ٠
- Canvas reference Y50.2200G
- Canvas with aluminium bands reference Y50.2200H
- PVC reference Y50.22001
- Laminated foil/film reference Y50.2200J
- Reinforcement •
 - Aluminium bands
 - 300mm centres reference Y50.2210A
 - 450mm centres reference Y50.2210B
 - Wire netting
- Valve and flange insulation
- Application
- Thickness table
 - Insulation thickness calculation methods reference Y50.2285
 - Non-domestic hot water service areas reference Y50.2300 •
 - Non-domestic heating installations reference Y50.2320
 - Chilled and cold water supplies to prevent condensation •
 - High emissivity reference Y50.2360
 - Low emissivity reference Y50.2380
 - Chilled water services
 - Phenolic foam reference Y50.2400
 - Nitrile rubber reference Y50.2410
 - Protection against freezing
 - Phenolic foam reference Y50.2430
 - Nitrile rubber reference Y50.2440
- Thickness of insulation

250.080 THERMAL INSULATION - PLANT:

- Type
- Application •
- Manufacturer and reference •
- Or approved equivalent
- Temperature of fluid in plant (°C)
- European Classification for Reaction to Fire Performance
- Class A1 reference Y50.1035A
- Class A2 reference Y50.1035B •
- ٠ Class B - reference Y50.1035C
- Class C reference Y50.1035D
- CFC's and HCFC's reference Y50.1040#
- Spread of flame as BS 476-7
- Beference Y50.1050A
- Smoke emission characteristics
- Reference Y50.1055A
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Materials
- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy
 - For plant design life reference Y50.2015A
- Details reference Y50.2015B
- Restrictions on use of materials reference Y50.2020
- Mineral fibre duct insulation
- Rigid •
 - Foil faced reference Y50.2040A
 - Flexible

S52 / 147

- Foil faced reference Y50.2050A
- Lamella duct insulation
 - Foil faced reference Y50.2060A
 - Kraft paper reference Y50.2060B
- Metal mesh faced mattresses
 - Galvanized mesh
 - One face reference Y50.2070A
 - Both faces reference Y50.2070B
 - Stainless steel mesh
 - One face reference Y50.2070C
- Both faces reference Y50.2070D
- Closed cell rigid phenolic foam (PF) slab
 - Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Foil faced reference Y50.2120A
- Reference Y50.2120B
- High density phenolic pipe and duct support foam • Reference Y50.2130A
- Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Closed cell nitrile rubber elastomeric sheet
- Reference Y50.2140A
- Vapour barrier coatings
 - Bitumen reference Y50.2180A
- Vinyl reference Y50.2180B
- Solvent polymers- reference Y50.2180C
- Bitumen emulsion- reference Y50.2180D
- Adhesives reference Y50.2190 •
- Protection
- Application
- Polyisobutylene- reference Y50.2200A
- Roofing felt reference Y50.2200B
- Flat aluminium-zinc coated steel reference Y50.2200C
- Ribbed aluminium-zinc coated steel reference Y50.2200D
- Aluminium sheeting reference Y50.2200E
- Galvanized sheet steel reference Y50.2200F
- Canvas reference Y50.2200G
- Canvas with aluminium bands reference Y50.2200H

300mm centres - reference Y50.2210A

450mm centres - reference Y50.2210B

PVC - reference Y50.22001

Reference Y50.2230A

Aluminium-zinc coated steel

Supply pre-insulated boiler flues

Non-domestic hot water supply services

Supply cylinder jackets

Thickness table

KJ TAIT ENGINEERS

Mineral fibre insulation for boiler flues

- Laminated foil/film reference Y50.2200J
- Reinforcement
 - Aluminium bands ٠

Wire netting

Aluminium

•

Protection for heat exchangers and other vessels

With chest covers - reference Y50.2230B

With aluminium casing - reference Y50.2240A

Pre-insulated storage vessels - reference Y50.2260

Pumps and other irregular shapes - reference Y50.2280

Insulation thickness calculation methods - reference Y50.2285

S52

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CLEAN STEAM**

- Mineral wool reference Y50.2290
- Phenolic foam reference Y50.2300
- Non-domestic heating installations
- Mineral wool reference Y50.2310
- Phenolic foam reference Y50.2320
- Domestic central heating and hot water systems, mineral wool reference Y50.2330
- Chilled water services
- Mineral wool reference Y50.2390
- Phenolic foam reference Y50.2400
- Nitrile rubber reference Y50.2410
- Protection against freezing
 - Mineral wool reference Y50.2420
 - Phenolic foam reference Y50.2430
 - Nitrile rubber reference Y50.2440
- Environmental thickness on warm air ductwork reference Y50.2450
- Condensation control on chilled air ductwork
- Mineral wool reference Y50.2460
- Phenolic foam reference Y50.2470
- Thickness of insulation

250.090 WORKMANSHIP PIPEWORK INSULATION:

- General reference Y50.3010
- Installation of foil faced mineral wool insulation reference Y50.3020
- Installation of foil faced phenolic foam insulation reference Y50.3030
- Installation of insulation with canvas finish reference Y50.3040
- Installation of closed cell nitrile rubber insulation reference Y50.3050
- Installation of protection

٠

- Polyisobutylene (PIB) reference Y50.3120
- Sheet metal finish
- Reference Y50.3130A
- Canvas reference Y50.3150 •
- Roofing felt reference Y50.3160 ٠
- Aluminium sheeting reference Y50.3170 ٠
- Aluminium-zinc coated steel reference Y50.3180 ٠
- Rigid PVC reference Y50.3190
- Laminated foil/film reference Y50.3195
- Flanges and valves reference Y50.3210
- Liners reference Y50.3220
- Installation where insulation is carried through pipeline support
- Reference Y50.3230A
- Closed cell insulation reference Y50.3230B
- Installation where insulation is not carried through pipeline support reference Y50.3240
- Liquid vapour barriers reference Y50.3260
- Integrity of vapour barriers reference Y50.3270

250.100 WORKMANSHIP DUCTWORK INSULATION:

- General reference Y50.3010
- Installation of foil faced semi-rigid slab insulation reference Y50.3060 •
- Installation of foil faced flexible insulation reference Y50.3070
- Installation of foil faced lamella insulation reference Y50.3080 •
- Installation of protection
- Polyisobutylene (PIB) reference Y50.3120
- Sheet metal finish ٠
 - Reference Y50.3140A
 - Reference Y50.3140#
- Canvas reference Y50.3150
- Roofing felt reference Y50.3160

S52 / 149

- Aluminium sheeting reference Y50.3170
- ٠ Aluminium-zinc coated steel - reference Y50.3180
- Rigid PVC reference Y50.3190 •
- Laminated foil/film reference Y50.3195
- Installation of ductwork fire protection insulation reference Y50.3200
- Installation where insulation is not carried through ductline support reference Y50.3240
- Installation where insulation is carried through ductwork support reference Y50.3250 ٠
- Liquid vapour barriers reference Y50.3260 •
- Integrity of vapour barriers reference Y50.3270

250.110 WORKMANSHIP EQUIPMENT INSULATION:

- General reference Y50.3010
- Installation of insulation on tanks reference Y50.3090
- Installation of mineral wool insulation on vessels reference Y50.3100
- Installation of phenolic foam insulation on vessels reference Y50.3110
- Installation of protection
 - Polyisobutylene (PIB) reference Y50.3120 Sheet metal finish •
 - Reference Y50.3140A
 - Reference Y50.3140#
 - Canvas reference Y50.3150
 - Roofing felt reference Y50.3160
 - Aluminium sheeting reference Y50.3170
 - Aluminium-zinc coated steel reference Y50.3180
 - Rigid PVC reference Y50.3190
- Laminated foil/film reference Y50.3195
- Liquid vapour barriers reference Y50.3260 •
- Integrity of vapour barriers reference Y50.3270
- Water tanks reference Y50.3280

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

- Comply with work section general clauses reference Y51.1000 and those detailed below. • Carry out testing and commissioning as specified in section
- 251.040 COMMISSIONING:
- Type
- Application •
- Cleaning ductwork systems reference Y51.3010
- Commissioning codes reference Y51.3020

Boiler plant - reference Y51.3050

• Plant items - reference Y51.3080

- Commissioning
 - Water distribution Including BSRIA pre-commissioning check list Reference Y51.3030A
 - Air distribution

• Instruments and gauges

Distribution

KJ TAIT ENGINEERS

Reference Y51.3090A

Commissioning records

 Including BSRIA pre-commissioning check list Reference Y51.3040A

Refrigerating systems - reference Y51.3060

VAV systems including BSRIA pre-commissioning checklist - reference Y51.3040B

Gas plant and systems - reference Y51.3055

Automatic control systems - reference Y51.3070

• Performance test records - reference Y51.4050 Distribution

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL:

Comply with work section general clauses reference Y54.1000 and those detailed below. Provide identification - mechanical as specified in work section

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

254.040 PLANT AND EQUIPMENT IDENTIFICATION:

- Type
- Application
- Lettering

254.045 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416: Reference Y54.2035

254.050 VALVE AND COCK IDENTIFICATION: Reference Y54,2040

254.090 INSTRUMENT IDENTIFICATION: Reference Y54.2080

254.100 DANGER AND WARNING NOTICES: Reference Y54.2090

254.110 SYSTEM IDENTIFICATION INSTALLATION CHARTS:

- Type
- Application •
- Perspex sheet glazing with frame reference Y54.2100A

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL:

Comply with work section general clauses reference Y90.1000 and those detailed below.

Carry out fixing to building fabric as specified in work section

290.020 FIXINGS:

- Type
- Application •
- Standards reference Y90.2010
- Plugs reference Y90.2020 •
- Screws reference Y90.2030 •
- Cast-in fixings reference Y90.2040
- Shot fired fixings reference Y90.2050
- Self adhesive fixings reference Y90.2060
- Proprietary channel inserts reference Y90.2070
- Non-penetrative support systems reference Y90.2080 • • Manufacturer and reference
 - Or approved equivalent

290.030 WORKMANSHIP:

- Type
- Application

- For air systems To BSRIA Application Guide 3/89.3 - reference Y51.3100A
- For water systems To BSRIA Application Guide 2/89.3 - reference Y51.3100B
- BMS commissioning
- Control system specification details required for commissioning reference Y51.3110
- Pre-commissioning reference Y51.3120
- Plant ready for control system commissioning •
- Reference Y51.3130A
- Control system requirements for plant commissioning reference Y51.3140
- Commissioning reference Y51.3150

251.050 PERFORMANCE TESTING:

• Type

•

- Application •
- System performance testing reference Y51.4010
- Testing of residential ventilation systems reference Y51.4015
- Environmental tests
 - Artificial loads reference Y51.4020A •
 - Ambient Air Quality reference Y51.4020B
 - Reference Y51.4020#
- Recorders reference Y51.4030
- Seven day space temperature recorders
 - Number
 - For (weeks)
- Relative humidity recorders
 - Number
 - For (weeks)
- Testing to specified conditions
 - Rainwater Systems reference Y51.4040A

 - Sanitary Systems reference Y51.4040B
 Cold Water Systems reference Y51.4040C
 Fire Fighting Systems reference Y51.4040D

 - Hydraulic Systems reference Y51.4040E Requirements
 - Medical Gas and Air Systems reference Y51.4040F Laboratory and Industrial Systems
 - Reference Y51.4040G Requirements
 - Gas Systems reference Y51.4040H
 - Silencers and Acoustic Treatment Reference Y51.4040I Noise criteria
 - Acoustic Enclosures reference Y51.4040J
 - Reference Y51.4040#
 - On completion of all static testing carry out a pressure/flow to demonstrate that each system will provide an effective fire fighting jet of 500 litres/min through a 65mm diameter nozzle at a pressure of 4.5 bar measured at the highest outlet.
 - Any inability to sustain this requirement, or any undue pressure loss in the system must be investigated and any remedial work required carried out.
 - Provide temporary pumps and if required, a storage tank to enable all Performance Testing to be carried out.
 - After obtaining and recording the approval of the Fire Officer and the Contract Administrator to the systems, drain down each riser and leave ready for use.
 - All performance testing will be witnessed by the Contract Administrator and will consist of Localised smoke puff tests on selected detectors in all zones to ensure all aspects of the
 - electrical installation, plunger actuation and fire damper operation react as required.
 - The gas bottles will be disconnected during all performance testing.

Laminated plates, multi-coloured with outer layer removed for lettering - reference Y54.2030B

S52

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CLEAN STEAM**

- Drilling reference Y90.3010 •
- Proprietary fixings reference Y90.3020 •
- Fixing to reinforced concrete reference Y90.3030
- Fixing to brickwork reference Y90.3040
- Fixing to timber rails reference Y90.3050
- Fixing to hollow stud/tile/block wall
- Reference Y90.3060A
- Fixing to concrete, brickwork or blockwork
- Reference Y90.3070A
- Fixing to metalwork •
 - Reference Y90.3080A
- Fixing to structural steelwork and concrete structures
- Reference Y90.3090A

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S52

300.000 PRODUCTS/MATERIALS:

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS:

All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.010 PRESSURE REDUCING VALVES - INTEGRAL SENSOR TYPE:

- Application Clean steam and condensate
- Manufacturer and reference refer to valve schedule •
- Or approved equivalent
- Components •
 - Stainless steel valve and seat and return spring.
 - Control spring and handwheel.
 - Integral sensor with an alpha/numeric pressure set-point indicator and locking facility.

300.030 PRESSURE REDUCING VALVES - DIRECT ACTING TYPE:

- Application Clean steam and condensate •
- Manufacturer and reference refer to prefered equipment list and valve schedule
- Or approved equivalent
- Components
- Stainless steel valve and seat and return spring. ٠
- Control spring and handwheel.
- Integral sensor with an alpha/numeric pressure set-point indicator and locking facility.

300.040 PACKAGED CONDENSATE PUMP UNIT - STEAM:

- Type
- Application •
- Manufacturer and reference Refer to Prefered manufacturers list
- Or approved equivalent
- Components
- Steam operated pump.
- Condensate receiver. ٠
- Drain trap set. •
- Inlet strainer. ٠
- Isolating valves.
- Fit pump bodies with flow counters.
- Tubular frame.

300.050 CONDENSATE RECOVERY UNITS:

- Type
- Application Clean Steam and condensate •
 - Manufacturer and reference Refer to preferred manufacturers list • Or approved equivalent
 - Supply packaged type condensate recovery units capable of handling condensate at 98°C. Unit
 - Duplex pump unit.
 - Condensate receivers

 - Copper with copper interconnecting pipework to pump inlet.
 - Copper with mild steel interconnecting pipework to pump inlet.
 - Stainless steel with stainless steel interconnecting pipework.
- Receiver connections •
 - Screwed inlet. •
 - Screwed outlet.
 - Vent.
 - Inspection hatch.
 - Level control.
 - Overflow.
 - Water level gauge.
 - Drain cock.
 - High water level alarm.
 - Pump
- Controls
 - Direct on line starters. •

 - Control panel incorporating contactors, running lights, selector switch for automatic changeover.
 - High water level alarm.

300.080 STEAM SEPARATORS:

- Application Clean steam and condensate
- Manufacturer and reference Refer to valve schedule • Or approved equivalent
- Provide baffle type separators.
- Material •
- Iron bodies.
- Steel bodies.
- Connections
 - Screwed end.
 - Flanged end.
 - Screwed bottom drain.
 - Installation
 - Horizontal.
 - Vertical.

310.000 WORKMANSHIP:

310.010 INSTALLATION: Install steam equipment in accordance with manufacturer's recommendations.

BS APPENDIX

BS 21:1985

Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions).

Partially superseded by BS EN 10226-1:2004

KJ TAIT ENGINEERS

Mild steel galvanized after manufacture with mild steel interconnecting pipework to pump inlet.

Direct on line starter with hand/off/auto selector switch and triple pole changeover switch.

S52

BS EN 10226-1:2004

Pipe threads where pressure tight joints are made on the threads. Part 1 Taper external threads and parallel internal threads. Dimensions, tolerances and designation

BS EN 10312:2002 Welded stainless steel tubes for the conveyance of aqueous liquids including water for human consumption. Technical delivery conditions

BS EN 1092-1:2002 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Part 1 Steel flanges

BS EN 1092-3:2003 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Part 3 Copper alloy flanges

BS ISO 9000-2:1997 Quality management and quality assurance standards. Generic guidelines for the application of ISO 9001, ISO 9002 and ISO 9003

S61 DRY RISERS

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES To provide Fire Fighting facilities in cores identified on the drawings. All in accordance with Building Standards a dry riser installation with inlets at ground level and outlets at all floors.

100.020 DESIGN PARAMETERS Dry riser main installation shall comply in all respects with the current Building Standards Regulations 2000. BS5306 Part 1: 2006 and BS5041 and shall satisfy the requirements of the Fire Prevention Department and HMI

100.030 SYSTEM DESCRIPTION

Dry risers shall be located within each escape stair enclosure.

The dry risers shall be heavy quality galvanised steel piping screwed and socketed or rolled grooved. Fittings shall be galvanised malleable iron. Each dry riser shall be fitted with a 2-way inlet breeching comprising two 65 mm male instantaneous couplings with protective cap and suitable length of chain, two copper allow check valves and a 25 mm drain in a suitable vertical inlet box.

Each inlet box shall have dimensions of 395 mm wide x 595 mm high x 295 mm deep, shall be of galvanised mild steel and have a fall in the base for draining. The door shall be fitted with a night latch type lock and shall be lettered "DRY RISER INLET".

The inlet box frame and door shall be supplied in a polished stainless steel finish to suit the Architect's requirements.

Landing valves shall be polished chrome finish of the oblique pattern globe type. Valves shall be flanged and fitted with a 65 mm instantaneous female coupling with removable blank cap and chain. Valves shall be fitted with a cast iron hand-wheel with open and shut directions.

The outlet box frame and door shall be supplied in a polished stainless steel finish to suit the Architect's requirements

Please refer to Appendix A for the Preferred Manufacturers List and Appendix B for the Pipework Specification

100.050 SYSTEM SCHEMATICS Refer to RMF - KJ Tait Engineers Drawing 2053-Z-(59)-424.

100.060 SYSTEM DRAWINGS Refer to RMF - KJ Tait Engineers Drawing 2053-Z-(53)-series.

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.010 GENERAL: Comply with work section general clauses reference Y10.1000 and those detailed below.

210.020 STEEL PIPES AND FITTINGS:

- Application Dry Riser
- Carbon steel pipes to BS 1387
- Medium, galvanized reference Y10.2010C
- Carbon steel fittings to BS 1387
- Reference Y10.2020A
- Carbon steel fittings to BS 1965-1 Medium weight - reference Y10.2060B

KJ TAIT ENGINEERS

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE DRY RISERS

- Malleable cast iron fittings, screwed ٠
 - Galvanised reference Y10.2070B
 - Fittings, grooved for mechanical joints
 - Galvanised steel reference Y10.2080D
 - Reference Y10.2080#
- Jointing materials
 - Circular flanges
 - Screwed flanges reference Y10.3010B
 - Jointing rings for circular flanges
 - Metallic for flanges to BS EN 1092-1 reference Y10.3020B
 - Screwed joints to BS 21
 - Paste and hemp and PTFE tape reference Y10.3030A
 - PTFE tape reference Y10.3030B
 - Where chemical cleaning is required reference Y10.3030C
 - Mechanical joints, grooved steel pipes ٠
 - Reference Y10.3140A
 - Reference Y10.3140#
 - Flexible flange adapters, sleeve type
 - Reference Y10.3180A

210.070 PIPEWORK ACCESSORIES:

- Pipe rings and clips
- Steel pipework reference Y10.3200A

210.080 GENERAL WORKMANSHIP

- Appearance reference Y10.4010
- Spacing reference Y10.4020
- Gradients reference Y10.4030
- Air venting requirements
 - Automatic air vents reference Y10.4040B
- Drain requirements reference Y10.4050
- Expansion and contraction reference Y10.4060
- Pipe fittings •
 - Bends/swept tees reference Y10.4070A ٠
- Elbows/square tees reference Y10.4070B
- Fabricated junctions reference Y10.4080
- Fabricated fittings
 - Ferrous reference Y10.4090
 - Non-ferrous reference Y10.4100
- Pipes through walls and floors reference Y10.4110
- Pipe sleeves
- Reference Y10.4120A
- Pipe sleeves through fire barriers reference Y10.4125
- Connections to equipment reference Y10.4130
- Temporary plugs, caps and flanges •
 - Reference Y10.4150A.
- Flanged joints general reference Y10.4160
- Dissimilar metals reference Y10.4170
- Pipe rings and clips reference Y10.4180
- Pipe supports reference Y10.4210
- Support spacing reference Y10.4220
- Maintenance and renewal reference Y10.4240
- Cleaning reference Y10.4250
- Non-ferrous components reference Y10.4260

210.090 WORKMANSHIP, STEEL PIPEWORK:

Flanged joints - reference Y10.5040

- Screwed joints reference Y10.5050 • Mechanical joints - reference Y10.5060
- Anchors
 - U-bolts reference Y10.5070A
 - Flanges reference Y10.5070B

211.000 PIPELINE ANCILLARIES

211.010 GENERAL:

Comply with work section general clauses reference Y11.1000 and those detailed below.

211.180 WORKMANSHIP:

- Installation reference Y11.4010
- Location reference Y11.4020 •
- Vent cocks reference Y11.4060
- Terminal unit connections installation reference Y11.4120

211.210 DRAIN COCKS:

- Throughway gland cock type
 - Reference Y11.2440A
- Screwdown to BS 2879, type 1 reference Y11.2450
- Ball type reference Y11.2460

211.220 VENT COCKS:

- Manufacturer and reference
- Norsen Hose Reels, type 211 air release / admittance valve.

Or approved equivalent

225.000 CLEANING AND CHEMICAL TREATMENT

225.010 GENERAL:

Comply with work section general clauses reference Y25.1000 and those detailed below.

225.040 PRELIMINARY CHECKS:

Reference Y25.2030A

225.050 PROCEDURAL PRECAUTIONS:

Reference Y25.2040A

225.090 FLUSHING:

- Application
- BSRIA Application Guide 1/2001 reference Y25.3010A
 - System filling

 - Temporary connection from fire hydrant pipework.
 - By installation of temporary tank and pump arrangement.
- Flushing reference Y25.3010B

225.150 DOCUMENTATION: Reference Y25.3090

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below.

KJ TAIT ENGINEERS

 Temporary connection from mains in compliance with the Water Supply (Water Fittings) Regulations 1999, and the Water Supply (Water Fittings) (Amendment) Regulations 1999.

- 251.030 STATIC TESTING:
- Pressure testing •
 - General reference Y51.2010
 - Fire risers reference Y51.2050
- Testing records reference Y51.2110

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL:

Comply with work section general clauses reference Y54.1000 and those detailed below. Services Identification drawings - reference Y54.2015

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

254.040 PLANT AND EQUIPMENT IDENTIFICATION:

- Lettering •
 - Engraved plates filled with paint reference Y54.2030A ٠
 - Laminated plates, multi-coloured with outer layer removed for lettering reference Y54.2030B
 - Clear perspex back filled to reveal lettering reference Y54.2030C

254.045 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416:

Reference Y54.2035

254.050 VALVE AND COCK IDENTIFICATION: Reference Y54,2040

254,100 DANGER AND WARNING NOTICES: Reference Y54.2090

254.110 SYSTEM IDENTIFICATION INSTALLATION CHARTS:

- Perspex sheet glazing with frame reference Y54.2100A
- Hardboard in hardwood frame and glazed reference Y54.2100B
- Plastic encapsulated chart reference Y54.2100C •

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL:

Comply with work section general clauses reference Y90.1000 and those detailed below.

290.020 FIXINGS:

- Standards reference Y90.2010 •
- Plugs reference Y90.2020
- Screws reference Y90.2030
- Cast-in fixings reference Y90.2040
- Shot fired fixings reference Y90.2050
- Proprietary channel inserts reference Y90.2070

290.030 WORKMANSHIP:

- Drilling reference Y90.3010
- Proprietary fixings reference Y90.3020
- Fixing to reinforced concrete reference Y90.3030
- Fixing to brickwork reference Y90.3040
- Fixing to timber rails reference Y90.3050
- Fixing to hollow stud/tile/block wall
- Reference Y90.3060A
- Fixing to concrete, brickwork or blockwork

Reference Y90.3070A

- Fixing to metalwork
- Reference Y90.3080A
- Fixing to structural steelwork and concrete structures
- Reference Y90.3090A

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S61

300.000 GENEBAL

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.010 STANDARDS: Comply with BS 5306-1.

300.020 FIRE AUTHORITY REQUIREMENTS: Ensure all system components are approved by local Fire Authority and bear Water Authority's stamp of approval and, where required, that of Fire Authority.

300.040 BONDING: Incorporate provision for earth bonding.

310.000 PRODUCTS/MATERIALS

310.010 INLET BREECHINGS:

- Manufacturer and reference
- Norsen Hose Reels, type 217 vertical dry riser inlet cabinet complete with 65mm male Norsen Hose Reels, type 201 inlet breeching.

Or approved equivalent

- Standard BS 5041-3.
- Components
- Instantaneous inlet couplings to BS 336.
- Protecting cap retained by a chain.
- Non-return valve.
- Drain valve.
- Breeching
 - Two-way breeching for 100mm riser.
- Inlet box
 - Standard
 - BS 5041-5, to suit breeching inlet Components
 - - Wired glazed door with lock.
 - Identification.

310.020 LANDING VALVES:

Manufacturer and reference

instantaneous inlets to BS336, caps, chains, non-return valves, 25mm drain valve and 100mm flanged outlet. Inlet cabinet shall be complete with brushed stainless steel frame and door panel.

- Norsen Hose Reels, type CF vertical dry riser outlet cabinet complete with 65mm female ٠ instantaneous outlet to BS336, blank cap, chain strap, padlock and 65mm flanged inlet. Outlet cabinet shall be complete with brushed stainless steel frame, architrave and door panel. Norsen Hose Reels, type 220 landing valve.

Or approved equivalent

- Location •
- Located 750mm above floor level.
- Standard BS 5041-2.
- Components
- Instantaneous coupling to BS 336.
- Protecting cap with retaining chain. •
- Leather strap and padlock to secure valve in closed position.
- Outlet boxes

Install landing valves in purpose made outlet boxes.

Standard ٠ BS 5041-4.

310.030 DRAIN VALVES:

- Manufacturer and reference
- Norsen Hose Reels

Or approved equivalent

Standard •

BS 5041-3. Secure a notice in inlet box to locate system drain valves in accordance with BS 5041-5.

320.000 WORKMANSHIP

320.010 INSTALLATION OF DRY RISERS:

Install and test dry risers in accordance with BS 5306-1.

Install, test and commission all fire protection systems to requirements of local Fire Authority. Make changes in direction with bends or long radius fittings. Extend rising main progressively as building works proceed.

320.020 INSTALLATION OF INLET BOXES: Install inlet boxes in position indicated on drawings.

320.030 SITING OF LANDING VALVES:

Provide landing valves in positions indicated on drawings.

- Siting •
 - Within a ventilated lobby of a lobby approach stairway.
 - In a stairway enclosure.

S61

S65 FIRE HYDRANTS

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES Provision of fire mains and associated ground hydrants to assist fire fighting.

100.020 DESIGN PARAMETERS BS 5588, BS 5041, BS 5306 and Building Standards Regulations 2000

100.030 SYSTEM DESCRIPTION

As indicated on the drawings a single 200 dia fire hydrant ring main shall be installed in the building landscaping. The fire hydrant main shall take an unmetered -water supply connection by others at site boundary.

As indicated on the drawings type 2 WRC approved underground fire hydrants and valve box shall be installed.

100.060 SYSTEM DRAWINGS Refer to RMF - KJ Tait Engineers Drawing 2053-Z-(5-)006

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.010 GENERAL: Comply with work section general clauses reference Y10.1000 and those detailed below.

210.050 PLASTICS PIPES AND FITTINGS:

- Manufacturer Refer to pipework specification Or approved equivalent
- Fluid conveyed Water
- Polyethylene to BS 6730
- Polyethylene to BS 6572
 - Reference Y10.2660A
- Jointing materials
 - Jointing materials for plastics pipes to BS 7291
 - Thermal fusion reference Y10.3095D
 - Reference Y10.3095#

210.080 GENERAL WORKMANSHIP

- Appearance reference Y10.4010
- Spacing reference Y10.4020
- Gradients reference Y10.4030
- Expansion and contraction reference Y10.4060
- Pipe fittings
- Bends/swept tees reference Y10.4070A
- Connections to equipment reference Y10.4130
- Temporary plugs, caps and flanges •
- Reference Y10.4150A.
- Flanged joints general reference Y10.4160 • •
- Isolation and regulation Reference Y10.4230A
- Maintenance and renewal reference Y10.4240
- Cleaning reference Y10.4250

210.120 WORKMANSHIP, PLASTICS PIPES:

Jointing polybutylene pipes and fittings - reference Y10.8050

S65

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE FIRE HYDRANTS

All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.010 STANDARDS: Comply with BS 5306-1

300.020 FIRE AUTHORITY REQUIREMENTS: Ensure all system components are approved by local Fire Authority and bear Water Authority's stamp of approval and, where required, that of Fire Authority.

310.020 UNDERGROUND HYDRANTS:

- Standard
 - Provide underground hydrants in accordance with BS 5306-1 and BS 750.
 - Provide surface box frame and cover in accordance with BS 750.
 - Indicate position of hydrant by use of a plate in accordance with BS 3251.
- 320.000 WORKMANSHIP

320.010 HYDRANTS:

Install and test fire hydrants in accordance with BS 5306-1. Install test and commission all fire protection systems to requirements of local Fire Authority.

210.130 WORKMANSHIP: •

- Protection of buried pipes Unmarked - reference Y10.9040A
- Marked reference Y10.9040B • Location

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below.

251.030 STATIC TESTING:

- Pressure testing •
 - General reference Y51.2010
 - Underground pipework •
 - 1 hour reference Y51.2030A
 - 4 hours reference Y51.2030B
 - Water mains reference Y51.2040
 - Fire risers reference Y51.2050
- Testing records reference Y51.2110
 - Distribution as required in Section A64

251.040 COMMISSIONING:

- Commissioning •
 - Water distribution
 - Including BSRIA pre-commissioning check list Reference Y51.3030A
 - Plant items reference Y51.3080
- Instruments and gauges ٠
- Reference Y51.3090A
- Commissioning records
- Distribution as required in Section A64
- For water systems
- To BSRIA Application Guide 2/89.3 reference Y51.3100B

251.050 PERFORMANCE TESTING:

- System performance testing reference Y51.4010
- Testing to specified conditions
 - Fire Fighting Systems reference Y51.4040D
 - Performance test records reference Y51.4050
 - Distribution as required in Section A64

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL:

Comply with work section general clauses reference Y54.1000 and those detailed below.

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

254.050 VALVE AND COCK IDENTIFICATION: Reference Y54.2040

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S65

300.000 GENERAL

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS:

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES Installation of gaseous fire suppression to protect IT hardware installations

100.020 DESIGN PARAMETERS

The installation must be designed and installed by a specialist contractor to the requirements of BS ISO 14520. The Loss Prevention Certification Board (LPCB) shall approve the design manual and system components.

The installation contractor must carry BAFE LPS 1204 approval.

100.030 SYSTEM DESCRIPTION

A gaseous fire suppression system shall be installed to provide an automatic/manual extinguishing system for the protected areas detailed below:-

•12 x Interstitial Comms Rooms

- •Level 2 Hardware Room
- •UPS Room
- •Level 1 Main Comms Room
- •Level 1 Server Room

The proposed fire extinguishing gas shall be Argonite, which is inert gaseous blend of 50% argon and 50% Nitrogen. The system shall be designed to provide a residual oxygen level of 12-13% allowing operation by personnel whilst in operational mode.

The gaseous fire fighting systems shall be designed using two central individual gas storage systems situated in the interstitial floors. The two N+N systems shall be designed to serve the North and South sides with gas storage within the plant towers.

When a Fire is detected the control panel will send a releasing signal (Automatic Mode) to the appropriate master solenoid on the main cylinder bank and also to the appropriate solenoid on the diverter valve manifold for the Zone area in which a fire has been detected (If in Manual mode the release will need to be made manually using the pull release on the front of the corresponding Gas Suppression Fire Detection panel in alarm).

The master solenoid valves on the cylinder bank will be positioned so they operate all the down stream cylinders but a non-return valve in the pilot line will prevent them cylinders. In this way only the appropriate numbers of cylinders are released for the hazard in alarm.

After a discharge the diverter valve that has been operated needs to be manually closed. The detection circuits should be reset and then a main/reserve change over switch operated such that releasing signals from the main control panel are switched over to the solenoids on the reserve bank of cylinders.

The cylinders that have been discharged from the main bank should be sent away for recharge, in the meantime the system is capable of providing protection from the reserve bank to any one of the eight areas should there be a further fire. If the reserve bank is operated the system will be non-operational until the cylinders from the main bank that have been sent away for re-charge are re-instated.

The system will provide an automatic detection facility operating on a double knock principle. Activation of a detector will sound an alarm condition. The confirmation of a second detector will operate the extinguishing facility automatically after a predetermined delay period. The second alarm distinguishable from the first will warn personnel of an imminent discharge. The activation of a detector will provide an LED indication at the head confirming its operation. The LED will remain lit until the

KJ TAIT ENGINEERS

system is reset. In rooms where the detectors are mounted in the ceiling or floor void a remote indicator will be installed within the room.

The enclosure shall be of adequate integrity to retain the design concentration (to a minimum height of the lowest insurable / fire risk) for a minimum of 10 minutes. The method of prediction shall be by room integrity (fan) test, as prescribed in the BS ISO 14520. If the minimum protected height is unknown, it shall be assumed to be no less than 75% the height of the room

Vents to external spaces shall be automatically dampened closed prior to release of the extinguishant. An inspection shall be made by the Argonite system installer to ensure that all the required dampers, door bottom seals, weather-stripping, caulking, and foam sealant have been installed and that the areas protected shall contain the Argonite to the minimum height for the full ten minutes required.

Where the protected area has a floor void, this too shall be protected, employing a minimum design concentration not below that of the main room compartment.

If a suspended ceiling is present, then all tiles shall be clipped and secured in place.

To limit the pressure in the enclosure to a maximum of 500pa there is a requirement to provide over pressure venting. The contractor shall include with their guotation their calculated free vent area and the number of over pressure vents required. Over pressure vents shall be certified 2 hour fire integrity to BS 476 part 20.

Room integrity testing shall be allowed to test the room prior to final commissioning. The aim of the room integrity test is to quantify leakage from an enclosure and use the total leakage area to provide a gas retention time prediction. A fan unit is fitted into an existing doorway by means of an adjusting frame and is used to pressurise the room. Leakage is guantified by measuring the air flow rate and the developed pressure within the room. A computer programme is then used to predict the retention capability of the enclosure.

The enclosure shall be of adequate integrity to retain the design concentration (to a minimum height of the lowest insurable / fire risk) for a minimum of 10 minutes. The method of prediction shall be by room integrity (fan) test, as prescribed in the BS ISO 14520.

A means of mechanically or naturally ventilating areas after discharge of the extinguishant should be provided.

100.040 CONTROL REQUIREMENTS

See Above and schematic drawing 2053-Z-(67) 003

100.050 SYSTEM SCHEMATICS Refer to RMF - KJ Tait Engineers drawings 2053-Z-(67) 003

100.060 SYSTEM DRAWINGS Contractor design install item

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.010 GENERAL: Comply with work section general clauses reference Y10.1000 and those detailed below.

210.080 GENERAL WORKMANSHIP

• Type

KJ TAIT ENGINEERS

S70

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE GAS FIRE FIGHTING

- Application
- Appearance reference Y10.4010
- Spacing reference Y10.4020
- Gradients reference Y10.4030
- Air venting requirements
 - Air bottles reference Y10.4040A
 - Automatic air vents reference Y10.4040B
- Drain requirements reference Y10.4050
- Expansion and contraction reference Y10.4060 •
- Pipe fittings •
 - Bends/swept tees reference Y10.4070A
- Elbows/square tees reference Y10.4070B
- Pipes through walls and floors reference Y10.4110
- Pipes through walls and floors fire stopping reference Y10.4110#
- Pipe sleeves
 - Reference Y10.4120A
 - Insulation carried through reference Y10.4120B
- Pipe sleeves through fire barriers reference Y10.4125
- Connections to equipment reference Y10.4130 ٠
- Distribution headers reference Y10.4140
- Temporary plugs, caps and flanges
- Reference Y10.4150A.
- Flanged joints general reference Y10.4160
- Dissimilar metals reference Y10.4170
- Pipe rings and clips reference Y10.4180
- Anchors - reference Y10.4190 Location
- As drawing numbers
- Slide guides reference Y10.4200 Location
- As drawing numbers
- Pipe supports reference Y10.4205
- Support spacing reference Y10.4220 •
- Isolation and regulation ٠
- Reference Y10.4230A
- Maintenance and renewal reference Y10.4240
- Cleaning reference Y10.4250
- Non-ferrous components reference Y10.4260 •

210.090 WORKMANSHIP, STEEL PIPEWORK:

- Туре
- Application
- Welding, general
 - Class 1 reference Y10.5010A
- Class 2 reference Y10.5010B
- Welded joints reference Y10.5020
- Painting welded joints reference Y10.5030
- Flanged joints reference Y10.5040
- Screwed joints reference Y10.5050
- Mechanical joints reference Y10.5060 •
- Anchors

KJ TAIT ENGINEERS

- U-bolts reference Y10.5070A
- Flanges reference Y10.5070B
- Pipework painting reference Y10.5090
- Installation of stainless steel pipework
- Compression joints reference Y10.5100

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE GAS FIRE FIGHTING

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL:

Comply with work section general clauses reference Y90.1000 and those detailed below. Carry out fixing to building fabric as specified in work section

290.020 FIXINGS:

• Type

S70

S70 / 167

- Application •
- Standards reference Y90.2010
- Plugs reference Y90.2020
- Screws reference Y90.2030 •
- Cast-in fixings reference Y90.2040
- Shot fired fixings reference Y90.2050
- Self adhesive fixings reference Y90.2060
- Proprietary channel inserts reference Y90.2070
- Non-penetrative support systems reference Y90.2080 • Manufacturer and reference
 - Or approved equivalent

290.030 WORKMANSHIP:

- Type
- Application
- Drilling reference Y90.3010 •
- Proprietary fixings reference Y90.3020 •
- Fixing to reinforced concrete reference Y90.3030
- Fixing to brickwork reference Y90.3040
- Fixing to timber rails - reference Y90.3050
- Fixing to hollow stud/tile/block wall
- Reference Y90.3060A
- Fixing to concrete, brickwork or blockwork •
- Reference Y90.3070A
- Fixing to metalwork
- Reference Y90.3080A
- Fixing to structural steelwork and concrete structures
- Reference Y90.3090A

291.000 OFF-SITE PAINTING AND ANTI-CORROSION TREATMENT

291.010 GENERAL

Comply with work section general clauses reference Y91.1000 and those detailed below. Carry-out off-site painting and anti-corrosion treatment as work section

291.020 PAINT MATERIALS:

- Type
- Application •
- Paint materials
 - Reference Y91.2010A
- Paint guality reference Y91.2020
- Heat resistant paint reference Y91.2030

291.030 WORKMANSHIP

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S70

300.000 GENERAL

KJ TAIT ENGINEERS

Non-penetrative support systems for roof mounted equipment - reference Y90.3100#

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

310.000 PRODUCTS/MATERIALS

310.065 RESERVE FACILITIES:

- Include for a 100% standby facility permanently connected into (the) (each) system at all times including signage to avoid inadvertent manual switch changeover.
- Provide each system with a boxed and wall mounted main/reserve selector switch.
- Provide each unit with L.E.D. indication of bottle bank selection.

310.075 PRESSURE SWITCH:

- Type
- Application •

Install on each system an automatic pressure switch, with manually re-setting to perform discharge signal functions when pressure of the extinguishant is released.

310.080 PRESSURE RELIEF VENTS:

- Type •
- Application •
- Manufacturer and reference •
- Or approved equivalent.
- Provide automatic pressure relief vent to suit gas volume and building restraints.

310.095 DISCHARGE NOZZLES:

Provide and install redial nozzles of the total flood type to give a controlled discharge through a calculated orifice.

310.100 CYLINDERS:

- General
 - Construct the gas cylinders from drawn seamless steel shot blasted and protected against corrosion by a metallised steel coating in accordance with the requirements of BS 5045-7 and BS EN 1964-1.
 - Each cylinder is to be of the required capacity at 200 or 300 bar stored pressure.
 - Ensure all cylinders have a nameplate showing the net quantity and type of gas stored, together with maintenance and recharge instructions.
 - Each cylinder is to be fitted with a pressure gauge indicating when the quantity of stored gas requires 'topping up'.

310.105 CYLINDER VALVES AND ACTUATORS:

- General •
 - Fit on each cylinder bank a solenoid valve or an electrical actuator, the remaining cylinders • being fitted with slave actuators which are pneumatically interconnected to provide simultaneous release of all cylinders.
 - The valves are to be constructed with a brass body with a stainless sleet or brass piston and operate on the pressure differential principle. The body is to incorporate a pressure operated safety disc assembly with facilities for electrical, pneumatic and manual control.
 - Each valve is to be complete with an independent actuator connected to the valve port and fitted with a pilot check valve to enable the actuator to be removed without any loss of pressure.
 - Each actuator port is to be fitted with a low pressure vent valve to prevent release of the gas should a check valve leak.
- Electrical Actuating Control

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE GAS FIRE FIGHTING

- Install a continuous duty type solenoid valve in the closed position to maintain equilibrium in the main cylinder valve.
- Ensure that the electrical connection is made via a flexible connector which may be easily removed for maintenance.
- Ensure any break in the circuit gives a fault signal at the main control panel.
- panel or by the manual release.
- Manual Actuator
 - Supply and fit a manual actuator to the top of the electrical actuator which will over-ride all button or pushing a lever.

310.110 ROOM INTEGRITY:

- Include for carrying out all necessary tests to establish the integrity of the gas protected area(s).
 - Envelope Design Review
 - and specifications, refining details and generally advising.
 - Envelope Construction Phase Review
 - Sealing and Testing of the Enclosure(s)
 - Include for carrying out a series of door fan tests to pressurise and depressurise the tight to pass a final integrity test to NFPA 2001 room integrity procedures.
- Manufacturer and reference
- Or approved equivalent.
- Required retention time

310.115 SIGNS:

Provide and fit adjacent to all entrances and exits to the protected areas(s) BS 5306, Section 5.1 • 'Gas Protected Area' warning signs.

310.120 ODOURISER:

 Include for supplying and installing a distinctive smelling odouriser on (the) (each) system adjacent to the gas storage bottles.

320.000 WORKMANSHIP

320.010 INSTALLATION GENERAL: Install, test and commission all fire protection systems to requirements of local Fire Authority.

BS APPENDIX

BS 5045-7:2000

Transportable gas containers. Part 7 Specification for seamless steel gas containers of water capacity 0.5 L up to 15 L for special portable applications

BS EN 1964-1:2000

Transportable gas cylinders. Part 1 Specification for the design and construction of refillable transportable seamless steel gas cylinders of water capacities from 0.5 litre up to and including 150 litres. Cylinders made of seamless steel with an Rm< value less than 1100 MPa

Ensure that the system operates electrically from either a signal from the extinguishant control

electrical instigation. The unit is to be operated by removing a safety clip and either pressing a

Include for providing a brief guidelines document, reviewing the room envelope, drawings

 Allow for two site visits, the first at an early stage to ensure that the partition construction operatives are aware of the air tightness standards that are required, and the second visit towards the end of the envelope construction process to visually inspect the envelope and issue a brief report listing those areas that potentially could leak and require upgrading.

room(s), identify leakage areas, then gradually seal (the) (each) room until it is sufficiently

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PACKAGED STEAM GENERATORS

T13 PACKAGED STEAM GENERATORS

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES

Provision of clean steam distributed around the building for laboratory process and ventilation humidification requirements

100.020 DESIGN PARAMETERS

The clean steam system has a peak load of 2,350 kW. The packaged clean steam system will achieve the following recommended chemistry limits for clean steam generators:

100.030 SYSTEM DESCRIPTION

The packaged steam generating system will generate medium pressure steam to serve the filtered clean steam systems that serve the humidification and process systems.

As indicated in section S52 the packaged steam boilers shall serve a single mediumpressure steam distribution system.the following two systems:-

•A Medium pressure steam (MPCS) at a pressure of 100 psi (690 KPA) 445KPA will run within each service tunnel and rise as indicated to serve the autoclaves glasswashers, humidifiers, fermentation vessels and other process equipment. All connections to equipment shall have pressure reducing stations before connection to any item of equipment. •Low pressure steam (LPCS) at a pressure of 103KPA will run within each service tunnel and rise as indicated with the plant towers to serve the main air handling unit humidifiers.

Three gas fired packaged steam generators shall be installed within the energy centre to provide steam at a minimum pressure of 100 psi (690 Kpa)445 KPa. The boilers shall be fully packed CE marked and constructed to exceed BS2790 1992 class 1.

The boiler package shall include the following:-

- •Packaged control system which shall be fully integrated into the main BMS system.
- •Fully modulating gas fired burners to operate at an intake gas pressure of 13.5 KPa.
- •Reverse Osmosis Wwater treatment and chemical dosage plant to treat pre softened water from the domestic water system.
- •Feed water system complete with steam injection.
- •Twin feed water pumps with auto change over facility to each boiler
- •Blow down separator
- •High integrity self monitoring water level limiters
- Automatic TDS blowdown system
- •Automatic main blowdown valve

The exhaust flues shall rise from the steam boilers and run in a 50mm thick insulated twin wall stainless steel packaged flue system. The flues exit the energy centre at high level and are then routed to the top of the adjacent plant tower. The steam boiler flues shall be connected into the same flue system that serves the both the water heating system. The flue shall be constructed from stainless steel grade 304/316 inner /outer skins.

The flue contractor shall be responsible for all flue system expansion devices, brackets, anchors and guides.

Boiler Room Combustion/Ventilation Air - The boiler room will be provided with positive pressure combustion/ventilation air units, one matched to each boiler, one for the clean steam generators and one for the water heaters. The air units will be packaged heating and ventilation type with outdoor air

damper, 30% efficient pre-filter, LTHW heating coil, draw through fan section and gravity operated discharge shutter. Heating coils will have 2-way control valves with coil circulating pumps for added freeze protection. Relief air dampers with limited cross ventilation ductwork will be provided to discharge excess air not consumed by the combustion process. The air units will be interlocked to run whenever the associated gas fired equipment is operational. Additionally, space thermostat will be provided to control ventilation sequence and regulate heating capacity during the winter months.

The steam system throughout will constructed in welded and steel pipework to suit size and pressure, whilst the condensate shall be copper pipework to suit size and pressure.

All services within the plant tower and energy centre shall be on spring vibration hangers to avoid structural borne vibration.

Please refer to Appendix A for the Preferred Manufacturers List and Appendix B for the Pipework Specification and Appendix C for the Valve Schedule

100.050 SYSTEM SCHEMATICS Refer to RMF - KJ Tait Engineers Schematic drawings 2053 - Z (59) 420, 430, 431 & 432

100.060 SYSTEM DRAWINGS Refer to RMF - KJ Tait Engineers (55) Series Drawings

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.010 GENERAL: Comply with work section general clauses reference Y10.1000 and those detailed below.

210.015 SANITARY FITTINGS:

Comply with work section general clauses reference Y10.1000 and those detailed below. • As schedule reference

210.020 STEEL PIPES AND FITTINGS:

- Application clean steam and condensate
- Austenitic stainless steel tubes for pressure purposes •
 - Reference Y10.2250A
 - Reference Y10.2250B
- Special materials
- Stainless steel to BS EN 10312 reference Y10.2220
- Jointing materials
 - Circular flanges
 - Welding flanges reference Y10.3010A
 - Screwed flanges reference Y10.3010B
 - Jointing rings for circular flanges
 - Non-metallic flat for flanges to BS EN 1092-1 reference Y10.3020A
 - Metallic for flanges to BS EN 1092-1 reference Y10.3020B
 - Screwed joints to BS 21and BS EN 10226-1.
 - PTFE tape reference Y10.3030B
 - Where chemical cleaning is required reference Y10.3030C
 - Reference Y10.3030#
 - Union connections
 - Railroad pattern reference Y10.3040A
 - Navy pattern reference Y10.3040B
 - Welding rods
 - Reference Y10.3050A

210.090 WORKMANSHIP, STEEL PIPEWORK:

T13/173

250.000 THERMAL INSULATION

250.010 GENERAL:

Comply with work section general clauses reference Y50.1000 and those detailed below.

- Supply thermal insulation as specified in section
- Supply thermal insulation as schedule reference Y50-Insulation
- Location

250.015 ZERO GLOBAL WARMING POTENTIAL (GWP): Use insulating materials with a Global Warming Potential (GWP) of zero.

250.017 ZERO OZONE DEPLETION POTENTIAL (ODP): Use insulating materials with an Ozone Depletion Potential (ODP) of zero.

250.020 INSTALLER SELECTION:

- Use a contractor specialising in the supply and installation of thermal insulation.
- Use one of the specialist companies listed below
- Or approved equivalent
- Use thermal insulation materials supplied by a manufacturer assessed and registered in accordance with BS ISO 9000-2.

250.040 CLOSED CELL MATERIALS THERMAL INSULATION - PIPEWORK:

- Type
- Application •
- Manufacturer and reference
- Or approved equivalent
- Temperature of fluid in pipes (°C)
- European Classification for Reaction to Fire Performance
 - Class A1 reference Y50.1035A
- Class A2 reference Y50.1035B
- Class B reference Y50.1035C
- Class C reference Y50.1035D
- CFC's and HCFC's reference Y50.1040#
- Spread of flame as BS 476-7
- Reference Y50.1050A
- Smoke emission characteristics •
- Reference Y50.1055A
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Materials
- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy •
 - For plant design life reference Y50.2015A
 - Details reference Y50.2015B
- Restrictions on use of materials reference Y50.2020
- Closed cell rigid phenolic foam (PF) preformed sections •
- Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
 - Foil faced reference Y50.2110A
 - Reference Y50.2110B
- High density phenolic pipe and duct support foam Reference Y50.2130A Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Closed cell nitrile rubber preformed flexible sections Reference Y50.2140A
- Vapour barrier permeance
- Vapour barrier coatings
 - Bitumen reference Y50.2180A
 - Vinyl reference Y50.2180B
 - Solvent polymers- reference Y50.2180C

- Type
- Application •
 - Welding, general Class 1 - reference Y10.5010A
 - Class 2 reference Y10.5010B
- Welded joints reference Y10.5020
- Painting welded joints reference Y10.5030
- Flanged joints reference Y10.5040
- Screwed joints reference Y10.5050
- Mechanical joints reference Y10.5060
- Anchors
 - U-bolts reference Y10.5070A
 - Flanges reference Y10.5070B
- Pipework painting reference Y10.5090
- Installation of stainless steel pipework
 - Compression joints reference Y10.5100

210.120 WORKMANSHIP, PLASTICS PIPES:

- Туре
- Application •
- Solvent welded joints, PVC reference Y10.8010
- Fusion joints, PE reference Y10.8020
- Mechanical fittings, PE reference Y10.8030
- Anchors, PVC reference Y10.8040
- Jointing polybutylene pipes and fittings reference Y10.8050

210.130 WORKMANSHIP:

- Type •
- Application
- Steam and condense mains
 - Trap sets at low points reference Y10.9020A
- Trap sets at low points and at automatic control valves Reference Y10.9020B

211.000 PIPELINE ANCILLARIES

211.260 EXPANSION ARRANGEMENTS/DEVICES:

- Manufacturer and reference Refer to prefered manufacturers list
- Or approved equivalent
- Expansion loops
- Steel •
 - Reference Y11.2610A
- Expansion compensators
 - Axial bellows
 - Screwed to BS 21 and BS EN 10226-1 reference Y11.2630A
 - Flanged to BS EN 1092-1 reference Y11.2630B
 - Bevelled for welding reference Y11.2630C
 - Grooved ends reference Y11.2630J
 - Articulated bellows
 - Screwed to BS 21 and BS EN 10226-1 reference Y11.2630D
 - Flanged to BS EN 1092-1 reference Y11.2630E
 - Bevelled for welding reference Y11.2630F

Flanged to BS EN 1092-1 - reference Y11.2630H

Bevelled for welding - reference Y11.2630I

Angular bellows

KJ TAIT ENGINEERS

Reference Y11.2630#

Screwed to BS 21 and BS EN 10226-1 - reference Y11.2630G

- Bitumen emulsion- reference Y50.2180D
- Adhesives reference Y50.2190
- Protection
 - Application
 - Polyisobutylene- reference Y50.2200A
 - Roofing felt reference Y50.2200B
 - Flat aluminium-zinc coated steel reference Y50.2200C
 - Ribbed aluminium-zinc coated steel reference Y50.2200D •
 - Aluminium sheeting reference Y50.2200E
 - Galvanized sheet steel reference Y50.2200F
 - Canvas reference Y50.2200G
 - Canvas with aluminium bands reference Y50.2200H
 - PVC reference Y50.22001
 - Laminated foil/film reference Y50.2200J
- Reinforcement
 - Aluminium bands •
 - 300mm centres reference Y50.2210A
 - 450mm centres reference Y50.2210B
 - Wire netting
- Valve and flange insulation
- Application
- Thickness table
- Insulation thickness calculation methods reference Y50.2285
- Non-domestic hot water service areas reference Y50.2300
- Non-domestic heating installations reference Y50.2320
- Chilled and cold water supplies to prevent condensation
 - High emissivity reference Y50.2360
 - Low emissivity reference Y50.2380
- Chilled water services
- Phenolic foam reference Y50.2400
- Nitrile rubber reference Y50.2410
- Protection against freezing
 - Phenolic foam reference Y50.2430
- Nitrile rubber reference Y50.2440
- Thickness of insulation

250.080 THERMAL INSULATION - PLANT:

- Type •
- Application
- Manufacturer and reference
- Or approved equivalent
- Temperature of fluid in plant (°C)
- European Classification for Reaction to Fire Performance
 - Class A1 reference Y50.1035A •
 - Class A2 reference Y50.1035B
 - Class B reference Y50.1035C
- Class C reference Y50.1035D
- CFC's and HCFC's reference Y50.1040#
- Spread of flame as BS 476-7
- Reference Y50.1050A
- Smoke emission characteristics
- Reference Y50.1055A
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Materials
- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy

T13/175

- For plant design life reference Y50.2015A
 - Details reference Y50.2015B
- Restrictions on use of materials reference Y50.2020
- Mineral fibre duct insulation
 - Rigid
 - Foil faced reference Y50.2040A
 - Flexible
 - Foil faced reference Y50.2050A
 - Lamella duct insulation
 - Foil faced reference Y50.2060A
 - Kraft paper reference Y50.2060B
 - Metal mesh faced mattresses
 - Galvanized mesh
 - One face - reference Y50.2070A
 - Both faces reference Y50.2070B
 - Stainless steel mesh
 - One face reference Y50.2070C
 - Both faces reference Y50.2070D
- Closed cell rigid phenolic foam (PF) slab

 - Foil faced reference Y50.2120A
 - Reference Y50.2120B
- High density phenolic pipe and duct support foam Reference Y50.2130A
- Closed cell nitrile rubber elastomeric sheet •
- Reference Y50.2140A
- Vapour barrier coatings
 - Bitumen reference Y50.2180A
 - Vinyl reference Y50.2180B
 - Solvent polymers- reference Y50.2180C
- Bitumen emulsion- reference Y50.2180D
- Adhesives reference Y50.2190 •
- Protection

•

•

•

Reinforcement

Aluminium bands

Wire netting

• Supply pre-insulated boiler flues

General - reference Y50.3010

Installation of protection

Sheet metal finish

KJ TAIT ENGINEERS

- Application •
- Polyisobutylene- reference Y50.2200A
- Roofing felt reference Y50.2200B

Canvas - reference Y50.2200G

PVC - reference Y50.22001

- Flat aluminium-zinc coated steel reference Y50.2200C
- Ribbed aluminium-zinc coated steel reference Y50.2200D
- Aluminium sheeting reference Y50.2200E

Laminated foil/film - reference Y50.2200J

300mm centres - reference Y50.2210A

450mm centres - reference Y50.2210B

Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.

Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.

Galvanized sheet steel - reference Y50.2200F

Canvas with aluminium bands - reference Y50.2200H

250.090 WORKMANSHIP PIPEWORK INSULATION:

Installation of foil faced phenolic foam insulation - reference Y50.3030

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PACKAGED STEAM GENERATORS

T13

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PACKAGED STEAM GENERATORS

- Reference Y50.3130A
- Aluminium sheeting reference Y50.3170
- Aluminium-zinc coated steel reference Y50.3180
- Laminated foil/film reference Y50.3195
- Flanges and valves reference Y50.3210
- Liners reference Y50.3220
- Installation where insulation is carried through pipeline support
- Reference Y50.3230A
- Closed cell insulation reference Y50.3230B
- Installation where insulation is not carried through pipeline support reference Y50.3240
- Liquid vapour barriers reference Y50.3260
- Integrity of vapour barriers reference Y50.3270

250.110 WORKMANSHIP EQUIPMENT INSULATION:

- General reference Y50.3010
- Installation of phenolic foam insulation on vessels reference Y50.3110
- Installation of protection
 - Sheet metal finish
 - Reference Y50.3140A
 - Reference Y50.3140#
 - Aluminium sheeting reference Y50.3170
 - Aluminium-zinc coated steel reference Y50.3180

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below.

Carry out testing and commissioning as specified in section

251.020 SPECIALIST:

- Use one of the following specialist commissioning engineers
- Or approved equivalent

251.030 STATIC TESTING:

- Application Clean steam and condensate
- Pressure testing
 - General reference Y51.2010 ٠
 - Water circulating and supply systems and steam and condense lines reference Y51.2020
 - Gas pipework
 - HVCA Guide TR6 reference Y51.2060A
 - To BS EN 12327 reference Y51.2060B
 - To IGE/UP/1 reference Y51.2060C
 - To IGE/UP/1A reference Y51.2060D
- On completion of all cleaning, flushing and air testing operations, recharge each system with clean water and subject them to sectional hydraulic tests of one and a half times the working pressure.
- There is to be no loss of pressure for a period of not less than 30 minutes for each test.
- Testing records reference Y51.2110
- Distribution

251.040 COMMISSIONING:

- Type •
- Application Clean steam and condensate
- Commissioning codes reference Y51.3020
- Commissioning
 - Water distribution
 - Including BSRIA pre-commissioning check list Reference Y51.3030A
 - Boiler plant reference Y51.3050

- Gas plant and systems reference Y51.3055
- Automatic control systems - reference Y51.3070
- Plant items reference Y51.3080
- Instruments and gauges
 - Reference Y51.3090A
- Commissioning records
- Distribution •
- For water systems
- To BSRIA Application Guide 2/89.3 reference Y51.3100B
- BMS commissioning •
- Control system specification details required for commissioning reference Y51.3110 •
- Pre-commissioning reference Y51.3120
- Plant ready for control system commissioning • Reference Y51.3130A
- Control system requirements for plant commissioning reference Y51.3140
- Commissioning reference Y51.3150

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL:

- Comply with work section general clauses reference Y54.1000 and those detailed below.
- Provide identification mechanical as specified in work section

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

254.030 DUCTWORK IDENTIFICATION: Reference Y54.2020

254.040 PLANT AND EQUIPMENT IDENTIFICATION:

- Type
- Application
- Lettering

254.045 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416:

Reference Y54.2035

254.050 VALVE AND COCK IDENTIFICATION: Reference Y54.2040

254.100 DANGER AND WARNING NOTICES: Reference Y54.2090

254.110 SYSTEM IDENTIFICATION INSTALLATION CHARTS:

- Type
- Application
- Perspex sheet glazing with frame reference Y54.2100A

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL:

Comply with work section general clauses reference Y90.1000 and those detailed below. Carry out fixing to building fabric as specified in work section

290.020 FIXINGS:

- Type
- Application

KJ TAIT ENGINEERS

Laminated plates, multi-coloured with outer layer removed for lettering - reference Y54.2030B

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PACKAGED STEAM GENERATORS

T13

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PACKAGED STEAM GENERATORS

- Standards reference Y90.2010 •
- Plugs reference Y90.2020 •
- Screws reference Y90.2030
- Cast-in fixings reference Y90.2040
- Proprietary channel inserts reference Y90.2070

290.030 WORKMANSHIP:

- Type
- Application •
- Drilling reference Y90.3010 •
- Proprietary fixings reference Y90.3020
- Fixing to reinforced concrete reference Y90.3030
- Fixing to brickwork reference Y90.3040
- Fixing to concrete, brickwork or blockwork
- Reference Y90.3070A
- Fixing to metalwork
- Reference Y90.3080A
- Fixing to structural steelwork and concrete structures
- Reference Y90.3090A
- Non-penetrative support systems for roof mounted equipment reference Y90.3100#

PART 3 SPECIFICATION CLAUSES SPECIFIC TO T13

300.000 GENERAL

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.010 PERFORMANCE:

Thermal performance of boilers for steam, hot water and high temperature heat transfer fluids in accordance with BS 845-1.

310.000 PRODUCTS/MATERIALS

310.010 STEAM GENERATOR:

- Application Clean steam and condensate
- Manufacturer and reference Refer to prefered preferred manufacturers list and equipment schedule
 - Or approved equivalent.
- Duty as schedule reference refer to RMF KJ Tait drawing 2053-Z-(59)708-D

310.020 BLOW DOWN VALVES - PARALLEL SLIDE TYPE:

- Application Clean steam and condensate
- Manufacturer and reference Packaged as part of unit •

310.030 BLOW DOWN TANKS:

- Application Clean steam and condensate
- Manufacturer and reference Packaged as part of unit •

310.050 CHIMNEYS AND FLUES:

- Application Clean steam and condensate
- Manufacturer and reference Refer to prefered preferred equipment manufacturers list Or approved equivalent
- Regulations
- **KJ TAIT ENGINEERS**

KJ TAIT ENGINEERS

• Ensure chimney heights comply with Clean Air Act Memorandum. Standards

- For outputs less than 60kW comply with BS 5440-1.
- Comply with BS 5854.
- Material
- Supply metal system chimney components in accordance with BS EN 1856-1 and BS EN 1856-2.

320.000 WORKMANSHIP

320.010 INSTALLATION:

Install all equipment on purpose made bases or supports, capable of carrying load of equipment. Comply with manufacturer's installation instructions. Install site erected equipment to manufacturer's instructions. Ensure joints are pressure tested prior to installation of lagging and casings. Replace all damaged equipment, lagging and casings.

320.030 CHIMNEY AND FLUE INSTALLATION:

- Install flue in accordance with BS 5854.
- Install factory made chimneys to BS EN 1856-1 and BS EN 1856-2 in accordance with BS 7566-3.

BS APPENDIX

BS 21:1985

Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions) Partially superseded by BS EN 10226-1:2004

BS 5440-1:2000

Installation and maintenance of flues and ventilation for gas appliances of rated input not exceeding 70 kW net (1st, 2nd and 3rd family gases). Part 1 Specification for installation and maintenance of flues

BS 5854:1980 Code of practice for flues and flue structures in buildings

BS 7566-3:1992 Installation of factory-made chimneys to BS 4543 for domestic appliances. Part 3 Specification for site installation

BS 845-1:1987 Methods for assessing thermal performance of boilers for steam, hot water and high temperature heat transfer fluids. Concise procedure

BS EN 10226-1:2004 Pipe threads where pressure tight joints are made on the threads. Part 1 Taper external threads and parallel internal threads. Dimensions, tolerances and designation

BS EN 10312:2002 Welded stainless steel tubes for the conveyance of aqueous liquids including water for human consumption. Technical delivery conditions

BS EN 1092-1:2002 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Part 1 Steel flanges

BS EN 12327:2000 Gas supply systems. Pressure testing, commissioning and decommissioning procedures. Functional requirements

T13

BS EN 1856-1:2003

Chimneys. Requirements for metal chimneys. Part 1 System chimney products

BS EN 1856-2:2004

Chimneys. Requirements for metal chimneys. Part 2 Metal liners and connecting flue pipes

BS ISO 9000-2:1997 Quality management and quality assurance standards. Generic guidelines for the application of ISO 9001, ISO 9002 and ISO 9003

T14 HEAT PUMPS

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES Production of Chilled Water and LPHW Heating by geothermal heat pumps

100.020 DESIGN PARAMETERS Refer to T60

100.030 SYSTEM DESCRIPTION

Generally as indicated on the drawings a complete packaged geothermal heat pump system shall be designed and installed to provide primary chilled water and heating to the project. The geothermal heat pump system shall be designed and installed by a specialist contractor who will <u>under take</u> undertake the complete project. The final system shall generally comply with the RMF - K.J Tait schematic layouts.

A geothermal heat pump package utilising a closed loop borehole field in the primary rejection circuit shall be designed to serve the packaged heat pump layout as indicated on the generic layout. The primary loop pipework shall run from the heat pump plant room with a flow pipe running down the west tunnel and the return down the east tunnel. The tunnel flow and return pipework has been provisionally sized at 200 mm diameter and shall be installed by the services contractor when the prefabricated tunnel pipework and support system is installed. The tunnel pipework will stop 3 metres short at the borehole end and opposite the heat pump room at the other end with isolating valves and shall be fully tested and flushed. The specialist contractor shall extend from the isolating valves through the tunnel wall to the borehole field at one end and into the heat pump room at the other.

From the ends of the tunnel the flow and return pipes break out into the designated borehole field which is sited under the buildings car park. The pipework shall break out from the tunnels and shall terminate in a service vault which shall house the individual borehole system loops. A minimum of five valved and monitored loops shall run from the service vaults to the boreholes generally as indicated on the drawings.

The geothermal heat pump system will provide the first stage heating and cooling water for the building services systems. As the proposed borehole field will not be sufficient to provide the full system capability the specialist contractor shall provide within his tender a heat load profile for the proposed installation. This profile shall be used to determine the final central equipment heating and cooling loads. The generic system does reflect the current requirements from the system and shall be used as a guide, however the borehole field is the system maximum limitation.

A 100 metre deep test bore hole and conductivity test was undertaken during October 2008 and the test results are tabled in appendix D for determining the capacity of the proposed boreholes. Also a drawing indicating the limits of the proposed borehole field is also included in appendix D and shall be used to determine the number of boreholes that can be constructed.

The geothermal heat pump package shall utilise closed loop thermal piles in the primary heat rejection circuit. The thermal piles are structural piles with two continuous closed pipework loops within each structural pile. Every structural pile shall have the closed loop pipework installed within the pile and the packed contractor shall connect the piles with four system loops connected to the heat pump system.

The primary rejection system consists of 592 closed loop geothermal piles connected into four ground loops. Two ground loops are connected to six cooling, five heating and one standby reverse cycle heat pump units. A further two loops are connected to the other six cooling, five heating and one reverse cycle stand by unit.

KJ TAIT ENGINEERS

T14

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE HEAT PUMPS

Heavy weight - reference Y10.2060A

Galvanised - reference Y10.2070B

Fittings, grooved for mechanical joints

Cast iron - reference Y10.2080A

Black steel - reference Y10.2080B

Flanges to BS EN 1092-1 PN

• Reference Y10.3010#

• Reference Y10.3020#

Jointing rings for circular flanges

Painted cast iron - reference Y10.2080C

Galvanised steel - reference Y10.2080D

• Welding flanges - reference Y10.3010A Screwed flanges - reference Y10.3010B

Medium weight - reference Y10.2060B

• Reference Y10.2010#

Reference Y10.2020#

Carbon steel fittings to BS 1965-1

Reference Y10.2060#

Reference Y10.2070#

Reference Y10.2080#

• Jointing materials Circular flanges

• Malleable cast iron fittings, screwed Black - reference Y10.2070A

 Carbon steel fittings to BS EN 10255 Reference Y10.2020A

Ground Source Heat Pumps ---

The Ground source heat pumps (GSHP) will generate chilled water and LPHW via twenty four heat pumps. SixTen GSHP units will be generating hot water, with twelve units generating chilled water and two reverse cycle units units on stand by. The nominal total cooling load generated by the GSHP system will 1560 kW, whilst the nominal heating capacity will be 1400 kW. The two standby reverse cycle units will have automatic valved connections to allow the use of the unit in either heating or cooling mode

Chilled water will be generated and circulated in the GSHP secondary loop at 6 ℃. The heat pumps and secondary loop will be sized to handle a nominal heating water temperature difference of 6.7 °C resulting in an average design return water temperature of 12.7 °C.

LPHW heating will be generated and circulated in the GSHP secondary loop at 48.9 °C. The heat pumps and secondary loop will be sized to handle a nominal heating water temperature difference of 5.6 °C resulting in an average design return water temperature of 43.3 °C.

The Geothermal contractors system shall finish the secondary pipework system at valved connections in the heat pump plant room for extension to the main system by others.

The contractor shall allow for BMS interfaces to the following:-

•Connect to the heat pump control module to collect set point values, sensor outputs and unit alarms.

- •Temperature sensors as indicated on the schematics.
- •Flow meters as indicated on the drawings.
- Automatic control valves.
- •System fill unit alarm signal.
- •Pumps run status.
- •Pump alarm status.

Please refer to Appendix A for the Preferred Manufacturers List, and Appendix B for the Pipework Specification Appendix C for the Valve Schedule and Appendix D for the borehole field layout and test results.

100.050 SYSTEM SCHEMATICS Refer to RMF - KJ Tait Engineers Schematic drawings 2053 - Z (59) 430, 433, 436 & 436A

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.010 GENERAL: Comply with work section general clauses reference Y10.1000 and those detailed below.

210.020 STEEL PIPES AND FITTINGS:

- Application Heat Pump system Chilled and LPHW
- Carbon steel pipes to BS EN 10255
 - Heavy, black reference Y10.2010A
 - Medium, black reference Y10.2010B
 - Medium, galvanized reference Y10.2010C
 - Heavy, black, grooved ends reference Y10.2010E ٠
 - Medium, black, grooved ends reference Y10.2010F
 - Heavy, galvanized, grooved ends reference Y10.2010G
 - Medium, galvanized, grooved ends reference Y10.2010H

Screwed joints to BS 21and BS EN 10226-1.

•

•

- Paste and hemp and PTFE tape reference Y10.3030A
- PTFE tape reference Y10.3030B •
- Where chemical cleaning is required reference Y10.3030C
- Reference Y10.3030# •
- Union connections
 - Railroad pattern reference Y10.3040A
 - Navy pattern reference Y10.3040B
 - Reference Y10.3040#
- Welding rods
 - Reference Y10.3050A
 - Reference Y10.3050#
- Mechanical joints, grooved steel pipes
 - Reference Y10.3140A
 - Reference Y10.3140#
- Mechanical joints, plain end steel pipes
 - Reference Y10.3150A
 - Reference Y10.3150#
- Flexible couplings, sleeve type
 - Reference Y10.3170A
 - Reference Y10.3170#
- Flexible flange adapters, sleeve type
 - Reference Y10.3180A
 - Reference Y10.3180#

210.050 PLASTICS PIPES AND FITTINGS:

- Application Heat pump rejection loop
- Manufacturer Refer to prefered manufacturers list •
 - Or approved equivalent

T14 / 183

 Non-metallic flat for flanges to BS EN 1092-1 - reference Y10.3020A Metallic for flanges to BS EN 1092-1 - reference Y10.3020B

- Polyethylene pipe reference Y10.2520 •
- Polyethylene pipe to BS EN 1555 reference Y10.2528
- Polyethylene fittings reference Y10.2530
- Polyethylene fusion fittings to BS EN 1555 reference Y10.2538
- Polyethylene to WIS 4-32-17
 - Reference Y10.2665A
 - Reference Y10.2665#
- Polyethylene to BS EN 12201
 - Reference Y10.2668A
 - Reference Y10.2668B •
 - Reference Y10.2668# •
- Fittings reference Y10.2669#
- Special materials
 - Polyethylene to BS EN 13244 reference Y10.2653#
- Jointing materials
 - Jointing materials for plastics pipes to BS 7291
 - Reference Y10.3095#
- 210.080 GENERAL WORKMANSHIP
- Appearance reference Y10.4010
- Spacing reference Y10.4020
- Gradients reference Y10.4030 •
- Air venting requirements
 - Air bottles reference Y10.4040A
 - Automatic air vents reference Y10.4040B
 - Reference Y10.4040#
- Drain requirements reference Y10.4050
- Expansion and contraction reference Y10.4060
- Pipe fittings
 - Bends/swept tees reference Y10.4070A
 - Elbows/square tees reference Y10.4070B
- Reference Y10.4070#
- Fabricated junctions reference Y10.4080
- Fabricated fittings ٠
 - Ferrous reference Y10.4090
 - Non-ferrous reference Y10.4100
- Pipes through walls and floors reference Y10.4110
- Pipes through walls and floors fire stopping reference Y10.4110#
- Pipe sleeves
 - Reference Y10.4120A
 - Insulation carried through reference Y10.4120B ٠
 - Reference Y10.4120#
- Pipe sleeves through fire barriers reference Y10.4125
- Proprietary pipe sleeves through fire barriers reference Y10.4125#
- Connections to equipment reference Y10.4130
- Distribution headers reference Y10.4140 ٠
- Temporary plugs, caps and flanges •
 - Reference Y10.4150A.
 - Reference Y10.4150#
- Flanged joints general reference Y10.4160 •
- Dissimilar metals reference Y10.4170
- Pipe rings and clips reference Y10.4180
- Pipe supports reference Y10.4205
- Support spacing reference Y10.4220
- Isolation and regulation
- Reference Y10.4230A
- Reference Y10.4230# •

T14

- C0605LMB Revised Stage E Mechanical Specification Including Agreed VE HEAT PUMPS
- Maintenance and renewal reference Y10.4240 •
- Cleaning - reference Y10.4250
- Non-ferrous components reference Y10.4260

210.120 WORKMANSHIP, PLASTICS PIPES:

- Solvent welded joints, PVC reference Y10.8010
- Fusion joints, PE reference Y10.8020
- Mechanical fittings, PE reference Y10.8030 •
- Anchors, PVC reference Y10.8040 •
 - Jointing polybutylene pipes and fittings reference Y10.8050

210.130 WORKMANSHIP:

- Protection of underground pipework reference Y10.9030 Location
- Protection of buried pipes
 - Unmarked reference Y10.9040A
- Marked reference Y10.9040B
- Steelwork painting
 - Reference Y10.9120A

225.000 CLEANING AND CHEMICAL TREATMENT

225.020 CLEANING AND CHEMICAL TREATMENT SPECIALIST:

- Application
- Reference Y25.2010 •
- Use one of the following specialists Refer to prefered manufacturers list
 - Or approved equivalent

225.030 MAINS WATER ANALYSIS:

- The following is an analysis of mains water taken from site supply point:-
 - Conductivity (uS/cm)
 - Total Dissolved Solids (mg/l)
 - pН •
 - Chloride CI (mg/l)
 - Calcium Ca (mg/l)
 - Magnesium Mg (mg/l)
 - Sodium Na (mg/l)
 - Potassium K (mg/l)
 - Total Hardness CaC0₃ •
 - Alkalinity CaC0₃ •
 - Total Iron Fe (ug/I)
 - Copper Cu (ug/l)

225.040 PRELIMINARY CHECKS:

Application •

Application

KJ TAIT ENGINEERS

•

•

•

Reference Y25.2030A •

Reference Y25.2040A

225.050 PROCEDURAL PRECAUTIONS:

Packaged plant - reference Y25.2060C

Dosing chemicals - reference Y25.2065

Including taking samples - reference Y25.2040B

225.060 CHEMICAL INJECTION AND DOSING METHODS: Method of introducing chemicals into closed systems - reference Y25.2060A Method of introducing chemicals into open recirculating systems - reference Y25.2060B

Dosing for closed systems - reference Y25.2060D

T14

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE HEAT PUMPS

250.017 ZERO OZONE DEPLETION POTENTIAL (ODP): Use insulating materials with an Ozone Depletion Potential (ODP) of zero.

250.020 INSTALLER SELECTION:

- Use a contractor specialising in the supply and installation of thermal insulation.
- Use thermal insulation materials supplied by a manufacturer assessed and registered in accordance with BS ISO 9000-2.

250.040 CLOSED CELL MATERIALS THERMAL INSULATION - PIPEWORK:

- Type
- Application •
- Manufacturer and reference
- Or approved equivalent
- Temperature of fluid in pipes (°C)
- European Classification for Reaction to Fire Performance Class A1 - reference Y50.1035A
 - Class A2 reference Y50.1035B

 - Class B reference Y50.1035C
- Class C reference Y50.1035D
- CFC's and HCFC's reference Y50,1040#
- Spread of flame as BS 476-7
- Reference Y50.1050A
- Smoke emission characteristics
- Reference Y50.1055A
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Materials •
- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy
 - For plant design life reference Y50.2015A Details - reference Y50.2015B
- Restrictions on use of materials reference Y50.2020
- Closed cell rigid phenolic foam (PF) preformed sections
- Foil faced reference Y50.2110A
- Reference Y50.2110B •
- High density phenolic pipe and duct support foam Reference Y50.2130A
- Closed cell nitrile rubber preformed flexible sections Reference Y50.2140A
- Vapour barrier permeance
- Vapour barrier coatings
 - Bitumen reference Y50.2180A
 - Vinyl reference Y50.2180B
 - Solvent polymers- reference Y50.2180C
 - Bitumen emulsion- reference Y50.2180D
- Adhesives reference Y50.2190 •
- Protection
- Application
- Polyisobutylene- reference Y50.2200A
- Roofing felt reference Y50.2200B
- Flat aluminium-zinc coated steel reference Y50.2200C
- Ribbed aluminium-zinc coated steel reference Y50.2200D
- Aluminium sheeting reference Y50.2200E ٠
- Galvanized sheet steel reference Y50.2200F
- Canvas reference Y50.2200G
- Canvas with aluminium bands reference Y50.2200H

225.070 MONITORING AND SAMPLING:

- Type
- Application
- Manufacturer and reference
- Or approved equivalent
- Monitoring reference Y25.2070A
- Remote location
- Sampling reference Y25.2070B
- Sampling kits reference Y25.2070C

225.080 CHEMICAL PROVISION:

- Type •
- Application
- Standard arrangement reference Y25.2080A

225.085 AVOIDANCE OF STAGNANT WATER IN PRESSURISATION UNIT EXPANSION VESSELS:

Reference Y25.2090

225.090 FLUSHING:

- Application
- BSRIA Application Guide 1/2001 reference Y25.3010A
 - Svstem fillina
 - Temporary connection from mains in compliance with the Water Supply (Water Fittings) Regulations 1999, and the Water Supply (Water Fittings) (Amendment) Regulations 1999.
 - By installation of temporary tank and pump arrangement.
- Flushing reference Y25.3010B

225.135 WATER TREATMENT:

Reference Y25.3075#

225.140 SERVICE VISITS:

- Reference Y25.3080
- Special requirements
 - At 6 monthly intervals carry out chlorination of the cooling tower circuit, and the cold and hot water domestic services.
 - Adopt procedures as indicated in HSE L8.
 - Include for 6 visits during the first 2 months commissioning ٠
 - Provide one annual review of system. ٠
 - Four times per annum send samples to independent laboratory for differential micro-biological • analysis.
 - Include for carrying out all necessary maintenance and inspections during the first twelve months following the agreed date of practical completion.
 - Use only fully qualified operatives for any maintenance carried out.

225.150 DOCUMENTATION:

Reference Y25.3090

250.000 THERMAL INSULATION

250.010 GENERAL:

Comply with work section general clauses reference Y50.1000 and those detailed below.

Supply thermal insulation as specified in section

250.015 ZERO GLOBAL WARMING POTENTIAL (GWP):

Supply thermal insulation as schedule reference Y50-Insulation

Use insulating materials with a Global Warming Potential (GWP) of zero.

Location

Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.

• Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.

- PVC reference Y50.22001
- Laminated foil/film reference Y50.2200J
- Reinforcement
- Aluminium bands
 - 300mm centres reference Y50.2210A
 - 450mm centres reference Y50.2210B
- Wire netting
- Valve and flange insulation
- Application
- Thickness table
- Insulation thickness calculation methods reference Y50.2285
- Non-domestic hot water service areas reference Y50.2300
- Non-domestic heating installations reference Y50.2320
- Chilled and cold water supplies to prevent condensation
 - High emissivity reference Y50.2360
 - Low emissivity reference Y50.2380
- Chilled water services
 - Phenolic foam reference Y50.2400
 - Nitrile rubber reference Y50.2410
- Protection against freezing
 - Phenolic foam reference Y50.2430
- Nitrile rubber reference Y50.2440
- Thickness of insulation

250.090 WORKMANSHIP PIPEWORK INSULATION:

- General reference Y50.3010
- Installation of foil faced phenolic foam insulation reference Y50.3030
- Installation of protection •
- Sheet metal finish
 - Reference Y50.3130A
- Flanges and valves reference Y50.3210
- Liners reference Y50.3220 •
- Installation where insulation is carried through pipeline support •
 - Reference Y50.3230A
- Closed cell insulation reference Y50.3230B
- Liquid vapour barriers reference Y50.3260
- Integrity of vapour barriers reference Y50.3270

251,000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below.

Carry out testing and commissioning as specified in section

251.020 SPECIALIST:

Use one of the following specialist commissioning engineers

Or approved equivalent

251.030 STATIC TESTING:

- Type
- Application •
- Pressure testing
 - General reference Y51.2010
 - Water circulating and supply systems and steam and condense lines reference Y51.2020 •
 - Underground pipework
 - 4 hours reference Y51.2030B
- On completion of all cleaning, flushing and air testing operations, recharge each system with clean water and subject them to sectional hydraulic tests of one and a half times the working pressure.

- C0605LMB Revised Stage E Mechanical Specification Including Agreed VE HEAT PUMPS
- There is to be no loss of pressure for a period of not less than 30 minutes for each test.
- Testing records - reference Y51.2110 Distribution

251.040 COMMISSIONING:

Type

T14

- Application
- Cleaning ductwork systems reference Y51.3010
- Commissioning codes reference Y51.3020 •
- Commissioning •
 - Water distribution Including BSRIA pre-commissioning check list Reference Y51.3030A
 - Refrigerating systems reference Y51.3060
 - Automatic control systems reference Y51.3070
 - Plant items reference Y51.3080
- Instruments and gauges
 - Reference Y51.3090A
- Commissioning records
 - Distribution
 - For water systems To BSRIA Application Guide 2/89.3 - reference Y51.3100B
- BMS commissioning •
- Control system specification details required for commissioning reference Y51.3110
- Pre-commissioning reference Y51.3120 •
- Plant ready for control system commissioning
- Reference Y51.3130A
- Control system requirements for plant commissioning reference Y51.3140
- Commissioning reference Y51.3150

251.050 PERFORMANCE TESTING:

- Type •
- Application
- System performance testing reference Y51.4010
- Environmental tests
- Artificial loads reference Y51,4020A
- Ambient Air Quality reference Y51.4020B
- Reference Y51.4020#
- Recorders reference Y51.4030
 - Seven day space temperature recorders • Number
 - For (weeks)
 - Relative humidity recorders
 - Number
 - For (weeks)
- Testing to specified conditions
 - Rainwater Systems reference Y51.4040A
 - Sanitary Systems reference Y51.4040B
 - Cold Water Systems reference Y51.4040C
 - Fire Fighting Systems reference Y51.4040D
 - Hydraulic Systems reference Y51.4040E Requirements

Laboratory and Industrial Systems

Gas Systems - reference Y51.4040H

Silencers and Acoustic Treatment

Reference Y51.4040G

Requirements

KJ TAIT ENGINEERS

Medical Gas and Air Systems - reference Y51.4040F

> Reference Y51.4040I Noise criteria

- ٠ Acoustic Enclosures - reference Y51.4040J
- Reference Y51,4040#
- On completion of all static testing carry out a pressure/flow to demonstrate that each system will provide an effective fire fighting jet of 500 litres/min through a 65mm diameter nozzle at a pressure of 4.5 bar measured at the highest outlet.
 - Any inability to sustain this requirement, or any undue pressure loss in the system must be investigated and any remedial work required carried out.
 - Provide temporary pumps and if required, a storage tank to enable all Performance Testing to be carried out.
- After obtaining and recording the approval of the Fire Officer and the Contract Administrator to the systems, drain down each riser and leave ready for use.
- All performance testing will be witnessed by the Contract Administrator and will consist of
 - Localised smoke puff tests on selected detectors in all zones to ensure all aspects of the electrical installation, plunger actuation and fire damper operation react as required.
 - The gas bottles will be disconnected during all performance testing.
- Performance test records reference Y51.4050
- Distribution

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL:

Comply with work section general clauses reference Y54.1000 and those detailed below.

Provide identification - mechanical as specified in work section

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

254.030 DUCTWORK IDENTIFICATION: Reference Y54.2020

254.040 PLANT AND EQUIPMENT IDENTIFICATION:

- Type
- Application • •
- Lettering
- Laminated plates, multi-coloured with outer layer removed for lettering reference Y54.2030B

254.045 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416:

Reference Y54.2035

254.050 VALVE AND COCK IDENTIFICATION: Reference Y54.2040

254.090 INSTRUMENT IDENTIFICATION: Reference Y54.2080

254.100 DANGER AND WARNING NOTICES: Reference Y54.2090

254.110 SYSTEM IDENTIFICATION INSTALLATION CHARTS:

- Type
- Application
- Perspex sheet glazing with frame reference Y54.2100A

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL:

KJ TAIT ENGINEERS

Comply with work section general clauses reference Y90.1000 and those detailed below. Carry out fixing to building fabric as specified in work section

290.020 FIXINGS:

- Standards reference Y90.2010
- Plugs reference Y90.2020
- Screws reference Y90.2030
- Cast-in fixings reference Y90.2040
- Proprietary channel inserts reference Y90.2070 •

290.030 WORKMANSHIP:

- Drilling reference Y90.3010
- Proprietary fixings reference Y90.3020 •
- Fixing to reinforced concrete reference Y90.3030 •
- Fixing to brickwork reference Y90.3040
- Fixing to concrete, brickwork or blockwork •
- Reference Y90.3070A
- Fixing to metalwork
- Reference Y90.3080A
- Fixing to structural steelwork and concrete structures Reference Y90.3090A

PART 3 SPECIFICATION CLAUSES SPECIFIC TO T14

300.000 PRODUCTS/MATERIALS

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.040 WATER-TO-WATER HEAT PUMP:

 Manufacturer and reference Refer to prefered manufacturers list Or approved equivalent

Supply heat pump complete with evaporator and drain pan, compressor, condenser and expansion valve.

• Z (59) 706

300.050 VERTICAL GROUND ARRAY COLLECTOR:

- Type
- Application
- Manufacturer/supplier and reference Refer to prefered manufacturers list
- Or approved equivalent.

Engage a borehole specialist to develop design, supply, install including all civil works, commission and set to work the borehole.

Supply heat pump complete with vertical ground collector and circulation pump. • Water to water.

- Z (59) 705 & 706

310.000 WORKMANSHIP

310.010 INSTALLATION: Install heat pump in accordance with manufacturer's recommendations.

T14

Duty as schedule reference Refer to RMF - KJ Tait Engineers equipment schedule drawing 2053 -

Duty as schedule reference Refer to RMF - KJ Tait Engineers equipment schedule drawing 2053 -

BS 1965-1:1963

Specification for butt-welding pipe fittings for pressure purposes. Part 1 Carbon steel. Replaced by BS EN 10253-1:1999 but remains current

BS EN 10226-1:2004 Pipe threads where pressure tight joints are made on the threads. Part 1 Taper external threads and parallel internal threads. Dimensions, tolerances and designation

BS EN 10255:2004 Non-alloy steel tubes suitable for welding or threading. Technical delivery conditions

BS EN 1092-1:2002 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Part 1 Steel flanges

BS ISO 9000-2:1997 Quality management and quality assurance standards. Generic guidelines for the application of ISO 9001, ISO 9002 and ISO 9003

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PRIMARY HEAT DISTRIBUTION

T20 PRIMARY HEAT DISTRIBUTION

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES Installation of LTHW Boiler plant, Ancillary Plant and Distribution system to provide the primary heating distribution service to the building.

100.020 DESIGN PARAMETERS See System Description

100.030 SYSTEM DESCRIPTION

The Primary Heat Distribution network within the building is generated by a mixture of geothermal ground source heat pumps and high efficiency gas fired boilers.

Gas Fired Boilers - Low temperature heating water (LTHW) will be generated centrally by two 1400 kW output gas fired high efficiency condensing boilers, operating in parallel and connected to a common primary pipe header.

There will also be space provisions for an additional future 1400 kW output condensing boiler and associated pumps/piping to be installed to meet potential future increased load requirements. Heating water will be generated and circulated in the primary heating loop at 8249 °C.

Two gas fired low NOx packaged condensing hot water boilers shall be installed within the energy centre to provide low pressure hot water. The boilers shall be fully CE marked and PED approved.

The boiler package shall include the following:-

•Packaged control system which shall be fully integrated into the main BMS system. •Fully modulating gas fired burners to operate at an intake gas pressure of 13.5 KPa.

•Shell and 3 Single pass tube vertical tube condensing construction

- •Hinged top entry access door. •Safety valve.
- •Flow temperature indication.

 High temperature thermostat with manual reset. •Flue gas temperature indication.

The boilers and primary loop will be sized to handle a nominal heating water temperature difference of 16.5 6.0 °C resulting in an average design return water temperature of 65.5 43.0 °C.

Heating primary water will be injected into the secondary heating system via a three port control valve to provide secondary heating water at a temperature of 48.9 °C. The secondary loop and equipment is sized to create a nominal return water temperature differential of 5.6 °C resulting in an average return water temperature of 43.3 ℃.

Boilers will be vented through double wall stainless steel flues which penetrate the Energy Centre roof into the chiller compound. and are routed to the top of the adjacent plant tower. A gas monitoring system shall be installed to monitor and measure the carbon monoxide levels in the chiller compound. The detection system shall interface with the BMS control system to provide a warning of high carbon monoxide levels in the area, and a local alarm sounder/beacon. -

Ground Source Heat Pumps - Ground source heat pumps (GSHP) will generate hot water and chilled water via twenty four heat 20 pumps. Ten 6 GSHP units will be generating hot water, with twelve units generating chilled water and two reverse cycle units units on stand by.

The total heat generated by the GSHP system will 1400 ?? kW.

T14

T20

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PRIMARY HEAT DISTRIBUTION

Heating water will be generated and circulated in the GSHP secondary loop at 48.9 °C. The heat pumps and secondary loop will be sized to handle a nominal heating water temperature difference of 5.6 ℃ resulting in an average design return water temperature of 43.5 ℃.

The combined LTHW - GSHP heating system will have four (4) expansion tanks, an air separator with a twin pump make up unit complete with a 32 mm quick fill makeup water connection which includes de-coupling section, isolation valves, backflow preventor and pressure gauges.

The expansion tank capacity will be sized to handle the peak expansion volume of the heating system with one of the four (4) tanks out of service.

For details of heat pump units see section T14

Boiler Room Combustion/Ventilation Air - The boiler room will be provided with positive pressure combustion/ventilation air units, one matched to each boiler, one for the clean steam generators and one for the water heaters. The air units will be packaged heating and ventilation type with outdoor air damper, 30% efficient pre-filter, LTHW heating coil, draw through fan section and gravity operated discharge shutter.

Heating coils will have 2-way control valves with coil circulating pumps for added freeze protection. Relief air dampers with limited cross ventilation ductwork will be provided to discharge excess air not consumed by the combustion process. The air units will be interlocked to run whenever the associated gas fired equipment is operational. Additionally, space thermostat will be provided to control ventilation sequence and regulate heating capacity during the winter months.

The combustion/ventilation air units are nominally sized to provide 0.50 litres per second of total combustion/ventilation air per kW input capacity of the gas fired equipment. Heating coil capacity is based on minus 6.7 °C entering air temperature and 10 °C leaving air temperature. Combustion/ventilation air units are sized as follows:

- Boilers Installed: CVAU-1 and 2 - 820 litres per second •
- CVAU-3 820 litres per second (allowance only). Boilers (future):
- CVAU-4 1.390 litres per second Steam Generators:
- Hot Water Generators: CVAU-5 1,190 litres per second

For details of the secondary heating distribution system see section T31.

100.040 CONTROL REQUIREMENTS

Each boiler will be provided with automatic isolation valves so that as the building load increases or decreases boilers can be staged on and off to match the required capacity. Heating water will be circulated at a constant volume through boilers with matching fixed speed primary heating pumps, which operate in a duty/standby mode whenever the boiler plant is required.

The pumps will automatically change over on a fault condition or under a duty share function after a preset period of time as dictated by the BMS. Run and fault indication will be displayed at the BMS for each pump, along with positive run indication via a differential pressure switch piped across each pump head.

2 No LPHW and 2 No GSHP heating variable speed pumpsets serving secondary variable volume circuits within the building.

Pipework pressure will be monitored by sensors within each riser by the BMS and the variable speed pumps adjusted to suit the load conditions.

Each pumpsets operates in a duty/standby mode whenever zone heating is required. The pumps will automatically change over on a fault condition or under a duty share function after a preset period of time as dictated by the BMS. Run and fault indication will be displayed at the BMS for each pump, along with positive run indication via a differential pressure switch piped across each pumpset. A

variable flow control strategy will be adopted using a pump capable of variable flow control. A centrifugal pump with variable speed drive will be used to match heat supply to demand.

4 No combustion air handling units interlocked with the associated gas fired boiler, hot water heater or steam generators. Each air handling unit shall be complete with intake damper, pre-filter, face and by pass heater battery, heating coil circulating pump and 2 speed motors on units CVAU 4 & 5)

1 No twin pump system pressurisation unit. This will be a package system provided with pump trip, common fault and low pressure indication for use with the BMS. The pressurisation unit will be energised permanently and a low pressure alarm will shutdown all relevant pump and boiler plant.

Gas safety shut down system shall be design and installed complete with BMS and fire alarm interfaces.

The pumps, air handling units, pressurisation unit, de-areator and associated BMS controls will be powered and wired by the controls specialist from the associated HVAC control panel.

All services within the plant tower and energy centre shall be supported on spring vibration hangers to avoid structural borne vibration.

Please refer to Appendix A for the Preferred Manufacturers List and Appendix B for the Pipework Specification.

100.050 SYSTEM SCHEMATICS Refer to RMF - KJ Tait Engineers Schematic drawings 2053 - Z (59) 430, 436 & 457

100.060 SYSTEM DRAWINGS Refer to RMF - KJ Tait Engineers (55) Series Drawings

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.010 GENERAL:

Comply with work section general clauses reference Y10.1000 and those detailed below. Supply pipes and fittings as specified in work section T31

210.020 STEEL PIPES AND FITTINGS:

- Type
- Application
- Fluid conveyed
 - Working pressure
 - Working temperature
- Carbon steel pipes to BS 1387
 - Heavy, black reference Y10.2010A
 - Medium, black reference Y10.2010B
 - Medium, galvanized reference Y10.2010C
 - Heavy, galvanized reference Y10.2010D ٠
 - Heavy, black, grooved ends reference Y10.2010E
 - Medium, black, grooved ends reference Y10.2010F
 - Heavy, galvanized, grooved ends reference Y10.2010G
 - Medium, galvanized, grooved ends reference Y10.2010H
 - Reference Y10.2010#
- Carbon steel fittings to BS 1387
 - Reference Y10.2020A
 - Reference Y10.2020#
- Non-alloy seamless steel tubes to BS EN 10216-1 reference Y10.2030#
- Non-alloy and alloy seamless steel tubes to BS EN 10216-2 reference Y10.2040#

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PRIMARY HEAT DISTRIBUTION

- Non-alloy welded steel tubes to BS EN 10217-1 reference Y10.2050# •
- Non-alloy and alloy welded steel tubes to BS EN 10217-2 reference Y10.2055#
- Stainless steel push-fit fittings reference Y10.2257
- Carbon steel fittings to BS 1965-1
- Heavy weight reference Y10.2060A
- Medium weight reference Y10.2060B
- Reference Y10.2060#
- Malleable cast iron fittings, screwed
 - Black reference Y10.2070A
 - Galvanised reference Y10.2070B
 - Reference Y10.2070#
- Fittings, grooved for mechanical joints
 - Cast iron reference Y10.2080A ٠
 - Black steel reference Y10.2080B
 - Painted cast iron reference Y10.2080C
 - Galvanised steel reference Y10.2080D ٠
 - Reference Y10.2080#
- Compression couplings to BS EN ISO 8434-1
 - Steel reference Y10.2215A ٠
 - Stainless steel reference Y10.2215B
 - Reference Y10.2215#
- Austenitic stainless steel to BS 3605 •
- Reference Y10.2250A
- Reference Y10.2250#
- Stainless steel, grooved for mechanical joints
- Reference Y10.2255A
- Reference Y10.2255#
- Special materials
 - Wrought steel fittings to BS EN 10241 reference Y10.2090#
 - Wrought carbon and ferritic alloy steel fittings to BS 1640-3 reference Y10.2100#
 - Forged carbon and alloy steel to BS 3799 reference Y10.2110# ٠
 - Wrought and cast austenitic chromium-nickel steel fittings to BS 1640-4 reference ٠ Y10.2120#
 - Carbon steel to BS 534 reference Y10.2130# ٠
 - Non-alloy steel tubes to BS EN 10224 reference Y10.2135#
 - Alloy fine grain seamless steel tubes to BS EN 10216-3 reference Y10.2140#
 - Alloy fine grain welded steel tubes to BS EN 10217-3 reference Y10.2145#
 - Submerged arc welded non-alloy and alloy steel tubes to BS EN 10217-5 reference ٠ Y10.2150#
 - Submerged arc welded non-alloy steel tubes to BS EN 10217-6 - reference Y10.2155#
 - Non alloy and alloy seamless steel tubes to BS EN 10216-4 reference Y10.2160#
 - Non-allov welded steel tubes to BS EN 10217-4 reference Y10.2170#
 - Carbon & stainless steel compression couplings to BS 4368-1- reference Y10.2200#
 - Stainless steel to BS EN 10312 reference Y10.2220
 - Austenitic stainless steel to BS 4825-1 reference Y10.2230#
 - Austenitic stainless steel to BS 4825-2, BS 4825-3, BS 4825-4, BS 4825-5 reference Y10.2240#
- Jointing materials •
- Circular flanges
 - Flanges to BS EN 1092-1 PN
 - Welding flanges reference Y10.3010A
 - Screwed flanges reference Y10.3010B
 - Reference Y10.3010#
- Jointing rings for circular flanges
 - Non-metallic flat for flanges to BS EN 1092-1 reference Y10.3020A
 - Metallic for flanges to BS EN 1092-1 reference Y10.3020B
 - Reference Y10.3020#

T20 / 197

T20

Screwed to BS 21 - reference Y11.2630A

Expansion compensators

Axial bellows

- Flanged to BS EN 1092-1 reference Y11.2630B
- Bevelled for welding reference Y11.2630C Grooved ends - reference Y11.2630J

Galvanized after manufacture.

- Hose compensators
- Screwed to BS 21 reference Y11.2640A
- Flanged to BS EN 1092-1 reference Y11.2640B

- C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PRIMARY HEAT DISTRIBUTION
 - Screwed joints to BS 21
 - Paste and hemp and PTFE tape reference Y10.3030A
- PTFE tape reference Y10.3030B
 - Where chemical cleaning is required reference Y10.3030C
 - Reference Y10.3030#
 - Union connections
 - Railroad pattern reference Y10.3040A
 - Navy pattern reference Y10.3040B
 - Reference Y10.3040#
 - Welding rods
 - Reference Y10.3050A
 - Reference Y10.3050#
 - Use press fitting jointing system for stainless steel pipe to BS 3605.
 - Jointing equipment for press fitting jointing system reference Y10.3125
 - Press fittings for stainless steel pipe reference Y10.3130#
 - Use press fitting jointing system for thin walled carbon steel pipe. • Jointing equipment for press fitting jointing system - reference Y10.3125
 - Press fittings for thin walled carbon steel pipe reference Y10.3132#
 - Use press fitting jointing system for copper pipe.
 - Jointing equipment for press fitting jointing system reference Y10.3125
 - Press fittings for copper pipe reference Y10.3135#
 - Mechanical joints, grooved steel pipes
 - Reference Y10.3140A
 - Reference Y10.3140#
 - Mechanical joints, plain end steel pipes
 - Reference Y10.3150A
 - Reference Y10.3150#
 - Mechanical joints, grooved stainless steel pipes
 - Reference Y10.3152A
 - Reference Y10.3152#
 - Flexible couplings, sleeve type
 - Reference Y10.3170A
 - Reference Y10.3170#
 - Flexible flange adapters, sleeve type

211.260 EXPANSION ARRANGEMENTS/DEVICES:

Reference Y10.3180A

Reference Y11.2610A

Copper - reference Y11.2620

Reference Y10.3180#

211.000 PIPELINE ANCILLARIES

211.010 GENERAL:

Expansion loops

Steel

•

Comply with work section general clauses reference Y11.1000 and those detailed below.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PRIMARY HEAT DISTRIBUTION

- Motors over temperature protection •
- Thermistors reference Y92.2060A
- Drives
- Indirect drives
 - Flat belt reference Y92.2070B
- Direct coupled drives
 - Reference Y92.2080A
- Variable speed drive reference Y92.2085
 - Guards
 - Reference Y92.2090A

220.050 PUMP MOTOR STARTER:

- Incorporated in Control/monitoring reference W60.
 - Comply with reference section general clauses reference Y72.1000 and those detailed below.
 - Electrical supply
 - 3 phase reference Y72.1010A
 - Single phase reference Y72.1010B
 - General
 - Motors below 0.37kW reference Y72.2130A
 - Motors above 0.37kW reference Y72.2130B
 - Current limiting type reference Y72.2140
 - Direct-on-line type reference Y72.2150
 - Star delta type reference Y72.2160
 - Auto-transformer type
 - Reference Y72.2170A
 - Inverter type
 - Reference Y72.2190A
 - Automatic changeover for run/standby duty
 - Single power supply reference Y72.2200
 - Workmanship, installation reference Y72.3010

220.060 WORKMANSHIP:

General - reference Y20.4010 Pipeline connections - reference Y20.4020 Mountings - reference Y20.4030 Alignment - reference Y20.4040 Access - reference Y20.4050

Flexible connections •

- EPDM rubber, up to 100°C
- Flanged to BS EN 1092-1 reference Y11.2650A
- Screwed to BS 21 reference Y11.2650B
- Terminal unit connections
 - Heating services
 - Stainless steel reference Y11.2660A
 - Stainless steel with guick release couplings Reference Y11.2660B
 - Rubber reference Y11.2660C
 - Chilled water services
 - Stainless steel reference Y11.2660D
 - Stainless steel with quick release couplings • Reference Y11.2660E

220.000 PUMPS

220.010 GENERAL:

Comply with work section general clauses reference Y20.1000 and those detailed below.

• Provide pumps as schedule reference Y20-Pumps

220.030 PUMP:

- Manufacturer and reference Grundfos as per Pump Schedule Y20-Pumps • Or approved equivalent
- Provide identical stand-by pump.
- Provide twin pump set with autochangeover. •
- Duty as schedule reference Y20-Pumps •
- Temperature of fluid (°C) 80oC •
- Centrifugal pumps •
- Direct drive in-line. Reference Y20.2010D
- Direct drive, immersed rotor. Reference Y20.2010E
- Variable flow control - reference Y20.2015
- Connections
 - Flanged to BS 4504-3.3 PN
 - Flanged to BS EN 1092-2 PN •
 - Screwed to BS 21.
- Accessories
 - Drive belts reference Y20.3010
 - Matching flanges PN •
 - Flanged to BS EN 1092-1 reference Y20.3020A
 - Flanged to BS EN 1092-2 reference Y20.3020B

220.040 PUMP MOTOR DRIVE - ELECTRIC:

- Comply with reference section general clauses reference Y92.1000 and those detailed below.
- Electrical supply to BS 7697
 - Single phase.
- Three phase.
- Operating conditions
- Standard operating conditions reference Y92.2010A
- Motors
 - General Reference Y92.2020 ٠
 - Slide rails Reference Y92.2030
 - Plinths Reference Y92.2040
- Motor rating •
 - Up to and including 0.75kW reference Y92.2050A
 - Above 0.75kW up to and including 4kW reference Y92.2050B
 - Above 4kW squirrel cage, totally enclosed reference Y92.2050E
 - Above 4kW wound rotor, totally enclosed reference Y92.2050F

T31

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE LOW TEMPERATURE HOT WATER HEATING

- At all pipework connections to terminal equipment.
- Across all ports of control valves.
- At the base of all risers.

Pressure Gauges - Whether indicated on the drawings or not pressure gauges shall be installed in the pipework at the following positions:-

- Across all major equipment connections.
- Across all pipework strainers.

Thermometers – Whether indicated on the drawings or not thermometers shall be installed in the pipework at the following positions:-

- Across all major equipment connections.
- In all storage vessels

The contractor shall ensure that All services within the plant tower and energy centre shall be on supported spring vibration hangers to avoid structural borne vibration.

Contractors shall take due cognisance of the specification clause 520. 030 Design Responsibilities.

Under the above clause the pipework and ductwork support system is a contractor's design responsibility, therefore the 2053-Z-(59)-500 series drawings shall be used as generic design intent drawings. VE M 006.

Contractors shall note that under VE M 018 aluminium protection within plant room areas is limited to 2.2 metres above finished floor level.

Please refer to Appendix A for the Preferred Manufacturers List and Appendix B for the Pipework Specification and Appendix C for the Valve Schedule

100.040 CONTROL REQUIREMENTS

• A variable flow control strategy will be adopted using a pump capable of variable flow control. A centrifugal pump with variable speed drive will be used to match heat supply to demand.

100.050 SYSTEM SCHEMATICS Refer to RMF - KJ Tait Engineers Schematic drawings 2053 - Z (59) 430, 435 & 457

100.060 SYSTEM DRAWINGS (Refer to RMF - KJ Tait Engineers (55) Series Drawings for Pipework design

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.010 GENERAL: Comply with work section general clauses reference Y10.1000 and those detailed below.

210.015 PIPEWORK TYPE AND SIZE

All heating pipework shall be mild steel Heavy Grade. Joints on all permanently concealed pipework and pipework over 50mm size shall be welded. All other pipework may have screwed or welded joints. Where the Contractor elects to use screwed joints, at least one of the two engaging components shall be taper threaded, and the jointing between them shall be made with approved jointing material.

210.020 STEEL PIPES AND FITTINGS:

Type Mild Steel Pipework

- Application Heating
- Fluid conveyed Water
 - Working pressure 5 Bar

T31 LOW TEMPERATURE HOT WATER HEATING

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES

Installation of LTHW Boiler plant, Ancillary Plant and Distribution system to provide heating service to the building.

100.020 DESIGN PARAMETERS See System Description.

100.030 SYSTEM DESCRIPTION

Low Temperature Heating Water (LTHW) Secondary System - Centrally generated heating water will be distributed from the Energy Centre via dual mains in the basement service tunnel.

Two Three LPHW secondary variable speed pumps and two GSHP secondary variable will be used to circulate heating water (48.9 °C to 43.3 °C) from the primary loop to the building via the service tunnels.

The end-suction secondary heating water pumps will circulate the heating water to preheat coils in air handling units, combustion/ventilation air units, VAV reheat batteries, fan coil units and miscellaneous heating equipment. The pumps will have variable frequency drives to match the required water flow to the building load. Air handling unit coils and boiler room combustion/ventilation air units will be provided with 2-way control valves and coil circulation pumps for added freeze protection.

Miscellaneous heating equipment will have 2-way and 3-way control valves as detailed on the drawings. 3-way valves will be added at the end of the piping loop to allow for minimum water circulation.

Reheat Water - The VAV reheat system LPHW water will be an extension of the LPHW heating water system. The building has an estimated peak reheat load of 1.200 kW. Reheat batteries will be designed with a 5.6 ℃ temperature difference (48.9 ℃ to 43.3 ℃). Terminal reheat batteries will be provided with 2-way control valves. 5% of the design system flow will circulate through 3-way control valves to maintain minimum circulation. Reheat water shall be distributed throughout the building via six (6) sets of vertical risers. Each building supply and return riser will range in size from 50 mm to 65 mm and be provided with valved connections at each floor.

LTHW will be distributed via welded steel pipework within each service tunnel and rise as indicated to serve the heating equipment equipment.

Heating Pipework Ancillaries

Commissioning Valves – Whether indicated on the drawings or not fixed orifice commissioning valves shall be installed in the return pipework connections at the following positions:-

- At all pipework major equipment connections to provide proportional balancing.
- At all pipework connections to terminal equipment provide proportional balancing. ٠
- At all major pipework branches to provide proportional system balancing.
- At the base of all risers to provide proportional system balancing

Flexible Connections – Whether indicated on the drawings or not flexible connections shall be installed in the flow and return pipework connections at the following positions:-

- At all pipework major equipment connections.
- At all pipework connections to terminal equipment. ٠
- At all major building movement joints. ٠

Test Points – Whether indicated on the drawings or not test points shall be installed in the pipework at the following positions:-

• At all major equipment connections.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE LOW TEMPERATURE HOT WATER HEATING

T31

- Working temperature 80/60
- Carbon steel pipes to BS 1387
- Heavy, black reference Y10.2010A Heavy, black, grooved ends - reference Y10.2010E
- Carbon steel fittings to BS 1387
- Reference Y10.2020A
- Carbon steel fittings to BS 1965-1
- Heavy weight reference Y10.2060A
- Fittings, grooved for mechanical joints
- Black steel reference Y10.2080B
- Jointing materials
 - Circular flanges •
 - Flanges to BS EN 1092-1 PN
 - Welding flanges reference Y10.3010A
 - Screwed flanges reference Y10.3010B
 - Jointing rings for circular flanges
 - Non-metallic flat for flanges to BS EN 1092-1 reference Y10.3020A
 - Metallic for flanges to BS EN 1092-1 reference Y10.3020B
 - Screwed joints to BS 21
 - Paste and hemp and PTFE tape reference Y10.3030A
 - PTFE tape reference Y10.3030B
 - Where chemical cleaning is required reference Y10.3030C
 - Union connections
 - Navy pattern reference Y10.3040B
 - Welding rods
 - Reference Y10.3050A
 - Mechanical joints, grooved steel pipes Reference Y10.3140A
 - Mechanical joints, plain end steel pipes
 - Reference Y10.3150A
 - Flexible couplings, sleeve type
 - Reference Y10.3170A
 - Flexible flange adapters, sleeve type
 - Reference Y10.3180A

210.030 COPPER PIPES AND FITTINGS:

- Application Local connections to fancoil VAV units
- Fluid Conveyed Water
 - Working pressure 5 Bar
 - Working temperature 80/60
- Copper pipe, half hard (Class X)
- Uncoated reference Y10.2270A
- Capillary fittings for copper tubing
- General potable range reference Y10.2310A
- Compression fittings for copper tubing
- Type A compression fittings reference Y10.2320A
- Copper to BS EN 12449
- Reference Y10.2330A
- Copper to BS EN 12450
- Reference Y10.2332A
- Jointing materials
 - Capillary joints
 - Lead free solder reference Y10.3070A
 - Use push-fit joints for copper pipe.
 - Jointing equipment for push-fit system reference Y10.3102
 - Jointing equipment for press fitting system reference Y10.3125
 - Use press fitting jointing system for copper to BS EN 1057.

T31 / 203

- 210.070 PIPEWORK ACCESSORIES:
- Wall, floor and ceiling masking plates Plastic - reference Y10.3190B
- Pipe rings and clips
 - Steel pipework reference Y10.3200A

210.080 GENERAL WORKMANSHIP

- Appearance reference Y10.4010
- Spacing reference Y10.4020 •
- Gradients reference Y10.4030
- Air venting requirements •
 - Air bottles reference Y10.4040A
 - Automatic air vents reference Y10.4040B
- Drain requirements reference Y10.4050 •
- Expansion and contraction reference Y10.4060 •
- Pipe fittings

•

•

•

- Bends/swept tees reference Y10.4070A
- Elbows/square tees reference Y10.4070B
- Fabricated junctions reference Y10.4080
- Fabricated fittings
 - Ferrous reference Y10.4090
 - Non-ferrous reference Y10.4100
- Pipes through walls and floors reference Y10.4110 •
 - Pipe sleeves
 - Reference Y10.4120A
 - Insulation carried through reference Y10.4120B
- Pipe sleeves through fire barriers reference Y10.4125 •
- Connections to equipment reference Y10.4130
- Distribution headers reference Y10.4140
- Temporary plugs, caps and flanges Reference Y10.4150A.
- Flanged joints general reference Y10.4160
- Dissimilar metals reference Y10.4170 •
- Pipe rings and clips reference Y10.4180
- Anchors reference Y10.4190 Location
- To be agreed on site with engineer and in conjunction with expansion bellows manufacturer. Slide guides - reference Y10.4200
- Location
- bellows manufacturer.
- Pipe supports reference Y10.4210
- Support spacing reference Y10.4220
- Isolation and regulation

Welding, general

KJ TAIT ENGINEERS

- Reference Y10.4230A
- Maintenance and renewal reference Y10.4240

210.090 WORKMANSHIP, STEEL PIPEWORK:

Painting welded joints - reference Y10.5030

Class 2 - reference Y10.5010B

Flanged joints - reference Y10.5040

Screwed joints - reference Y10.5050

Mechanical joints - reference Y10.5060

Welded joints - reference Y10.5020

Cleaning - reference Y10.4250 • Non-ferrous components - reference Y10.4260

To facilitate expansion, and agreed on site with engineer and in conjunction with expansion

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE LOW TEMPERATURE HOT WATER HEATING

- Anchors
 - U-bolts reference Y10.5070A
 - Flanges reference Y10.5070B
- Pipework painting reference Y10.5090

210.100 WORKMANSHIP, COPPER PIPEWORK:

- Compression joints reference Y10.6030
- Capillary joints reference Y10.6040
- Brazed joints reference Y10.6050 •
- Anchors •
 - Saddle clamps reference Y10.6060B
- Push-fit fitting system reference Y10.6090

210.130 WORKMANSHIP:

- Flexible couplings and flange adapters, sleeve type reference Y10.9010
- Protection of underground pipework reference Y10.9030 Location
- As indicated on drawings
- Protection of buried pipes
- Unmarked reference Y10.9040A
- Marked reference Y10.9040B
- Location As indicated on Drawings
- Protection of pipes in screed
 - Wrap with two protective tapes before laying.
 - Sheath with PVC
- Thermally insulated underground pipelines
 - To BS EN 253 reference Y10.9060A
- Corrosion protective tape reference Y10.9100
- Mechanical protective tape reference Y10.9110
- Steelwork painting
 - Reference Y10.9120A

211.000 PIPELINE ANCILLARIES

211.010 GENERAL:

Comply with work section general clauses reference Y11.1000 and those detailed below.

211.030 STOP VALVES:

- Type
- Manufacturer and reference Refer to Valve Schedule •

Or approved equivalent

- Service fluid •
 - Water
- WRAS approved.
- Kitemark certified.
- Pipe material •
 - To suit steel tube.
 - Ball type, copper alloy to BS EN 13828.
 - Lever operated
 - Screwed to BS 21 reference Y11.2080C
 - Compression to BS EN 1254-2 reference Y11.2080D
 - Lockshield
 - Screwed to BS 21 reference Y11.2080E
 - Compression to BS EN 1254-2 reference Y11.2080F
- Butterfly valves to BS EN 593
- Between flanges to BS EN 1092-2

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE LOW TEMPERATURE HOT WATER HEATING

- Lever operated reference Y11.2090A
- Gear operated reference Y11.2090B

211.050 DOUBLE REGULATING VALVES:

- Manufacturer and reference Refer to valve schedule

T31

Or approved equivalent.

- Service fluid
- Water
- WRAS approved.
- Kitemark certified. •
- Pipe material
- To suit steel tube.

211.060 FLOW MEASUREMENT VALVES:

- Type
- Commissioning sets/stations.
- Manufacturer and reference Refer to Valve schedule

Or approved equivalent.

- Service fluid
 - Water
- WRAS approved.
- Kitemark certified. •
- Pipe material
- To suit steel tube.
- Flow measurement devices to BS 7350
 - Section 3.2 Type 3
 - Copper alloy
 - Screwed to BS 21 reference Y11.2230A
 - Cast iron
 - Flanged to BS EN 1092-2 reference Y11.2230C
 - Section 3.2 Type 4
 - Copper alloy
 - Screwed to BS 21 reference Y11.2230E
 - Cast iron reference Y11.2230G

211.080 TEST PLUGS:

- Manufacturer and reference Refer to Valve Schedule • Or approved equivalent
- Self sealing test points reference Y11.2670A
- Valve controlled test points reference Y11.2670B

211.090 RADIATOR VALVES TO BS 2767:

- Manufacturer and reference Refer To valve schedule
- Or approved equivalent
- Kitemark certified.
- Type 4 - reference Y11.2260A
 - Finish

KJ TAIT ENGINEERS

Natural.

211.100 PIPELINE STRAINERS:

Manufacturer and reference Refer to valve schehdule.

Tour & Andersson Ltd, Type TA641 (up to 50mm) and Type TA651 (greater than 50mm).

T31

• Three way - reference Y11.2315C

211.160 LOOSE ITEMS:

- Keys for spindle shank valves reference Y11.3010A
- For drain cocks reference Y11.3010B

211.170 CHECK VALVES:

- Manufacturer and reference Refer to valve schedule

•

- Or approved equivalent
- WRAS approved.
- Kitemark certified.
- Service fluid
- Water.
- Pipe material
- To suit steel tube.
- Swing check type to BS 5154
- Screwed to BS 21 reference Y11.2320A
- Flanged to BS EN 1092-3 reference Y11.2320B
- Check valve to BS EN 12334
 - Swing check
 - Flanged reference Y11.2330A
 - Wafer body reference Y11.2330B
- The contractor shall ensure the check valves are installed in accordance with the manufacturers instructions.

211.180 WORKMANSHIP:

- Installation reference Y11.4010
- Location reference Y11,4020
- Location of thermostatic radiator valves reference Y11.4025 •
- Positioning of components
- Flow/pressure measurement valves reference Y11.4030
- Double regulating variable orifice valves reference Y11.4040
- Control ball valves reference Y11.4045
- Control components
- Reference Y11.4050A
- Vent cocks reference Y11.4060
- Discharge connections
 - Safety and Relief valves reference Y11.4080A
 - Vent cocks reference Y11.4080B
 - Air bottles reference Y11.4080C
 - Automatic air vents reference Y11.4080D
- Expansion devices reference Y11.4090
- Flexible connections installation reference Y11.4110
- Terminal unit connections installation reference Y11.4120

211.210 DRAIN COCKS:

- Manufacturer and reference Refer to valve schedule Or approved equivalent
- WRAS approved.
- Kitemark certified. •
- Throughway gland cock type
- Reference Y11.2440A
- Screwdown to BS 2879, type 1 reference Y11.2450
- Ball type reference Y11.2460
- 211.220 VENT COCKS:

- Or approved equivalent
- Bronze

•

- Screwed to BS 21 reference Y11.2680A
- Cast iron
- Flanged to BS EN 1092-2 reference Y11.2680D

211.110 THERMOSTATIC RADIATOR VALVES TO BS EN 215-1 AND BS 7556:

- Type All Thermostatic Valves with or without remote capillary in public areas shall be tamperproof, and shall require a "special" tool to facilitate setpoint adjustment.
- -Manufacturer and reference Thermostatic Radiator valves will be Hertz models as follow:
- -Model 7728-91-⁴/₂ reverse angle TRV body 9861-40 Herzcules anti tamper sensor with 4c Turndown facility for public areas including classrooms and LRC. Return valve shall be 3924-01 -/2-angle with preset and drain facility.
- Model 7728-91-¹/₂-reverse angle TRV body 7230-06sp2 Quatro low-temp sensor 10-22 c for office areas, where the general public/students will not be left unatended. The adjustment will be limited within certain limits without a tool. Return valve shall be 3924-01-¹/₂ angle with preset and drain facility.
- Model 7723-92 ³/4 straight TRV body 7430-18 8m capillary remote sensor, for trench heating in Public areas including classrooms and LRC. Return valve shall be 3923-02-3/4-straight with preset and drain facility.
- Model 7723-92 ³/4 straight TRV body 7430-18 8m capillary remote sensor, for trench heating, for office areas, where the general public/students will not be left unatended. The adjustment will be limited within certain limits without a tool. Return valve shall be $3923-02^{-3}$ /₄-straight with preset and drain facility
- The valves shall be capable of full maintenance via the use of a propriatary tool (3 No to be provided) whilst the system is fully operational. The valves shall incorporate mechanical shut off not just Thermostatic Shut off.

Or approved equivalent

Kitemark certified.

- BS 7556 table 4 reference Y11.2270C
 - Pattern
 - Straight
 - Angle
- Tamper proof BS 7556 table 4 reference Y11.2270F
- Pattern
 - Straight
 - Angle

211.140 GAUGES:

- General reference Y11.2700A
 - 100mm finish black stove enamel
 - Direct mounting reference Y11.2700F
- Temperature gauges general reference Y11.2710A •
 - Vapour pressure to BS 5235
 - Direct mounting reference Y11.2710C
- Pressure and altitude gauges reference Y11.2720
- 211.150 CONTROL VALVES:
- WRAS approved. •
- Kitemark certified.
- Ball control valves
 - Open/close reference Y11.2315A
 - Two way reference Y11.2315B

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE LOW TEMPERATURE HOT WATER HEATING

T31

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE LOW TEMPERATURE HOT WATER HEATING

 Kitemark certified. Two way gland cock type - reference Y11.2470 Ball type - reference Y11.2480 Three way gland cock type - reference Y11.2490 Plug valve type Wrench operated - reference Y11.2500A Gear operated - reference Y11.2500B 	 Electrical supply Phase 1 Voltage (V) 230 Frequency (Hz) 50 Trace Heating Circuits shall be designed, sup manufacturer, and shall include the following; Roofed Plant Areas/Plant Rooms:
 211.230 AUTOMATIC AIR VENTS: Float type Reference Y11.2510A 	Chilled water pipework Water services Pipework (boosted cold water Domestic Hot water
 211.260 EXPANSION ARRANGEMENTS/DEVICES: Manufacturer and reference Engineering Appliances Refer to preferred equipment supplier schedule Or approved equivalent 	The trace heating controllers shall be weather manufactured in accordance with BS 6351 Pa form that best suits the project environment.
 Expansion loops Steel 	The control of the trace heating will be by the
Reference Y11.2610A Gelvanized after manufacture	The tracer shall be tested at the following stag
 Expansion compensators 	1 After installation
 Axial bellows Screwed to BS 21 - reference Y11.2630A 	2 After installation of the thermal insulation.
 Flanged to BS EN 1092-1 - reference Y11.2630B Bevelled for welding - reference Y11.2630C Grooved ends - reference Y11.2630J 	A test certificate shall be completed after each
 Articulated bellows Screwed to BS 21 - reference Y11.2630D Flanged to BS EN 1092-1 - reference Y11.2630E Bevelled for welding - reference Y11.2630F 	 Wiring (including power wiring) between transformed to the thermostats, distribution board shall be by t
 Angular bellows Screwed to BS 21 - reference Y11.2630G Flanged to BS EN 1092-1 - reference Y11.2630H Bevelled for welding - reference Y11.2630I 	 Constant power cable RCD protection - reference Y24.2010A MCB protection - reference Y24.2010B
 Flexible connections Terminal unit connections Heating services Stainless steel - reference Y11.2660A Stainless steel with quick release couplings Reference Y11.2660B 	 224.050 WORKMANSHIP: Installation of electric trace heating - reference Y24.30 Installation of piped trace heating Continous welding - reference Y24.3020A Thermal insulation - reference Y24.3040
 Chilled water services Stainless steel - reference Y11.2660D Stainless steel with quick release couplings Petersnen Y11.2660E 	225.000 CLEANING AND CHEMICAL TREATMENT 225.010 GENERAL:
	Comply with work section general clauses reference Y25.
224.000 TRACE HEATING 224.010 GENERAL: Comply with work section general clauses reference Y24.1000 and those detailed below.	 225.020 CLEANING AND CHEMICAL TREATMENT SPE Reference Y25.2010 Use one of the following specialists Pheonix Commiss Or approved equivalent
 224.020 ELECTRIC TRACE HEATING: Application All Chilled water, domestic hot water, mains water and cold water pipework on the roof, or in plantrooms will be trace heated. Power to the trace heating will be provided by the Controls Specialist. 	225.030 MAINS WATER ANALYSIS:Application HeatingReference Y25.2020A
 Manufacturer and reference WinterGard, manufactured by Raychem Ltd. Or approved equivalent Quality assured to BS EN ISO 9002. 	225.040 PRELIMINARY CHECKS:Reference Y25.2030A
• Duty	225.050 PROCEDURAL PRECAUTIONS:

KJ TAIT ENGINEERS

KJ TAIT ENGINEERS

oplied and installed by the Trace Heating

r and mains cold water)

r protected to a minimum of IP 68 and art 1. It shall be supplied and installed in a

controls specalist.

ges:

ch stage.

ace heating circuits terminals units and, the Controls specialist.

8010

1000 and those detailed below.

ECIALIST:

sioning Services Ltd

- Reference Y25.2040A •
- Including taking samples reference Y25.2040B

225.060 CHEMICAL INJECTION AND DOSING METHODS:

- Application Heating •
- Method of introducing chemicals into closed systems reference Y25.2060A
- Packaged plant reference Y25.2060C
- Dosing for closed systems reference Y25.2060D
- Dosing chemicals reference Y25.2065

225.070 MONITORING AND SAMPLING:

- Sampling reference Y25.2070B
- Sampling kits reference Y25.2070C

225.080 CHEMICAL PROVISION:

Standard arrangement - reference Y25.2080A

225.090 FLUSHING:

- BSRIA Application Guide 1/2001 reference Y25.3010A
 - System filling
 - Temporary connection from mains in compliance with the Water Supply (Water Fittings) Regulations 1999, and the Water Supply (Water Fittings) (Amendment) Regulations 1999.
 - Temporary connection from fire hydrant pipework.
 - By installation of temporary tank and pump arrangement.
- Flushing reference Y25.3010B

225.110 CHEMICAL CLEANING AND SOLIDS REMOVAL:

- Application Heating
- BSRIA Application Guide 1/2001
 - Inhibited acid reference Y25.3030A
 - Formulated products reference Y25.3030B

225.140 SERVICE VISITS:

Reference Y25.3080

- Special requirements
 - Four times per annum send samples to independent laboratory for differential micro-biological analysis.

225.150 DOCUMENTATION: Reference Y25.3090

250.000 THERMAL INSULATION

250.010 GENERAL:

Comply with work section general clauses reference Y50.1000 and those detailed below.

250.020 INSTALLER SELECTION:

- Use a contractor specialising in the supply and installation of thermal insulation.
- Use thermal insulation materials supplied by a manufacturer assessed and registered in • accordance with BS ISO 9000-2.

250.040 CLOSED CELL MATERIALS THERMAL INSULATION - PIPEWORK:

- Application Heating, Chilled Water and Water Services
- Manufacturer and reference Kingspan
- Or approved equivalent
- Temperature of fluid in pipes (°C) 80/60 Heating and 6/12 Chilled Water
- European Classification for Reaction to Fire Performance
- Class A1 reference Y50.1035A
- Class A2 reference Y50.1035B

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE LOW TEMPERATURE HOT WATER HEATING

- Class B reference Y50.1035C
- Class C reference Y50.1035D ٠
- CFC's and HCFC's reference Y50.1040Z •
- Spread of flame as BS 476-7
- Reference Y50.1050A
- Smoke emission characteristics
- Reference Y50.1055A
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Thermal conductivity reference Y50.2010 •
- Thermal performance life expectancy
- For plant design life reference Y50.2015A
- Restrictions on use of materials reference Y50.2020
- Closed cell rigid phenolic foam (PF) preformed sections
 - Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Foil faced reference Y50.2110A
- Reference Y50.2110B
- High density phenolic pipe and duct support foam Reference Y50.2130A Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Closed cell nitrile rubber preformed flexible sections
 - Reference Y50.2140A
- Vapour barrier permeance
- Reference Y50.2170A
- Vapour barrier coatings
- Solvent polymers- reference Y50.2180C
- Adhesives reference Y50.2190
- Protection
 - Application Plantrooms shall be finished in ribbed aluminium, and the roof area shall be finished with Fibre reinforced Plastic, as supplied by Fibaroll polyisobutylene- reference Y50.2200A or approved equivalent. Type FR/UBV/GRAY/1.5 installed fully in accordance with the manufactureres instructions.
- Reinforcement
 - Aluminium bands •
 - 300mm centres reference Y50.2210A
 - Wire netting
 - 50mm x 19g reference Y50.2210C
- Valve and flange insulation
 - Application All chilled water valves and flanges and all external heating valves and flanges shall be insulated.
 - Aluminium casing reference Y50.2220A
 - Closed cell material for cold applications reference Y50.2220C
- Thickness table
 - Insulation thickness calculation methods reference Y50.2285
 - Non-domestic hot water service areas reference Y50.2300
 - Non-domestic heating installations reference Y50.2320
 - Chilled and cold water supplies to prevent condensation High emissivity - reference Y50.2360
 - Chilled water services
 - Phenolic foam reference Y50.2400
 - Protection against freezing
- Phenolic foam reference Y50.2430
- Thickness of insulation to BS 5422 reference Y50.2490#

251,000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below.

T31
C0605LMB Revised Stage E Mechanical Specification Including Agreed VE LOW TEMPERATURE HOT WATER HEATING

251.020 SPECIALIST:

Use an approved one of the following specialist commissioning engineers Pheonix Commissioning Services Ltd

- Or approved equivalent
- The commissioning Specialist shall allow for revisiting the commissioning of the building over the first 18 month occupied period to allow for final control system seasonal adjustment, to ensure the systems are set up efficiently and meet the user's requirements.

251.030 STATIC TESTING:

- Pressure testing
 - General reference Y51.2010
 - Water circulating and supply systems and steam and condense lines reference Y51.2020
- Testing records reference Y51.2110

251.040 COMMISSIONING:

- Commissioning codes reference Y51.3020 •
- Commissioning
- Water distribution
 - Including BSRIA pre-commissioning check list Reference Y51.3030A
- Instruments and gauges
- Reference Y51.3090A
- Commissioning records
- For water systems
 - To BSRIA Application Guide 2/89.3 reference Y51.3100B
- BMS commissioning
- Control system specification details required for commissioning reference Y51.3110
- Pre-commissioning reference Y51.3120
- Plant ready for control system commissioning
- Reference Y51.3130A
- Control system requirements for plant commissioning reference Y51.3140
- Commissioning reference Y51.3150

252.000 VIBRATION ISOLATION MOUNTINGS

252.010 GENERAL:

Comply with work section general clauses reference Y52.1000 and those detailed below.

252.050 PIPEWORK HANGERS:

- Turret compression hangers
 - Synthetic rubber reference Y52.2050A
 - Lockable facility reference Y52.1040
 - Neoprene reference Y52.2050B
 - Lockable facility reference Y52.1040
- Spring compression hangers reference Y52.2060
- Lockable facility reference Y52.1040
- Combined turret/spring compression hangers
- Synthetic rubber reference Y52.2070A
- Lockable facility reference Y52.1040
- Neoprene reference Y52.2070B
 - Lockable facility reference Y52.1040

252.080 VIBRATION ISOLATION HOSES:

Vibration isolation hoses - reference Y52.2100

252.100 WORKMANSHIP

General - reference Y52.3010

- Cast in situ bases reference Y52.3020 •
- Fixing - reference Y52.3030
- Horizontally restrained spring mountings reference Y52.3040

252.110 PIPE, WALL AND RISER SEALS:

Mineral fibre packing - reference Y52.2120B

254,000 IDENTIFICATION - MECHANICAL

254.010 GENERAL:

Comply with work section general clauses reference Y54.1000 and those detailed below. Services Identification drawings - reference Y54.2015

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

254.040 PLANT AND EQUIPMENT IDENTIFICATION:

- Lettering
 - Engraved plates filled with paint reference Y54.2030A

254.045 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416: Reference Y54.2035

254.050 VALVE AND COCK IDENTIFICATION: Reference Y54.2040

254,100 DANGER AND WARNING NOTICES: Reference Y54.2090

254.110 SYSTEM IDENTIFICATION INSTALLATION CHARTS: Plastic encapsulated chart - reference Y54.2100C

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL:

Comply with work section general clauses reference Y90.1000 and those detailed below.

290.020 FIXINGS:

- Standards reference Y90.2010
- Plugs reference Y90.2020 •
- Screws reference Y90.2030 •
- Cast-in fixings reference Y90.2040 •
- Shot fired fixings reference Y90.2050
- Proprietary channel inserts reference Y90.2070

290.030 WORKMANSHIP:

- Drilling reference Y90.3010
- Proprietary fixings reference Y90.3020
- Fixing to reinforced concrete reference Y90.3030
- Fixing to brickwork reference Y90.3040
- Fixing to timber rails reference Y90.3050
- Fixing to hollow stud/tile/block wall Reference Y90.3060A
- Fixing to concrete, brickwork or blockwork
- Reference Y90.3070A
- Fixing to metalwork
- Reference Y90.3080A
- Fixing to structural steelwork and concrete structures

PART 3 SPECIFICATION CLAUSES SPECIFIC TO T31

300.000 GENERAL

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.010 SITE DIMENSIONS:

Check dimensions on site prior to ordering.

300.020 TESTING:

Test at manufacturer's works to appropriate British Standard to suit pressure and temperature conditions of system.

300.030 UNDERFLOOR HEATING INSTALLER SELECTION:

- Use one of the specialist companies listed below to carry out the design, supply, installation, testing and commissioning of the underfloor heating system.
- Rehau or approved equivalent

310.000 PRODUCTS/MATERIALS

310.020 RADIATORS GENERALLY:

Ensure radiators are manufactured and rated in accordance with BS EN 442.

- System conditions
 - Mean water temperature (^eC) 70

310.030 RADIATORS - STEEL PANEL:

- Type Flat panel
- Manufacturer and reference Stelrad
- Or approved equivalent
- Duty as schedule reference T31-Radiators -E0504-T31
- -Type
 - Single panel.
 - Double panel.
 - Vertical style.
 - Horizontal style
- Connections
- Wrought iron bosses welded on at manufacturer's works.
- Air cock
- Provide return end air cock recessed within unit length.
- Finish
- Degrease and protect against rusting before application of a high quality stove primer.
 Stove enamelled, colour Ral 9010
- Testing
- Test to BS EN 442, not less than 7 bar (gauge) or one and a half times maximum working pressure whichever is greater.
- Accessories
- Wall brackets.
- Side panel and top grille

310.080 FAN CONVECTOR HEATERS

Type Door Curtain Heaters (2 no.) Refer to section

T31

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE LOW TEMPERATURE HOT WATER HEATING

- Application Main Entrance Level 1& LRC Entrance Level 1 Manufacturer and reference Biddle Invisidor M W 200 FU's
- Or approved equivalent
- Duty as schedule reference 11 20 kW
- Duty as schedule reference T31-Fan convectors Refer to section U70
- Standard
- Ensure fan convector heaters are rated in accordance with BS EN 442 and BS 4856.
- Arrangement
- Free hanging or recessed in accordance with architects requirements.

310.090 CONTINUOUS NATURAL CONVECTORS:

- Type Perimiter Trench Heating
- Application All areas where full height glazing is installed •
 - schedule.
 - Or approved equivalent
 - Duty as schedule reference T31-Natural convectors
 - Type
 - Trench Heating
 - Materials
 - Finned tubes
 - Copper.
 - Fins
 - Aluminium.
 - Casing
 - Provide back plates complete with brackets to support finned tube. Manufacture back plates from
 - mild steel.
 - Provide front plates manufactured from mild steel.

 - Finish Painted.
 - Outlet
 - Top outlet.
 - Grille
 - Aluminium arille.

Accessories Trench heaters shall be Sill Line type 'Dash 03' 305mm wide x 185mm deep. Casings shall be manufactured from 1.2mm zintec sheet and all integral components painted black. The heating element arrangement shall be 2 of 28mm diameter copper tubes with locked aluminium fins. Heat output will be minimum 697 W/m at LPHW 60/80 °C & EAT 20 °C, water velocity 0.92m/s. The arille shall be durable aluminium natural satin anodised to AA15 finishes and fixed to the trench casing in the vertical place. The casing shall be fitted with levelling screws with lock-nuts or adjustable legs to fix/level as required. Casings can be site cut as required with suitable jointing straps supplied.

- ٠
- 310.100 RADIANT PANELS:
- Type Ceiling
- Manufacturer and reference Solray
- Or approved equivalent
- Duty as equipment schedule reference T31 Radiant Panels
- Standard
 - BS EN 14037-1
 - BS EN 14037-2 BS EN 14037-3
- Matorial
- - Copper.

KJ TAIT ENGINEERS

Manufacturer and reference Sill Line Perimeter Heating Ltd as per preferred equipment supplier

Coil and Header, coil minimum diameter 20mm and header minimum diameter 32mm.

T60 CENTRAL REFRIGERATION PLANT

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES: Production of Chilled Water for Air Handling Cooling and Process

100.020 DESIGN PARAMETERS: Chiller Efficiency

The ESEER of the chiller shall be no less than 4.0 @ 30 °C ambient.

- Ambient Temperatures
 - Supply chiller capable of providing rated output at an ambient dry bulb temperature of 35°C.
 - Supply chiller capable of operating but at a reduced output at higher ambient dry bulb temperature of 40°C.

100.030 SYSTEM DESCRIPTION:

The primary chilled water distribution network within the building is generated by a mixture of geothermal ground source heat pumps and air cooled water chillers.

Ground Source Heat Pumps - Ground source heat pumps (GSHP) will generate chilled water & LPHW via twenty four heat pumps. Ten 6 GSHP units will be generating hot water, with twelve units generating chilled water and two reverse cycle units units on stand by for either system. The nominal total cooling load generated by the GSHP system is 1560 kW.

Chilled water will be generated and circulated in the GSHP secondary loop at 6℃. The heat pumps and secondary loop will be sized to handle a nominal heating water temperature difference of 6.7 °C resulting in an average design return water temperature of 12.7 °C.

The GSHP chilled water is introduced into the chilled water system on the suction side of the secondary pumps and mixes with the chilled water from the chillers at 5.5℃ water which allows 0.5℃ temperature rise in the mixture and pump gains. A chilled water flow supply temperature of 6.0 °C from the Energy Centre is distributed from the system.

Primary Air Cooled Chillers - Chilled water will be generated centrally by four three nominal 1,560 kW air cooled chillers operating in parallel and connected to a common primary header. There will also be a space provision for an two additional 1,560 kW machine and associated pumps/piping to be installed to meet potential future increased load requirements. Chillers will be selected to deliver 1560 kW while supplying 5.5 ℃ water which allows 0.5 ℃ temperature rise in the mixture with the heat pump system and pump gains. Therefore supplying a chilled water supply temperature from the Energy Centre of 6.0 ℃ to the distribution system.

For ease of installation each nominal chiller will be two packaged R134A air cooled water chillers. Each packaged air cooled water chiller shall be complete with:-

•Manufactured with C.E. & P.E.D. approvals. •R134A refrigerant fully charged into the compressors. •Inverter variable speed drive screw compressors.

●An operating ESEER of at least 4.0 @ 30 °C ambient.

- •0.95 power factor correction at all load stages.
- •Step-less capacity control from 10% to 100%.
- •Electronic expansion valves.
- •Low ambient head pressure control.
- •Factory fitted power and control panel with single entry supply isolator.

Front panel, minimum thickness 2mm. Aluminium.

- Finish
 - Primed for painting on site.
 - Stove enamelled.
 - Polished.
- Insulation

Insulate back of panel with 40mm minimum thickness material

- Tented Back
- Air venting

Provide air cock for venting in unit header.

- Access
- Provide access holes to valves through front plate.
- Support
 - Provide adjustable hangers for ceiling suspension.

310.150 UNDERFLOOR HEATING:

- Application Main Entrance area
- Manufacturer and reference Rehau
- Or approved equivalent
- Duty as equipment schedule reference T31-Ufloor htg
- Pipe and fittings
 - Crosslinked polyethylene (PE-X) BS 7291-3.
 Ends plain, and finish natural.
- Manifolds Located in false Floor
- Controls to be interfaced with BMS

320.000 WORKMANSHIP

320.010 INSTALLATION:

Install in accordance with manufacturer's recommendations to give a neat appearance, with supports out of view where possible. Ensure equipment is firmly fixed and level.

320.020 BUILDERSWORK:

Mark out positions for battens fixed by others, when fixing equipment to stud walling.

320.030 SECOND FIX:

Allow for removal and second fix of

radiators.

320.040 ISOLATION: Fit an isolating valve on flow and a regulating valve on return unless otherwise indicated.

320.050 EMBEDDED PIPE COILS INSTALLATION:

For plastic pipe coils embedded in screed, comply with manufacturer's instructions for installation. Lay insulation and pipework on floor slab and test prior to screeding. Protect against damage to pipework before screeding is carried out. Install panels at depth and in position shown on drawings. Fix or secure pipework in accordance with manufacturer's fixing arrangements.

320.060 UNDERFLOOR HEATING INSTALLATION: Install underfloor heating in accordance with manufacturer's instructions.

•Volt free contacts for chiller start, general fault run and pump start conditions.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CENTRAL REFRIGERATION PLANT**

•Micro-processor control panel for all machine function with BMS interface.

Anti vibration mountings.

- •Full acoustic package including intake and exhaust silencers to met the boundary noise criteria as set by the acoustic engineers SBA.
- •Complete commissioning by manufacturers engineers.
- •Full end of line chiller test and certification.

Chillers will be air cooled roof mounted units with refrigerant having an ODP less than 0.06. A manufacture packaged refrigerant leak detection system will be provided for each unit. A site acoustic criterion is very onerous and chillers will be provided with full additional acoustic protection to achieve the values scheduled on the drawings. Sound attenuators directly applied to the chillers will not be permitted as they interfere with maintenance operations. The chiller enclosure on the roof shall be designed to supplement the resulting chiller noise ratings.

Each chiller will be provided with automatic isolation valves so that as the building load increases or decreases chillers can be staged on and off to match the required capacity. Chilled water will be circulated at a constant volume through chillers with matching primary pumps.

The chilled water system will have a packaged twin pump pressurisation make up unit with two (2) expansion tanks with a 32 mm quick fill make up water connection which includes isolation valves, backflow preventor and pressure gauges.

Process Chillers - Process chilled water will be generated centrally by two (2) 730 kW process chillers operating as main and stand-by and connected to a common primary header. The process chilled water system serves the containment, EM and NMR air handling units as well as fan coil units and various process loads. The system has an estimated peak load of 730 kW, one redundant chiller is provided for N+1 capacity. The process chilled water system will operate continuously and be supplied by essential power.

The two packaged air cooled R134A process chillers will be of the same manufacturer and type as the air conditioning chillers. Each packaged air cooled water chiller shall be complete with:-

- •Manufactured with C.E. & P.E.D. approvals.
- •R134A refrigerant fully charged into the compressors.
- •Designed to operate with a 15% glycol / 85% water mixture.
- •Inverter variable speed drive screw compressors.
- •An operating ESEER of at least 4.0 @ 30 ℃ ambient.
- •0.95 power factor correction at all load stages.
- •Step-less capacity control from 10% to 100%.
- •Electronic expansion valves.
- •Low ambient head pressure control.
- •Factory fitted power and control panel with single entry supply isolator.
- •Volt free contacts for chiller start, general fault run and pump start conditions.
- •Micro-processor control panel for all machine function with BMS interface.
- •Anti vibration mountings.

•Full acoustic package including intake and exhaust silencers to met the boundary noise criteria as set by the acoustic engineers SBA.

- •Complete commissioning by manufacturers engineers.
- •Full end of line chiller test and certification.

Chillers will be air cooled roof mounted units with refrigerant having an ODP less than 0.06. A manufacture packaged refrigerant leak detection system will be provided for each unit. A site acoustic criterion is very onerous and chillers will be provided with additional acoustic protection to achieve the values scheduled on the drawings. Sound attenuators directly applied to the chillers will not be permitted as they interfere with maintenance operations. The chiller enclosure on the roof shall be designed to supplement the resulting chiller noise ratings.

Each chiller will be provided with automatic isolation valves to accommodate main and stand-by

operation. Chilled water will be circulated at a constant volume through chillers with matching primary pumps.

The chilled water system will have a packaged twin pump pressurisation/glycol fill make up unit with two (2) expansion tanks with a 32 mm guick fill make up water connection which includes isolation valves, backflow preventor and pressure gauges.

All services within the plant tower and energy centre shall be on spring vibration hangers supported to avoid structural borne vibration.

Contractors shall take due cognisance of the specification clause 520. 030 Design Responsibilities.

Under the above clause the pipework and ductwork support system is a contractor's design responsibility, therefore the 2053-Z-(59)-500 series drawings shall be used as generic design intent drawings. VE M 006.

Contractors shall note that under VE M 018 aluminium protection within plant room areas is limited to 2.2 metres above finished floor level.

Please refer to Appendix A for the Preferred Manufacturers List and Appendix B for the Pipework Specification and Appendix C for the Valve Schedule.

100.040 CONTROL REQUIREMENTS: see above

100.050 SYSTEM SCHEMATICS: Refer to RMF - KJ Tait Engineers Schematic drawings 2053 - Z (59) 433, 436

100.060 SYSTEM DRAWINGS: Refer to RMF - KJ Tait Engineers (55) Series Drawings

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.010 GENERAL:

Comply with work section general clauses reference Y10.1000 and those detailed below. Supply pipes and fittings as specified in work section T31

220.000 PUMPS

220.010 GENERAL:

Comply with work section general clauses reference Y20.1000 and those detailed below. Provide pumps as schedule reference Refer to RMF - KJ Tait Engineers 2053-Z-(59)-705-D

224.000 TRACE HEATING

224.010 GENERAL: Comply with work section general clauses reference Y24.1000 and those detailed below.

225,000 CLEANING AND CHEMICAL TREATMENT

225.010 GENERAL:

Comply with work section general clauses reference Y25.1000 and those detailed below. Supply cleaning and chemical treatment as specified in section T31

250.000 THERMAL INSULATION

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CENTRAL REFRIGERATION PLANT**

250.010 GENERAL:

- Comply with work section general clauses reference Y50.1000 and those detailed below.
- Supply thermal insulation as specified in section
- Supply thermal insulation as schedule reference Y50-Insulation
 - Location

250.020 INSTALLER SELECTION:

- Use a contractor specialising in the supply and installation of thermal insulation.
- Use one of the specialist companies listed below
- Or approved equivalent
- Use thermal insulation materials supplied by a manufacturer assessed and registered in accordance with BS ISO 9000-2.

250.030 MINERAL FIBRE THERMAL INSULATION - PIPEWORK:

Type As per specification section T31, clause 250

250.040 CLOSED CELL MATERIALS THERMAL INSULATION - PIPEWORK:

- Type
- Application
- Manufacturer and reference
- Or approved equivalent
- Temperature of fluid in pipes (°C)
- European Classification for Reaction to Fire Performance
 - Class A1 reference Y50.1035A
 - Class A2 reference Y50.1035B
 - Class B reference Y50.1035C ٠
 - Class C reference Y50.1035D
- CFC's and HCFC's reference Y50.1040#
- Spread of flame as BS 476-7
 - Reference Y50.1050A
 - Reference Y50.1050#
- Smoke emission characteristics
 - Reference Y50.1055A
- Reference Y50.1055#
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Materials
- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy
- For plant design life reference Y50.2015A
- Details reference Y50.2015B •
- Reference Y50.2015#
- Restrictions on use of materials reference Y50.2020
- Closed cell rigid phenolic foam (PF) preformed sections
- Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Foil faced reference Y50.2110A •
- Reference Y50.2110B ٠
- Reference Y50.2110#
- High density phenolic pipe and duct support foam Reference Y50.2130A
- Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Closed cell nitrile rubber preformed flexible sections
- Reference Y50.2140A
- Reference Y50.2140#
- Vapour barrier permeance
- Reference Y50.2170A
- Reference Y50.2170#
- Vapour barrier coatings
- Bitumen reference Y50.2180A

T60 / 221

Manufacturer and reference

Or approved equivalent

Temperature of fluid in pipes (°C)

Class A1 - reference Y50.1035A

KJ TAIT ENGINEERS

• Type

Application

•

- Vinyl reference Y50.2180B
 - Solvent polymers- reference Y50.2180C
- Bitumen emulsion- reference Y50.2180D
- Reference Y50.2180#
- Adhesives reference Y50.2190
- Protection
- Application
- Polyisobutylene- reference Y50.2200A
- Roofing felt reference Y50.2200B
- Flat aluminium-zinc coated steel reference Y50.2200C
- Ribbed aluminium-zinc coated steel reference Y50.2200D
- Aluminium sheeting reference Y50.2200E
- Galvanized sheet steel reference Y50.2200F
- Canvas reference Y50.2200G
- Canvas with aluminium bands reference Y50.2200H
- PVC reference Y50.22001
- Laminated foil/film reference Y50.2200J
- Reference Y50.2200#
- Reinforcement
 - Aluminium bands
 - 300mm centres reference Y50.2210A
 - 450mm centres reference Y50.2210B
 - Wire netting
 - 50mm x 19g reference Y50.2210C
 - 50mm x 22g reference Y50.2210D
 - Reference Y50.2210#
- Valve and flange insulation
 - Application
 - Aluminium casing reference Y50.2220A
 - Aluminium-zinc coated steel casing reference Y50.2220B
 - Closed cell material for cold applications reference Y50.2220C
 - Cold applications reference Y50.2220D
 - Reference Y50.2220# •

Chilled water services

Protection against freezing

Thickness of insulation

- Thickness table
 - Insulation thickness calculation methods reference Y50.2285
 - Non-domestic hot water service areas reference Y50.2300
 - Non-domestic heating installations reference Y50.2320
 - Chilled and cold water supplies to prevent condensation
 - High emissivity reference Y50.2360 Low emissivity - reference Y50.2380

• Phenolic foam - reference Y50.2400

• Phenolic foam - reference Y50.2430

Nitrile rubber - reference Y50.2440

• Nitrile rubber - reference Y50.2410

Thickness of insulation to BS 5422 - reference Y50.2490#

250.050 CALCIUM SILICATE THERMAL INSULATION:

European Classification for Reaction to Fire Performance

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CENTRAL REFRIGERATION PLANT**

T60

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CENTRAL REFRIGERATION PLANT**

- Class A2 reference Y50.1035B ٠
- Class B reference Y50.1035C •
- Class C reference Y50.1035D
- Spread of flame as BS 476-7
- Reference Y50.1050A
- Reference Y50.1050#
- Smoke emission characteristics
- Reference Y50.1055A
- Reference Y50.1055#
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Materials
- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy
 - For plant design life reference Y50.2015A
 - Details reference Y50.2015B
 - Reference Y50.2015#
- Restrictions on use of materials reference Y50.2020
- Calcium silicate preformed reference Y50.2150
- Vapour barrier permeance
 - Reference Y50.2170A
- Reference Y50.2170#
- Vapour barrier coatings
- Bitumen reference Y50.2180A
- Vinyl reference Y50.2180B
- Solvent polymers- reference Y50.2180C
- Bitumen emulsion- reference Y50.2180D
- Reference Y50.2180#
- Adhesives reference Y50.2190
- Protection
 - Application ٠
 - Polyisobutylene- reference Y50.2200A
 - Roofing felt reference Y50.2200B
 - Flat aluminium-zinc coated steel reference Y50.2200C
 - Ribbed aluminium-zinc coated steel reference Y50.2200D
 - Aluminium sheeting reference Y50.2200E
 - Galvanized sheet steel reference Y50.2200F ٠
 - Canvas reference Y50.2200G
 - Canvas with aluminium bands reference Y50.2200H
 - PVC reference Y50.22001
 - Laminated foil/film reference Y50.2200J
 - Reference Y50.2200#
- Reinforcement •
 - Aluminium bands
 - 300mm centres reference Y50.2210A
 - 450mm centres reference Y50.2210B
 - Wire netting
 - 50mm x 19g reference Y50.2210C
 - 50mm x 22g reference Y50.2210D
 - Reference Y50.2210#
- Valve and flange insulation
- Application
- Aluminium casing reference Y50.2220A
- Aluminium-zinc coated steel casing reference Y50.2220B
- Closed cell material for cold application reference Y50.2220C
- Cold applications reference Y50.2220D
- Reference Y50.2220#

T60 / 223

KJ TAIT ENGINEERS

•

- Thickness of insulation • Insulation thickness calculation methods - reference Y50.2285
- Thickness of insulation to BS 5422 reference Y50.2490#

250.060 MINERAL FIBRE THERMAL INSULATION - DUCTWORK:

• Type

•

- Application •
- Manufacturer and reference
- Or approved equivalent
- Temperature of fluid in ducts (°C)
- European Classification for Reaction to Fire Performance
 - Class A1 reference Y50.1035A
 - Class A2 reference Y50.1035B
 - Class B reference Y50.1035C
- Class C reference Y50.1035D
- CFC's and HCFC's reference Y50.1040#
- Spread of flame as BS 476-7
 - Reference Y50.1050A
 - Reference Y50.1050#
- Smoke emission characteristics
 - Reference Y50.1055A
 - Reference Y50.1055#
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090 •
- Materials •
- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy
 - For plant design life reference Y50.2015A
 - Details reference Y50.2015B
 - Reference Y50.2015#
- Restrictions on use of materials reference Y50.2020 •
- Mineral fibre duct insulation

•

- Rigid •
 - Foil faced reference Y50.2040A
 - Reference Y50.2040# •
- Flexible

•

•

Foil faced - reference Y50.2050A

 Foil faced - reference Y50.2060A Kraft paper - reference Y50.2060B

One face - reference Y50.2070A

Both faces - reference Y50.2070B

One face - reference Y50.2070C

Both faces - reference Y50.2070D

Mitred joints - reference Y50.2080A

Butted joints - reference Y50.2080B

Section - reference Y50.2080C

PSM - reference Y50.2080D

Reference Y50.2050#

Reference Y50.2060#

Metal mesh faced mattresses

Lamella duct insulation

Galvanized mesh

Stainless steel mesh

Reference Y50.2070#

Fire protection insulation

Circular ductwork

Flat ductwork

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CENTRAL REFRIGERATION PLANT**

- Reference Y50.2080#
- Vapour barrier coatings
 - Bitumen reference Y50.2180A
 - Vinyl reference Y50.2180B
 - Solvent polymers- reference Y50.2180C
 - Bitumen emulsion- reference Y50.2180D
 - Reference Y50.2180#
- Adhesives reference Y50.2190
- Protection
- Application ٠
- Polyisobutylene- reference Y50.2200A
- Roofing felt reference Y50.2200B
- Flat aluminium-zinc coated steel reference Y50.2200C
- ٠ Ribbed aluminium-zinc coated steel - reference Y50.2200D
- Aluminium sheeting reference Y50.2200E ٠
- Galvanized sheet steel reference Y50.2200F ٠
- Canvas reference Y50.2200G
- Canvas with aluminium bands reference Y50.2200H
- PVC reference Y50.22001 ٠
- Laminated foil/film reference Y50.2200J
- Reference Y50.2200#
- Reinforcement ٠
 - Aluminium bands
 - 300mm centres reference Y50.2210A
 - 450mm centres reference Y50.2210B
 - Wire netting
 - 50mm x 19g reference Y50.2210C
 - 50mm x 22g reference Y50.2210D
 - Reference Y50.2210#
- Thickness table
 - Insulation thickness calculation methods reference Y50.2285
 - Environmental thickness on warm air ductwork- reference Y50.2450
 - Condensation control on chilled air ductwork reference Y50.2460
- Thickness of insulation
- Thickness of insulation to BS 5422 reference Y50.2490#

250.070 CLOSED CELL MATERIALS THERMAL INSULATION - DUCTWORK:

- Type •
- Application
- Manufacturer and reference
- Or approved equivalent
- Temperature of fluid in ducts (°C)
- European Classification for Reaction to Fire Performance
 - Class A1 reference Y50.1035A •
 - Class A2 reference Y50.1035B •
 - Class B reference Y50.1035C
 - Class C reference Y50.1035D
- CFC's and HCFC's reference Y50.1040#
- Spread of flame as BS 476-7
 - Reference Y50.1050A
 - Reference Y50.1050#
- Smoke emission characteristics
 - Reference Y50.1055A
 - Reference Y50.1055#
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Materials

T60 / 225

- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy
 - For plant design life reference Y50.2015A
 - Details reference Y50.2015B
 - Reference Y50.2015#
- Restrictions on use of materials reference Y50.2020
- Closed cell rigid phenolic foam (PF) slab
 - Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
 - Foil faced reference Y50.2120A
 - Reference Y50.2120B
 - Reference Y50.2120#
- High density phenolic pipe and duct support foam Reference Y50.2130A
- Closed cell nitrile rubber elastomeric sheet
 - Reference Y50.2140A
 - Reference Y50.2140#
- Vapour barrier coatings
 - Bitumen reference Y50.2180A
 - Vinyl reference Y50.2180B
 - Solvent polymers- reference Y50.2180C
- Bitumen emulsion- reference Y50.2180D
- Reference Y50.2180#
- Adhesives reference Y50.2190
 - Protection
 - Application
 - Polyisobutylene- reference Y50.2200A
 - Roofing felt reference Y50.2200B
 - Flat aluminium-zinc coated steel reference Y50.2200C
 - Ribbed aluminium-zinc coated steel reference Y50.2200D
 - Aluminium sheeting reference Y50.2200E
 - Galvanized sheet steel reference Y50.2200F
 - Canvas reference Y50.2200G
 - Canvas with aluminium bands reference Y50.2200H
 - PVC reference Y50.22001
 - Laminated foil/film reference Y50.2200J
 - Reference Y50.2200#

Reference Y50.2210#

250.080 THERMAL INSULATION - PLANT:

- Reinforcement
 - Aluminium bands

Wire netting

Thickness table

Y50.2475 Thickness of insulation

•

Type

Application

KJ TAIT ENGINEERS

 300mm centres - reference Y50.2210A 450mm centres - reference Y50.2210B

• 50mm x 19g - reference Y50.2210C

• 50mm x 22g - reference Y50.2210D

Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.

 Environmental thickness on warm air ductwork - reference Y50.2450 Condensation control on chilled air ductwork - phenolic foam - reference Y50.2470 Condensation control on chilled air ductwork - closed cell pvc nitrile foam - reference

Insulation thickness calculation methods - reference Y50.2285 Thickness of insulation to BS 5422 - reference Y50.2490#

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CENTRAL REFRIGERATION PLANT**

T60

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CENTRAL REFRIGERATION PLANT**

- Manufacturer and reference •
 - Or approved equivalent
 - Temperature of fluid in plant (°C)
- European Classification for Reaction to Fire Performance
- Class A1 reference Y50.1035A
- Class A2 reference Y50.1035B
- Class B reference Y50.1035C
- Class C reference Y50.1035D
- CFC's and HCFC's reference Y50.1040#
- Spread of flame as BS 476-7
- Reference Y50.1050A
- Reference Y50.1050#
- Smoke emission characteristics
- Reference Y50.1055A
- Reference Y50.1055#
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Materials
- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy
 - For plant design life reference Y50.2015A
 - Details reference Y50.2015B
 - Reference Y50.2015#
- Restrictions on use of materials reference Y50.2020
- Mineral fibre duct insulation
- Rigid
 - Foil faced reference Y50.2040A
 - Reference Y50.2040#
 - Flexible
 - Foil faced reference Y50.2050A
 - Reference Y50.2050#
- Lamella duct insulation
 - Foil faced reference Y50.2060A
 - Kraft paper reference Y50.2060B
- Reference Y50.2060#
- Metal mesh faced mattresses
- Galvanized mesh
 - One face reference Y50.2070A
 - Both faces reference Y50.2070B
- Stainless steel mesh
 - One face reference Y50.2070C
 - Both faces reference Y50.2070D
- Reference Y50.2070#
- Closed cell rigid phenolic foam (PF) slab
 - Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
 - Foil faced reference Y50.2120A
 - Reference Y50.2120B
- Reference Y50.2120#
- High density phenolic pipe and duct support foam Reference Y50.2130A
 - Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- High density phenolic pipe and duct support foam
- Reference Y50.2130B Closed cell nitrile rubber elastomeric sheet
- Reference Y50.2140A
 - Reference Y50.2140#
- Vapour barrier coatings

T60 / 227

- Bitumen reference Y50.2180A
- Vinyl reference Y50.2180B
- Solvent polymers- reference Y50.2180C
 - Bitumen emulsion- reference Y50.2180D
- Reference Y50.2180#
- Adhesives reference Y50.2190
- Protection
 - Application
 - Polyisobutylene- reference Y50.2200A
 - Roofing felt reference Y50.2200B
 - Flat aluminium-zinc coated steel reference Y50.2200C
 - Ribbed aluminium-zinc coated steel reference Y50.2200D
 - Aluminium sheeting reference Y50.2200E
 - Galvanized sheet steel reference Y50.2200F
 - Canvas reference Y50.2200G
 - Canvas with aluminium bands reference Y50.2200H
 - PVC reference Y50.22001
 - Laminated foil/film reference Y50.2200J
 - Reference Y50.2200#
- Reinforcement
 - Aluminium bands
 - 300mm centres reference Y50.2210A
 - 450mm centres reference Y50.2210B
 - Wire netting
 - 50mm x 19g reference Y50.2210C
 - 50mm x 22g reference Y50.2210D
 - Reference Y50.2210#
- Protection for heat exchangers and other vessels
 - Aluminium
 - Reference Y50.2230A
 - With chest covers reference Y50.2230B
 - Aluminium-zinc coated steel
 - Reference Y50.2230C
 - With chest covers reference Y50.2230D
- Reference Y50.2230#
- Mineral fibre insulation for boiler flues
 - With aluminium casing reference Y50.2240A
 - With aluminium-zinc coated steel reference Y50.2240B

Non-domestic hot water supply services

• Mineral wool - reference Y50.2290

Non-domestic heating installations

• Phenolic foam - reference Y50.2300

Mineral wool - reference Y50.2310

• Phenolic foam - reference Y50.2320

- Reference Y50.2240#
- Supply pre-insulated boiler flues

Supply cylinder jackets

Thickness table

KJ TAIT ENGINEERS

•

Pre-insulated storage vessels - reference Y50.2260

Pumps and other irregular shapes - reference Y50.2280

Insulation thickness calculation methods - reference Y50.2285

Domestic central heating and hot water systems, mineral wool - reference Y50.2330 Steam and condensate systems, mineral wool - reference Y50.2340 Chilled and cold water supplies to prevent condensation Mineral wool, high emissivity - reference Y50.2350 • Phenolic foam, high emissivity - reference Y50.2360 Mineral wool, low emissivity - reference Y50.2370

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CENTRAL REFRIGERATION PLANT**

- Phenolic foam, low emissivity reference Y50.2380
- Chilled water services
 - Mineral wool reference Y50.2390
 - Phenolic foam reference Y50.2400
 - Nitrile rubber reference Y50.2410
- Protection against freezing
- Mineral wool reference Y50.2420
- Phenolic foam reference Y50.2430
- Nitrile rubber reference Y50.2440
- Environmental thickness on warm air ductwork reference Y50.2450
- Condensation control on chilled air ductwork
 - Mineral wool reference Y50.2460
 - Phenolic foam reference Y50.2470
- Thickness of insulation
- Thickness of insulation to BS 5422 Reference Y50.2490#.

250.090 WORKMANSHIP PIPEWORK INSULATION:

- General reference Y50.3010
- Installation of foil faced mineral wool insulation reference Y50.3020
- Installation of foil faced phenolic foam insulation reference Y50.3030
- Installation of insulation with canvas finish reference Y50.3040 ٠
- Installation of closed cell nitrile rubber insulation reference Y50.3050 •
- Installation of protection
 - Polyisobutylene (PIB) reference Y50.3120 ٠
 - Sheet metal finish
 - Reference Y50.3130A
 - Reference Y50.3130#
 - Canvas reference Y50.3150
 - Roofing felt reference Y50.3160 •
 - Aluminium sheeting reference Y50.3170
 - Aluminium-zinc coated steel reference Y50.3180
 - Rigid PVC reference Y50.3190 •
 - Laminated foil/film reference Y50.3195
- Flanges and valves reference Y50.3210
- Liners reference Y50.3220
- Installation where insulation is carried through pipeline support
- Reference Y50.3230A
- Closed cell insulation reference Y50.3230B
- Reference Y50.3230#
- Installation where insulation is not carried through pipeline support reference Y50.3240
- Liquid vapour barriers reference Y50.3260
- Integrity of vapour barriers reference Y50.3270

250.100 WORKMANSHIP DUCTWORK INSULATION:

- General reference Y50.3010 •
- Installation of foil faced semi-rigid slab insulation reference Y50.3060 •
- Installation of foil faced flexible insulation reference Y50.3070
- Installation of foil faced lamella insulation reference Y50.3080 •
- Installation of protection
 - Polyisobutylene (PIB) reference Y50.3120 ٠
 - Sheet metal finish
 - Reference Y50.3140A
 - Reference Y50.3140#
 - Canvas reference Y50.3150
 - Roofing felt reference Y50.3160
 - Aluminium sheeting reference Y50.3170
 - Aluminium-zinc coated steel reference Y50.3180

- Rigid PVC reference Y50.3190
- Laminated foil/film reference Y50.3195
- Installation of ductwork fire protection insulation reference Y50.3200
- Installation where insulation is not carried through ductline support reference Y50.3240
- Installation where insulation is carried through ductwork support reference Y50.3250
- Liquid vapour barriers reference Y50.3260
- Integrity of vapour barriers reference Y50.3270 •

250.110 WORKMANSHIP EQUIPMENT INSULATION:

- General reference Y50.3010
- Installation of insulation on tanks reference Y50.3090
- Installation of mineral wool insulation on vessels reference Y50.3100
- Installation of phenolic foam insulation on vessels reference Y50.3110
- Installation of protection
 - Polyisobutylene (PIB) reference Y50.3120
 - Sheet metal finish
 - Reference Y50.3140A
 - Reference Y50.3140#
 - Canvas reference Y50.3150
 - Roofing felt reference Y50.3160
 - Aluminium sheeting reference Y50.3170
 - Aluminium-zinc coated steel reference Y50.3180
 - Rigid PVC reference Y50.3190
 - Laminated foil/film reference Y50.3195
- Liquid vapour barriers reference Y50.3260
- Integrity of vapour barriers reference Y50.3270 •
- Water tanks reference Y50.3280

PART 3 SPECIFICATION CLAUSES SPECIFIC TO T60

300.000 GENERAL:

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.010 DESIGN:

Supply refrigeration plant to achieve duty specified at design conditions. Achieve stable control over the specified range of duty. Ensure that main rotating and reciprocating components are dynamically balanced.

300.020 SPECIALIST INSTALLATION:

Ensure specialist carries out delivery, installation and commissioning of equipment. • Include for dismantling and rebuilding plant in position on site.

300.030 WORKS INSPECTION:

Include for inspection at manufacturer's works.

300.050 MAINTENANCE:

Provide full installation and commissioning instructions including:-

recommended maintenance instructions.

- normal operation and emergency procedures.
- fault analysis guide. manufacturer's test and commissioning certificates.

KJ TAIT ENGINEERS

daily, weekly, monthly, 6 monthly and annual maintenance schedules.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CENTRAL REFRIGERATION PLANT**

list of recommended spares, including cost and anticipated operational life. Ensure that major components are readily accessible for maintenance without dismantling or removing other components.

300.060 SAFETY STANDARDS:

Comply with BS EN ISO 12100 and BS EN 378. Ensure noise precautions are in accordance with the Health and Safety Executive Noise at Work regulations.

300.070 EQUIPMENT:

Comply with the following standards.

- Refrigerating compressors
 - Performance in accordance with BS 3122 and BS EN 12900.
 - Use lubricating oils in accordance with BS 2626, BS 6413-3.2 and manufacturer's recommendations.
 - Safety of motor-compressors to BS EN 60335-2-34.
- Refrigerating condensers •
 - BS 1608.
 - Performance in accordance with BS 1586.
- Motors
- BS 5000:Index
- Pressure vessels BS 7005.
- Materials
 - Manufacturer's standard.

300.075 REFRIGERANTS:

CFC and HCFC refrigerants are prohibited and must not be used.

- Leak detection system
 - Provide an electronic gas detection system on the refrigerant circuit.

300.080 EQUIPMENT SCHEDULES:

• Schedule reference T60-Chillers

310.020 PACKAGED AIR COOLED LIQUID CHILLER - SCREW COMPRESSOR:

- Manufacturer and reference Climaveneta Refer to preferred equipment supplier schedule.
- Or approved equivalent.
- Duty as schedule reference T60-Chillers

Supply screw compressor chiller complete with drive motor, compressor, condenser, evaporator, heat rejection fans, starting and control equipment and all auxiliary and ancillary items to complete refrigeration cycle.

Safety devices •

- Comply with BS EN 378. Provide protection against high pressure.
- reverse rotation on normal or emergency stops.
- failure of lubricating system (auto-stop). ٠
- zero or reduced condenser water flow.
- high condenser water temperature. •
- high oil temperature. ٠
- low oil temperature. ٠
- over or under voltage. ٠
- ٠ phase reversal.
- frequent starting.
- power interruption.
- high velocity gas impingement on tubes.
- Ancillaries
 - Filter drier with isolating valves. •
 - Oil filter with isolating valves. •
 - Low oil pressure switch.
 - Oil pressure relief valve.
- Accessories

• Air separator.

- Hand reset for safety cut-out devices.
- Refrigerant suction and discharge stop valves. ٠
- Oil pressure gauge.
- Oil sump/reservoir sight glass to BS EN 12178.
- Low pressure cut-outs with adjustable differential and set points.
- High oil temperature cut out.

310 105 CHILLED WATER BUFFER VESSEL

- Type Horizontal Cylinder
- Storage capacity 2000L
- Maximum working pressure 4 bar
- Working temperature 12oC

- Insulation closed cell
- Vapour sealing fibaroll Fittinge
- Temperature gauge.
- Pressure gauge.
- Drain cock.

310.120 PRESSURISATION PLANT:

- Application Chilled Water
- Manufacturer and reference Grundfos Refer to preferred equipment supplier schedule
 - Or approved equivalent
- Dutv
- Refer to equipment schedules
 - Static head (Pa) 0.5 bar
 - Chiller rating (kW) 400
 - Operating temperatures
 - Flow (°C)-6
 - Return (°C)-12
 - Fill (°C) 10

 - System water content (litres) 8000L •
 - Operating pressure (bar g) 4.0 •
 - Electrical supply to BS 7697
 - Single phase.
- Standard

Supply expansion vessels for sealed chilled water systems in accordance with BS 4814 and BS 7074-3.

- Components •
 - volt free contacts for common fault.
 - Include break tank with type A air gap in packaged unit.
- Plant type •
 - Use diaphragm expansion tank with air.
 - Use plant/pipework arrangement with re-circulating circuits to avoid stagnant water in pressurisation unit expansion vessel.
- Accessories
 - High pressure switch.
 - Low pressure switch.

Provide duty and standby pumps with auto changeover on failure; duty pump selector switch;

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PRIMARY/SECONDARY COOLING DISTRIBUTION

T61 PRIMARY/SECONDARY COOLING DISTRIBUTION

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES Roof mounted chiller shall provide a chilled water supply for distribution throughout the building.

100.020 DESIGN PARAMETERS See System Description.

100.030 SYSTEM DESCRIPTION

The chilled water systems shall be installed with a primary system being served by four roof top packaged air cooled water chillers and 12 geothermal heat pumps. These primary cooling systems serve the majority of the Air Handling Units.

The process chilled water is provided by two packaged roof top air cooled water chillers and serves the containment, EM and NMR air handling units, fan coil units for specialists areas, and other high heat gain process loads.

Ground Source Heat Pumps - Ground source heat pumps (GSHP) will generate chilled water LPHW via twenty four heat pumps. Ten GSHP units will be generating hot water, with twelve units generating chilled water and two reverse cycle units units on stand by. The nominal total cooling load generated by the GSHP system will 1560 kW.

Primary Chilled Water System - Centrally generated chilled water will be distributed from the Energy Centre via dual mains in the basement service tunnel. Chilled water will be circulated through chillers with matching constant speed primary pumps to form the primary loop, and the heat pumps and their separate pump system. Three secondary variable speed pumps will be used to circulate chilled water from the primary loop to the building via the service tunnels. Space is planned for both a two future chillers plus primary and secondary pumps.

Chilled water will be generated and circulated in the primary loop at 6.0° . The chillers and primary loop will be sized to handle a nominal chilled water temperature difference of 7.5 °C. Primary air handling units will have a $7.7 \,^{\circ}$ C design temperature difference (6.7 to $14.4 \,^{\circ}$ C).

The air cooled chilled water system piping will be designed to accommodate a total load of 6,240 kW and peak flow of 200 litres per second with four (4) chillers in operation. The heat pump chilled water system will be designed to accommodate a total load of 1560 kW. Chilled water risers serving the individual plant towers will be sized for each heat wheel in the tower to be off line for service.

FourThree primary chilled water pumps sized for 50 litres per second will circulate the chilled water through the air cooled chillers.

Three secondary chilled water pumps sized for 85 litres per second will circulate the chilled water to cooling coils in air handling units. The pumps will have variable frequency drives to match the required water flow to the building load. Air handling unit coils will be provided with 2-way control valves.

As indicated on the drawings variable volume secondary chilled water will be distributed to the air handling units systems via the east west tunnel headers with two risers per header rising through the plant tower serving the AHU's. Each floor will be provided with valved connections for service to secondary air handling units.

Process chilled water - Process chilled water will be generated and circulated in the primary loop at 3.3℃. The chillers and primary loop will be sized to handle a nominal chilled water temperature difference of 6.7 °C. Secondary air handling units and fan coil units will have matching 6.7 °C design temperature difference (3.3 to 10.0 ℃).

The process chilled water system will have 15% propylene glycol in solution for added freeze protection.

KJ TAIT ENGINEERS

The process chilled water system will be circulated by two (2) 26 litres per second constant volume end-suction pumps.

Chilled Water Pipework Ancillaries

- Commissioning Valves Whether indicated on the drawings or not fixed orifice commissioning valves shall be installed in the return pipework connections at the following positions:-• At all pipework major equipment connections to provide proportional balancing.
 - At all pipework connections to terminal equipment provide proportional balancing.
 - At all major pipework branches to provide proportional system balancing.
 - At the base of all risers to provide proportional system balancing

- Flexible Connections Whether indicated on the drawings or not flexible connections shall be installed in the flow and return pipework connections at the following positions:- At all pipework major equipment connections.
 - At all pipework connections to terminal equipment.
 - At all major building movement joints.

Test Points – Whether indicated on the drawings or not test points shall be installed in the pipework at the following positions:-

- At all major equipment connections.
- At all pipework connections to terminal equipment.
- Across all ports of control valves.
- At the base of all risers.

Pressure Gauges - Whether indicated on the drawings or not pressure gauges shall be installed in the pipework at the following positions:-

- Across all major equipment connections.
- Across all pipework strainers.

Thermometers – Whether indicated on the drawings or not thermometers shall be installed in the pipework at the following positions:-

- Across all major equipment connections.
- In all storage vessels

All services within the plant tower and energy centre shall be on spring vibration hangers supported to avoid structural borne vibration.

Contractors shall take due cognisance of the specification clause 520. 030 Design Responsibilities.

Under the above clause the pipework and ductwork support system is a contractor's design responsibility, therefore the 2053-Z-(59)-500 series drawings shall be used as generic design intent drawings. VE M 006.

Contractors shall note that under VE M 018 aluminium protection within plant room areas is limited to 2.2 metres above finished floor level.

Please refer to Appendix A for the Preferred Manufacturers List and Appendix B for the Pipework Specification and Appendix C for the Valve Schedule.

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.020 STEEL PIPES AND FITTINGS:

KJ TAIT ENGINEERS

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PRIMARY/SECONDARY COOLING DISTRIBUTION

- **Application Chilled Water** •
- Carbon steel pipes to BS 1387
 - Heavy, black reference Y10.2010A
 - Medium, black reference Y10.2010B
- Carbon steel fittings to BS 1387
- Reference Y10.2020A
- Carbon steel fittings to BS 1965-1
- Heavy weight reference Y10.2060A
- Medium weight reference Y10.2060B
- Malleable cast iron fittings, screwed
- Black reference Y10.2070A
- Compression couplings to BS EN ISO 8434-1
- Steel reference Y10.2215A
- Jointing materials
 - Circular flanges
 - Welding flanges reference Y10.3010A
 - Screwed flanges reference Y10.3010B
 - Jointing rings for circular flanges
 - Non-metallic flat for flanges to BS EN 1092-1 reference Y10.3020A
 - Metallic for flanges to BS EN 1092-1 reference Y10.3020B
 - Screwed joints to BS 21
 - Paste and hemp and PTFE tape reference Y10.3030A
 - PTFE tape reference Y10.3030B
 - Where chemical cleaning is required reference Y10.3030C
 - Union connections •
 - Railroad pattern reference Y10.3040A
 - Navy pattern reference Y10.3040B
 - Welding rods ٠
 - Reference Y10.3050A
 - Flexible couplings, sleeve type
 - Reference Y10.3170A
 - Flexible flange adapters, sleeve type
 - Reference Y10.3180A

210.070 PIPEWORK ACCESSORIES:

- Application Chilled Water
- Pipe rings and clips
 - Steel pipework reference Y10.3200A

210.080 GENERAL WORKMANSHIP

- Application Chilled Water
- Appearance reference Y10.4010
- Spacing reference Y10.4020
- Gradients reference Y10.4030
- Air venting requirements •
 - Air bottles reference Y10.4040A
- Automatic air vents reference Y10.4040B
- Drain requirements reference Y10.4050
- Expansion and contraction reference Y10.4060
- Pipe fittings •
 - Bends/swept tees reference Y10.4070A
 - Elbows/square tees reference Y10.4070B
- Fabricated junctions reference Y10.4080
- Fabricated fittings
- Ferrous reference Y10.4090
- Non-ferrous reference Y10.4100
- Pipes through walls and floors reference Y10.4110

- C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PRIMARY/SECONDARY COOLING DISTRIBUTION
- Pipe sleeves •

T61

- Reference Y10.4120A
- Insulation carried through reference Y10.4120B
- Pipe sleeves through fire barriers reference Y10.4125
- Connections to equipment reference Y10.4130
- Distribution headers reference Y10.4140
- Temporary plugs, caps and flanges
 - Reference Y10.4150A.
- Flanged joints general reference Y10.4160
- Dissimilar metals reference Y10.4170 •
- Pipe rings and clips reference Y10.4180
- Pipe supports reference Y10.4210
- Support spacing reference Y10.4220 •
- Isolation and regulation
- Reference Y10.4230A
- Maintenance and renewal reference Y10.4240
- Cleaning reference Y10.4250
- Non-ferrous components - reference Y10.4260

210.090 WORKMANSHIP, STEEL PIPEWORK:

- Application Chilled Water •
- Welding, general
- Class 1 reference Y10.5010A
- Class 2 reference Y10.5010B
- Welded joints reference Y10.5020
- Painting welded joints reference Y10.5030
- Flanged joints reference Y10.5040
- Screwed joints reference Y10.5050
- Mechanical joints reference Y10.5060
- Anchors
- U-bolts reference Y10.5070A
- Flanges reference Y10.5070B
- Pipework painting reference Y10.5090

211,000 PIPELINE ANCILLARIES

- 211.010 GENERAL:
- Supply valves as schedule reference Valve Schedule Location

211.030 STOP VALVES:

Manufacturer and reference Refer to valve schedule

Screwed to BS 21 - reference Y11.2020A

Ball type, copper alloy to BS EN 13828.

Or approved equivalent

Kitemark certified.

To suit steel tube.

Gate valves to BS 5154

• Reference Y11.2020#

Lever operated

KJ TAIT ENGINEERS

Pipe material

- Service fluid
 - Water WRAS approved.

 Compression to BS EN 1254-2 - reference Y11.2020B Flanged to BS EN 1092-3 - reference Y11.2020C

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PRIMARY/SECONDARY COOLING DISTRIBUTION

- Screwed to BS 21 reference Y11.2080C
- Compression to BS EN 1254-2 reference Y11.2080D
- Butterfly valves to BS EN 593
- Between flanges to BS EN 1092-2
 - Lever operated reference Y11.2090A
 - Gear operated reference Y11.2090B

211.050 DOUBLE REGULATING VALVES:

- Manufacturer and reference Refer to valve schedule •

•

Or approved equivalent.

- Service fluid
- Water
- WRAS approved.
- Kitemark certified.
- Pipe material
 - To suit steel tube.

211.060 FLOW MEASUREMENT VALVES:

- Type Commissioning sets/stations.
- Manufacturer and reference Refer to valve schedule

Or approved equivalent.

- Service fluid
- Water
- WRAS approved. •
- Kitemark certified.
- Pipe material

٠

•

- To suit steel tube.
- Flow measurement devices to BS 7350
 - Section 3.2 Type 3
 - Copper alloy
 - Screwed to BS 21 reference Y11.2230A
 - Cast iron
 - Flanged to BS EN 1092-2 reference Y11.2230C
 - Section 3.2 Type 4
 - Copper alloy
 - Screwed to BS 21 reference Y11.2230E
 - Cast iron reference Y11.2230G

211.080 TEST PLUGS:

- Manufacturer and reference Refer to valve schedule
- Or approved equivalent
- Self sealing test points reference Y11.2670A
- Valve controlled test points reference Y11.2670B

211.100 PIPELINE STRAINERS:

- Manufacturer and reference Refer to valve schedule
- Or approved equivalent
- Bronze •
 - Screwed to BS 21 reference Y11.2680A
- Cast iron
- Flanged to BS EN 1092-2 reference Y11.2680D

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PRIMARY/SECONDARY COOLING DISTRIBUTION

211.140 GAUGES:

T61

- General reference Y11.2700A
 - 100mm finish
 - Direct mounting reference Y11.2700F
- Reference Y11.2700#
- Temperature gauges general reference Y11.2710A Mercury in steel - reference Y11.2710B
- Vapour pressure to BS 5235
 - Direct mounting reference Y11.2710C
 - Remote mounting reference Y11.2710D
- Reference Y11.2710#
- Pressure and altitude gauges reference Y11.2720
- Vacuum gauges - reference Y11.2730
- Differential pressure gauges •

211.150 CONTROL VALVES:

- Manufacturer and reference As supplied by BMS Contractor Or approved equivalent
- WRAS approved.
- Kitemark certified. •
- Ball control valves •
 - Open/close reference Y11.2315A
 - Two way reference Y11.2315B
 - Three way reference Y11.2315C

211.160 LOOSE ITEMS:

- Keys for spindle shank valves reference Y11.3010A
- For drain cocks reference Y11.3010B •

211.170 CHECK VALVES:

- Type
- Application
- Manufacturer and reference Refer to valve schedule

Or approved equivalent

- WRAS approved.
- Kitemark certified. •
- Service fluid
- Water.
- Pipe material
 - To suit steel tube.
- Swing check type to BS 5154
 - Screwed to BS 21 reference Y11.2320A
 - Flanged to BS EN 1092-3 reference Y11.2320B
- Check valve to BS EN 12334
 - Swing check
 - Flanged reference Y11.2330A

211.175 VERIFIABLE BACKFLOW PREVENTER WITH REDUCED PRESSURE ZONE (RPZ VALVE):

- Manufacturer and reference Refer to valve schedule Or approved equivalent
- WRAS approved.
- Kitemark certified. •

Service fluid Water.

KJ TAIT ENGINEERS

General requirements - reference Y11.2395A.

- Assembly complete with ٠
 - Isolating valves
 - Strainers ٠
 - Pressure reducing valves
 - Non-return valves
 - Test points
 - Tamper free housing or secure cabinet
- Mounting
- Vertical.
- Horizontal.
- Installation reference Y11.2395B.
- On-site inspection and testing reference Y11.2395C.
- Record of installation and test data reference Y11.2395D.

211.180 WORKMANSHIP:

- Installation reference Y11.4010 •
- Location reference Y11.4020
- Positioning of components
 - Flow/pressure measurement valves reference Y11.4030
 - Double regulating variable orifice valves reference Y11.4040
 - Control ball valves reference Y11.4045 ٠
 - Control components
 - Reference Y11.4050A
- Vent cocks reference Y11.4060
- Valve stuffing boxes reference Y11.4070
- Discharge connections
 - Safety and Relief valves reference Y11.4080A •
 - Vent cocks reference Y11.4080B
 - Air bottles reference Y11.4080C •
 - Automatic air vents reference Y11.4080D
- Flexible connections installation reference Y11.4110
- Terminal unit connections installation reference Y11.4120 •

211.210 DRAIN COCKS:

- Manufacturer and reference Refer to valve schedule
- Or approved equivalent
- WRAS approved. •
- Kitemark certified.
- Throughway gland cock type
 - Reference Y11.2440A
- Screwdown to BS 2879, type 1 reference Y11.2450
- Ball type reference Y11.2460

211.220 VENT COCKS:

- Kitemark certified.
- Two way gland cock type reference Y11.2470
- Ball type reference Y11.2480
- Three way gland cock type reference Y11.2490
- Plug valve type •
 - Wrench operated reference Y11.2500A
 - Gear operated reference Y11.2500B

211.230 AUTOMATIC AIR VENTS:

- Float type
- Reference Y11.2510A

220.000 PUMPS

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PRIMARY/SECONDARY COOLING DISTRIBUTION

220.010 GENERAL:

Comply with work section general clauses reference Y20.1000 and those detailed below. Provide pumps as schedule reference drawing 2053-Z-(59)-705-D

220.030 PUMP:

T61

- Manufacturer and reference As Preferred Manufacturers list
- Or approved equivalent Centrifugal pumps
 - Horizontally mounted belt driven. Reference Y20.2010A
 - Vertically mounted belt driven. Reference Y20.2010B
 - Close coupled. Reference Y20.2010C
 - Direct drive in-line. Reference Y20.2010D
 - Direct drive, immersed rotor. Reference Y20.2010E
- Variable flow control reference Y20.2015
 - Connections
 - Flanged to BS EN 1092-1 PN •
 - Flanged to BS EN 1092-2 PN
 - Flanged to BS EN 1092-3 PN
 - Flanged to BS EN 1092-4 PN
 - Screwed to BS 21.
- Accessories
 - Drive belts reference Y20.3010
 - Matching flanges PN •
 - Flanged to BS EN 1092-1 reference Y20.3020A
 - Flanged to BS EN 1092-2 reference Y20.3020B
 - Flanged to BS EN 1092-4 reference Y20.3020C
 - Reference Y20.3020#

220.040 PUMP MOTOR DRIVE - ELECTRIC:

- Comply with reference section general clauses reference Y92.1000 and those detailed below.
 - Electrical supply to BS 7697
 - Single phase.
 - Three phase.
- Surge suppressors
 - Manufacturer fitted reference Y92.1040A
- Transient suppressors
- Manufacturer fitted reference Y92.1050A
- Operating conditions
 - Standard operating conditions reference Y92.2010A
- Motors
- General Reference Y92.2020 ٠
- Slide rails Reference Y92.2030
- Plinths Reference Y92.2040
- Motor efficiency

KJ TAIT ENGINEERS

- Class Eff 1 reference Y92.2025A
- Class Eff 2 reference Y92.2025B

Motors - over temperature protection

Thermistors - reference Y92.2060A

Motor rating

 Up to and including 0.75kW - reference Y92.2050A Above 0.75kW up to and including 4kW - reference Y92.2050B • Above 4kW squirrel cage, drip-proof - reference Y92.2050C Above 4kW wound rotor, drip-proof - reference Y92.2050D Above 4kW squirrel cage, totally enclosed - reference Y92.2050E Above 4kW wound rotor, totally enclosed - reference Y92.2050F Above 4kW squirrel cage, smokespill - reference Y92,2050G Above 4kW squirrel cage, energy efficient design - reference Y92.2050H

- Drives
 - Indirect drives
 - Toothed belt reference Y92.2070A
 - Flat belt reference Y92.2070B
 - Direct coupled drives
 - Reference Y92.2080A
 - Variable speed drive reference Y92.2085
 - Guards
 - Reference Y92.2090A

220.050 PUMP MOTOR STARTER:

- Incorporated in Control/monitoring reference W60.
- Comply with reference section general clauses reference Y72.1000 and those detailed below.
 - Electrical supply
 - 3 phase reference Y72.1010A
 - Single phase reference Y72.1010B
- General
 - Motors below 0.37kW reference Y72.2130A
 - Motors above 0.37kW reference Y72.2130B
- Current limiting type reference Y72.2140
- Direct-on-line type reference Y72.2150 ٠
- Star delta type reference Y72.2160 •
- Auto-transformer type
- Inverter type
- Reference Y72.2190A
- Automatic changeover for run/standby duty
 - Single power supply reference Y72.2200
 - Provide system malfunction audible alarm.
 - Dual power supply reference Y72.2210
- Workmanship, installation reference Y72.3010

220.060 WORKMANSHIP:

General - reference Y20.4010 Pipeline connections - reference Y20.4020 Mountings - reference Y20.4030 Alignment - reference Y20.4040 Access - reference Y20.4050

224.000 TRACE HEATING

224.020 ELECTRIC TRACE HEATING:

- Type
- Application Chilled Water
- Manufacturer and reference Refer to Preferred manufacturers list
- Or approved equivalent
- Quality assured to BS EN ISO 9002.
- Constant power cable
- RCD protection reference Y24.2010A
- MCB protection reference Y24.2010B
- Self regulating tape
- RCD protection reference Y24.2010C
- MCB protection reference Y24.2010D
- Reference Y24.2010#

225,000 CLEANING AND CHEMICAL TREATMENT

225.010 GENERAL:

Comply with work section general clauses reference Y25.1000 and those detailed below.

225.020 CLEANING AND CHEMICAL TREATMENT SPECIALIST: • Reference Y25.2010

225.040 PRELIMINARY CHECKS:

Reference Y25.2030A

225.050 PROCEDURAL PRECAUTIONS:

- Reference Y25.2040A
- Including taking samples reference Y25.2040B

225.080 CHEMICAL PROVISION:

Standard arrangement - reference Y25.2080A

225.090 FLUSHING:

- BSRIA Application Guide 1/2001 reference Y25.3010A System filling

 - Temporary connection from fire hydrant pipework.
 - By installation of temporary tank and pump arrangement.
- Flushing reference Y25.3010B

225.150 DOCUMENTATION: Reference Y25.3090

250.000 THERMAL INSULATION

250.010 GENERAL:

- Comply with work section general clauses reference Y50.1000 and those detailed below.
- Supply thermal insulation as specified in section T31

250.020 INSTALLER SELECTION:

- Use a contractor specialising in the supply and installation of thermal insulation.
- Use thermal insulation materials supplied by a manufacturer assessed and registered in accordance with BS ISO 9000-2.

250.040 CLOSED CELL MATERIALS THERMAL INSULATION - PIPEWORK:

- Application Chilled Water
- Manufacturer and reference
- Or approved equivalent
- Temperature of fluid in pipes (°C) 12/6
- European Classification for Reaction to Fire Performance
- Class A1 reference Y50.1035A
- Class A2 reference Y50.1035B
- Class B reference Y50,1035C
- Class C reference Y50.1035D
- CFC's and HCFC's reference Y50.1040#
- Spread of flame as BS 476-7
- Reference Y50.1050A
- Reference Y50.1050#
- Smoke emission characteristics
 - Reference Y50.1055A Reference Y50.1055#
 - Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Materials
- Thermal conductivity reference Y50.2010

 Temporary connection from mains in compliance with the Water Supply (Water Fittings) Regulations 1999, and the Water Supply (Water Fittings) (Amendment) Regulations 1999.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PRIMARY/SECONDARY COOLING DISTRIBUTION

T61

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PRIMARY/SECONDARY COOLING DISTRIBUTION

- Thermal performance life expectancy •
- Restrictions on use of materials reference Y50.2020
- Closed cell rigid phenolic foam (PF) preformed sections
- Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Foil faced - reference Y50.2110A
- Reference Y50.2110B
- Reference Y50.2110#
- High density phenolic pipe and duct support foam Reference Y50.2130A
- Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Closed cell nitrile rubber preformed flexible sections
- Reference Y50.2140A
- Reference Y50.2140#
- Vapour barrier permeance
- Reference Y50.2170A
- Reference Y50.2170#
- Vapour barrier coatings
- Bitumen reference Y50.2180A
- Vinyl - reference Y50.2180B
- Solvent polymers- reference Y50.2180C ٠
- Bitumen emulsion- reference Y50.2180D
- Reference Y50.2180#
- Adhesives reference Y50.2190 •
- Protection
 - Application
 - Polyisobutylene- reference Y50.2200A
 - Flat aluminium-zinc coated steel reference Y50.2200C
 - Ribbed aluminium-zinc coated steel reference Y50.2200D
 - Aluminium sheeting reference Y50.2200E •
 - Laminated foil/film reference Y50.2200J
 - Reference Y50.2200#
- Reinforcement •
 - Aluminium bands
 - 300mm centres reference Y50.2210A
- Valve and flange insulation
 - Application
 - Aluminium casing reference Y50.2220A •
 - Aluminium-zinc coated steel casing reference Y50.2220B
 - Closed cell material for cold applications reference Y50.2220C
 - Cold applications reference Y50.2220D
 - Reference Y50.2220#
- Thickness table
 - Insulation thickness calculation methods reference Y50.2285
 - Chilled and cold water supplies to prevent condensation ٠
 - High emissivity reference Y50.2360
 - Low emissivity reference Y50.2380
 - Chilled water services
 - Phenolic foam reference Y50.2400
 - Nitrile rubber reference Y50.2410
 - Protection against freezing
 - Phenolic foam reference Y50.2430
 - Nitrile rubber reference Y50.2440
- Thickness of insulation
- Thickness of insulation to BS 5422 reference Y50.2490#

250.090 WORKMANSHIP PIPEWORK INSULATION:

- General reference Y50.3010 •
- Installation of foil faced phenolic foam insulation reference Y50.3030

T61/243

KJ TAIT ENGINEERS

- Installation of protection • Polyisobutylene (PIB) - reference Y50.3120
 - Sheet metal finish
 - Reference Y50.3130A
 - Reference Y50.3130#
- Flanges and valves reference Y50.3210
- Liners reference Y50.3220 •
- Installation where insulation is carried through pipeline support • Reference Y50.3230A
- Liquid vapour barriers reference Y50.3260
- Integrity of vapour barriers reference Y50.3270

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

251.020 SPECIALIST:

- Use one of the following specialist commissioning engineers Refer to preferred manufacturers list
- Or approved equivalent
- set up efficiently and meet the user's requirements.

251.030 STATIC TESTING:

- Pressure testing
 - General reference Y51.2010
 - Water circulating and supply systems and steam and condense lines reference Y51.2020
- Testing records reference Y51.2110

251.040 COMMISSIONING:

- Commissioning codes reference Y51.3020
- Commissioning
- Water distribution
 - Including BSRIA pre-commissioning check list Reference Y51.3030A
- Commissioning records
 - For water systems To BSRIA Application Guide 2/89.3 - reference Y51.3100B

252.000 VIBRATION ISOLATION MOUNTINGS

252.010 GENERAL:

Comply with work section general clauses reference Y52.1000 and those detailed below.

252.050 PIPEWORK HANGERS:

- Turret compression hangers
 - Synthetic rubber reference Y52.2050A • Lockable facility - reference Y52.1040
 - Neoprene reference Y52.2050B
 - Lockable facility reference Y52.1040
- Spring compression hangers reference Y52.2060

Combined turret/spring compression hangers Synthetic rubber - reference Y52.2070A

Lockable facility - reference Y52.1040

Lockable facility - reference Y52.1040

Neoprene - reference Y52.2070B

Comply with work section general clauses reference Y51.1000 and those detailed below.

The commissioning Specialist shall allow for revisiting the commissioning of the building over the first 18 month occupied period to allow for seasonal adjustment, to ensure the systems are

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PRIMARY/SECONDARY COOLING DISTRIBUTION

• Lockable facility - reference Y52.1040

252.080 VIBRATION ISOLATION HOSES:

Vibration isolation hoses - reference Y52.2100

252.100 WORKMANSHIP

- General reference Y52.3010
- Fixing reference Y52.3030

252.110 PIPE, WALL AND RISER SEALS:

Mineral fibre packing - reference Y52.2120B

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL:

Comply with work section general clauses reference Y54.1000 and those detailed below.

Services Identification drawings - reference Y54.2015

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

254.040 PLANT AND EQUIPMENT IDENTIFICATION:

• Lettering

- Engraved plates filled with paint reference Y54.2030A ٠
- Laminated plates, multi-coloured with outer layer removed for lettering reference Y54.2030B ٠
- Clear perspex back filled to reveal lettering reference Y54.2030C

254.045 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416: Reference Y54.2035

254.050 VALVE AND COCK IDENTIFICATION: Reference Y54.2040

254.090 INSTRUMENT IDENTIFICATION: Reference Y54.2080

254.100 DANGER AND WARNING NOTICES: Reference Y54.2090

254.110 SYSTEM IDENTIFICATION INSTALLATION CHARTS:

- Perspex sheet glazing with frame reference Y54.2100A •
- Hardboard in hardwood frame and glazed reference Y54.2100B
- Plastic encapsulated chart reference Y54.2100C •

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL: Comply with work section general clauses reference Y90.1000 and those detailed below.

290.020 FIXINGS:

- Standards reference Y90.2010 •
- Plugs reference Y90.2020
- Screws reference Y90.2030
- Cast-in fixings reference Y90.2040
- Shot fired fixings reference Y90.2050
- Proprietary channel inserts reference Y90.2070

290.030 WORKMANSHIP:

- Drilling reference Y90.3010 •
- Proprietary fixings - reference Y90.3020
- Fixing to reinforced concrete reference Y90.3030
- Fixing to brickwork reference Y90.3040
- Fixing to timber rails reference Y90.3050
- Fixing to hollow stud/tile/block wall
- Reference Y90.3060A
- Fixing to concrete, brickwork or blockwork • Reference Y90.3070A
- Fixing to metalwork
 - Reference Y90.3080A
- Fixing to structural steelwork and concrete structures
- Reference Y90.3090A

T71 COLD ROOMS

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES To provide close controlled temperature environments

100.020 DESIGN PARAMETERS Type 1: 4 ℃ ± 0.22.0 ℃ RH 20% ± 5%. External Design Temperature +32 °C Cold Room Design Temperature +4 °C ±2 °C (at control point) Product Load Water 100 litres per 24-hour period. Entering at +20 °C being cooled to +4 °C within 12 Hrs, assuming that the product will give up its heat. Specific Heat Above Freezing 4.23 kJ/kg K Laboratory Equipment 750 watts Lighting 1114 watts Occupancy 4 persons, 4hrs per day (light work)

Type 2: -20 ℃ ± 0.22.0 ℃ RH 20% ± 5%. External Design Temperature +32℃ Cold Room Design Temperature -20 ℃ ±2 ℃ (at control point) Product Load Water 25 litres per 24-hour period. Entering at +20 °C being cooled to -20 °C within 12 Hrs.assuming that the product will give up its heat. Specific Heat Above Freezing 4.23 kJ/kg K Specific Heat Below Freezing 2.10 kJ/kg K Fusion Heat 334.00 kJ/kg Laboratory Equipment None Lighting 139 watts **Occupancy None**

100.030 SYSTEM DESCRIPTION

The architectural layouts shall define the required sizes and requirements including items such as floor and wall finishes, benching, over shelves, sinks and door provisions. The floor surface of cold rooms will be flush with adjacent finish floors; this is accommodated with depressions in the structural floor slabs.

The electrical layouts shall define the required sizes and requirements including items such as essential and non essential power outlets, lighting, switching and data outlets.

The mechanical layouts shall define the required sizes and requirements including items such as temperatures, alarms, ventilation rates, BMS connections and piped services requirements.

Cold rooms will be provided as complete pre-packed units custom designed to meet all requirements defined on the drawings. Each individual cold room will be provided with the following building services to complete the installation:

- •Essential power supply for each cold room refrigeration system
- •Non-essential power circuits for outlets within cold rooms (By Electrical Contractor)
- •Essential power circuits for outlets within cold rooms (By Electrical Contractor)
- Data/telecom connections for outlets within cold rooms (By Electrical Contractor)

•BMS Ethernet connection point at each suite of rooms to connect site system to the cold room trend controller.point(s) for monitoring and alarm

- •Supply and extract air connection for each individual room or inner room
- •Piped service connections when required

All piping, wiring, fittings and outlets within and at the entrance to cold room will be supplied with prepacked units meeting all other design standards for the project.

Cold rooms will be fitted with panic release, panic alarm panel and interface to BMS for high temperature alarm and remote indication of panic alarm. An external digital readout of both cold room temperature and humidity simultaneously and high temperature alarm will be provided by the cold room vendor. When inner lower temperature rooms occur two (2) sets of external readouts will be provided.

Each suite of cold rooms shall be connected to the main BMS system via a local area outstation. The following points shall be monitored from each cold room:-

- System Healthy.
- System On.
- System Fault.
- Compressor Run.
- Compressor Fault. •
- Room temperature.
- High & low temperature alarm.
- Room humidity in +4^oC rooms only.
- Oxygen depletion alarm in 4^oC rooms only.

Cold room design conditions are either 4 °C or -20 °C as defined on the drawings. Temperature must be controlled to ± 0.22.0 °C with no relative humidity control at 20% ± 5%. Each individual cold room or inner cold room will be provided with duplex air cooled inverter driven refrigeration systems for standalone operation and N+1 capacity. Each refrigeration system will have a separate essential power supply.

The refrigeration systems will be sized to accommodate outdoor air supplied at 8 litres per second per person and saturated at $1011 \,^{\circ}\text{C} \pm 2 \,^{\circ}\text{C}$. Outdoor air will be provided from the laboratory air handling system and controlled at a constant volume and temperature. Air supplied from the lab system will be introduced through the cold room refrigeration system, cooled prior to discharge into the cold room to minimise condensation formation. Supply air will be removed by a matching constant volume extract connection. Cold rooms will be balanced with a slight positive pressure.

Air cooled condensing units for cold room will be suspended within the interstitial ceiling void above the cold room.

All cold rooms evaporator coils shall be manufactured with copper coils, copper fins with electro-tinned plating

100.040 CONTROL REQUIREMENTS See Above

100.050 SYSTEM SCHEMATICS

100.060 SYSTEM DRAWINGS

Refer to RMJM Architectural Room Data Layout drawings 2053 - Z (40) 021 Refer to RMF - KJ Tait Engineers Mechanical Room Data Layout drawings 2053 - Z (50) 021 Refer to RMF - KJ Tait Engineers Electrical Room Data Layout drawings 2053 - Z (60) 021

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

210.000 PIPELINES

210.010 GENERAL: Comply with work section general clauses reference Y10.1000 and those detailed below.

210.030 COPPER PIPES AND FITTINGS:

Type

KJ TAIT ENGINEERS

Trapped Person Alarm (additional interface primary alarm direct to security panel by others).

- Application
- Fluid Conveyed •
 - Working pressure
 - Working temperature
- Copper pipe, half hard (Class X)
- Uncoated reference Y10.2270A
- Capillary fittings for copper tubing
- General potable range reference Y10.2310A
- Compression fittings for copper tubing
- Type A compression fittings reference Y10.2320A

210.070 PIPEWORK ACCESSORIES:

- Type
- Application •
- Wall, floor and ceiling masking plates •
- Chromium plated reference Y10.3190A.
- Plastic reference Y10.3190B
- Pipework support reference Y10.4210 •
- Wire rope suspension system reference Y10.4215#

210.080 GENERAL WORKMANSHIP

- Type
- Application •
- Appearance reference Y10.4010
- Spacing reference Y10.4020 •
- Gradients reference Y10.4030
- Air venting requirements •
 - Air bottles reference Y10.4040A ٠
 - Automatic air vents reference Y10.4040B
- Drain requirements reference Y10.4050
- Expansion and contraction reference Y10.4060
- Pipe fittings
 - Bends/swept tees reference Y10.4070A ٠
 - Elbows/square tees reference Y10.4070B
- Pipes through walls and floors reference Y10.4110
- Pipes through walls and floors fire stopping reference Y10.4110# •
- Pipe sleeves
 - Reference Y10.4120A
- Insulation carried through reference Y10.4120B
- Pipe sleeves through fire barriers reference Y10.4125
- Connections to equipment reference Y10.4130
- Distribution headers reference Y10.4140
- Temporary plugs, caps and flanges •
- Reference Y10.4150A.
- Flanged joints general reference Y10.4160
- Dissimilar metals reference Y10.4170 •
- Pipe rings and clips reference Y10.4180 •
- Anchors reference Y10.4190 • Location
- As drawing numbers
- Slide guides reference Y10.4200 Location
 - As drawing numbers
- Pipe supports reference Y10.4205
- Support spacing reference Y10.4220
- Isolation and regulation
 - Reference Y10.4230A

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE COLD ROOMS

- Maintenance and renewal reference Y10.4240 •
- Cleaning - reference Y10.4250
- Non-ferrous components reference Y10.4260

210.090 WORKMANSHIP, STEEL PIPEWORK:

Type

T71

- Application Welding, general
- Class 1 reference Y10.5010A
- Class 2 reference Y10.5010B
- Welded joints reference V10 5020
- Painting welded joints reference Y10.5030
- Flanged joints reference Y10.5040
- Screwed joints reference Y10.5050
- Mechanical joints reference Y10.5060
- Anchors
- U-bolts reference Y10.5070A
- Flanges reference Y10.5070B
- Pipework painting reference Y10.5090
- Installation of stainless steel pipework
- Compression joints reference Y10.5100

210.100 WORKMANSHIP, COPPER PIPEWORK:

- Capillary joints reference Y10.6040
- Anchors
 - Flanges reference Y10.6060A
 - Saddle clamps reference Y10.6060B

211.000 PIPELINE ANCILLARIES

211.010 GENERAL:

Comply with work section general clauses reference Y11.1000 and those detailed below

- Supply valves as specified in work section •
- Supply valves as schedule reference Y11-valves Location
- Supply valves as schedule reference
 - Location
 - At end of this work section.
- Supply local controls as schedule reference
- Location
- At end of this work section.

211.030 STOP VALVES:

- Type
- **Application** •
- Manufacturer and reference Or approved equivalent
- Service fluid

WRAS approved.
 Kitemark certified.

KJ TAIT ENGINEERS

Pipe material

- Water
- Operating temperature (^{*}C) PN rating

• To suit copper tube.

To suit plastic tube.

Stop taps to BS 1010-2

To suit steel tube.

T71

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE COLD ROOMS

COLD ROOMS	COLD R
Screwed to BS 21 and BS EN 10226-1 - reference Y11.2010A	Reference Y25.2010
 Capillary to BS EN 1254-1 - reference Y11.2010B 	 Use one of the following specialists
 Stop valves to BS EN 1213 for potable water supplies 	 Or approved equivalent
 Compression ends for copper - reference Y11.2015A 	
 Compression ends for plastics - reference Y11.2015B 	225.030 MAINS WATER ANALYSIS:
Capillary - reference Y11.2015C	Application
Threaded - reference Y11.2015D	Reference Y25:2020A
Gate valves to BS EN 12288	I ne following is an analysis of mains water takei
 Screwed to BS EN ISO 228-1, or ISO 7-1 - reference Y11.2020A 	 Conductivity (uS/cm) Table Direction of Opticial (use (i))
Compression to BS EN 1254-2 - reference Y11.2020B	 I otal Dissolved Solids (mg/l)
 Flanged to BS EN 1092-3 - reference Y11.2020C 	● pH
Loose nut/union end - reference Y11.2020D	Chloride CI (mg/l)
Gate valves to BS EN 1171	Calcium Ca (mg/l)
 Flanged to BS EN 1092-2 - reference Y11.2030A 	 Magnesium Mg (mg/l)
Globe valves to BS 5154	 Sodium Na (mg/l)
 Screwed to BS 21 and BS EN 10226-1 - reference Y11.2040A 	 Potassium K (mg/l)
 Flanged to BS EN 1092-3 - reference Y11.2040B 	Total Hardness CaC0 ₃
Compression to BS EN 1254-2 - reference Y11.2040C	Alkalinity CaC0 ₃
 Compression to BS EN 1254-3 - reference Y11.2040D 	Total Iron Fe (ug/l)
Globe valves to BS EN 13789	Copper Cu (ug/l)
 Flanged to BS EN 1092-2 - reference Y11.2050A 	
Parallel slide to BS EN 1171	225.040 PRELIMINARY CHECKS:
Reference Y11.2060A	Application
 Handwheel operated gate type to BS EN 1984 	 Reference Y25.2030A
 Flanged to BS EN 1092-1 - reference Y11.2070A 	
Threaded reference Y11.2070D	225.050 PROCEDURAL PRECAUTIONS:
Auxiliary connections	Application Defense Vot 00 10 1
 Ball type, copper alloy to BS EN 13828. 	Reference Y25.2040A
 Screw driver/key operated 	Including taking samples - reference Y25.2040B
 Screwed to BS-21 and BS EN 10226-1 - reference Y11.2080A 	
 Compression to BS EN 1254-2 - reference Y11.2080B 	243.000 HEATING/COOLING COILS
Lever operated	
 Screwed to BS 21 and BS EN 10226-1 - reference Y11.2080C 	Comply with work section general clauses reference
 Compression to BS EN 1254-2 - reference Y11.2080D 	Supply with work section general bladdes reference
Lockshield	Location
 Screwed to BS 21 and BS EN 10226-1 - reference Y11.2080E 	At and of this work section
 Compression to BS EN 1254-2 - reference Y11.2080F 	Supply cooling coils as schedule reference
 Butterfly valves to BS EN 593 	Couply could as schedule reference
Between flanges to BS EN 1092-2	At and of this work section
Lever operated - reference Y11.2090A	Supply in-duct heater batteries schedule referen
Gear operated - reference Y11.2090B	Cuppin Function
Between mechanical joints	Elecation
Lever operated - reference Y11.2090C	243 040 REERIGEBANT COOLING COIL
Gear operated - reference Y11.2090D	Manufacturer and reference
Sluice type to BS 5163-1 and BS 5163-2	Or approved equivalent
Lubricated plug cock type to BS 5158	Duty as schedule reference
	Duty as schedule reference Duty
225.000 CLEANING AND CHEMICAL TREATMENT	Befrigerant
	 Evanoration temperature (°C)
225.010 GENERAL:	Rating (k/M)
Comply with work section general clauses reference Y25.1000 and those detailed below.	• Air flow rate (m^{3}/s)
 Supply cleaning and chemical treatment as specified in section 	 Air valocity (m/s)
Provide water treatment in accordance with schedule reference	Maximum air velocity
Location	
	 Z./JIII/S. Resistance to air flow (Pa)
225.020 CLEANING AND CHEMICAL TREATMENT SPECIALIST:	• Air condition on coil dry hulb $({}^{0}C)$
Application	• All condition on coll - dry built (C) • Air condition on coll - wet hulb $\binom{90}{2}$
	• All condition on coil - wet buib (C)

KJ TAIT ENGINEERS

n from site supply point:-

Y43.1000 and those detailed below.

nce Y43-Battery

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE COLD ROOMS

- Air condition off coil dry bulb (°C)
- Air condition off coil wet bulb (°C)
- Coil
 - Copper with aluminium fins reference Y43.2020A
- Accessories
 - Drip tray reference Y43.3010
 - Provide removable drip trays.
 - Drain traps
 - Glass
 - Under suction reference Y43.3020A
 - Eliminator plates reference Y43.3030
 - Duct connections
 - AHU reference Y43.3050A
 - External flange reference Y43.3050B
 - Internal flange reference Y43.3050C
 - Spigot reference Y43.3050D •
 - Reference Y43.3050#
 - Matching flanges ductwork reference Y43.3060 •
 - Matching flanges pipework reference Y43.3070
 - Access doors reference Y43.3100
 - Access walkway reference Y43.3110

243.050 HEATING COIL - ELECTRIC:

- Type •
- Application
- Included in air handling unit AHU
- Manufacturer and reference
- Or approved equivalent
- Duty as schedule reference
- Duty
 - ٠ Rating (kW)
 - Air flow rate (m^3/s) ٠
 - Air velocity (m/s) ٠
 - Resistance to air flow (Pa) ٠
 - Air condition on coil (°C) •
 - ٠ Air condition off coil (°C)
 - Maximum sheath temperature (°C) •
 - Electrical supply .
 - Single phase, 240volt, 50Hz.
 - Three phase, 415volt, 50Hz.
- Heater type
 - Air duct heaters reference Y43.2040A
 - Electrical details
 - Phase
 - Single phase. ٠
 - Three phase and neutral, star wiring.
 - Three phase balanced across phases.
 - Stages •
 - IP •
- Accessories
- Duct connections ٠
- Access doors reference Y43.3100
- Access walkway reference Y43.3110

250.000 THERMAL INSULATION

250.010 GENERAL:

T71/253

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE COLD ROOMS

Comply with work section general clauses reference Y50.1000 and those detailed below.

250.015 ZERO GLOBAL WARMING POTENTIAL (GWP): Use insulating materials with a Global Warming Potential (GWP) of zero.

250.017 ZERO OZONE DEPLETION POTENTIAL (ODP): Use insulating materials with an Ozone Depletion Potential (ODP) of zero.

250.020 INSTALLER SELECTION:

- Use a contractor specialising in the supply and installation of thermal insulation.
- Use thermal insulation materials supplied by a manufacturer assessed and registered in accordance with BS ISO 9000-2.

250.040 CLOSED CELL MATERIALS THERMAL INSULATION - PIPEWORK:

- Manufacturer and reference
- Or approved equivalent
- European Classification for Reaction to Fire Performance
- Class A1 reference Y50.1035A
- Class A2 reference Y50.1035B
- Class B reference Y50.1035C
- Class C reference Y50.1035D
- CFC's and HCFC's reference Y50,1040# •
- Spread of flame as BS 476-7
- Reference Y50.1050A
- Smoke emission characteristics
- Reference Y50.1055A
- Electrical bonding terminal reference Y50.1080 •
 - Inspection and testing reference Y50.1090
- Materials • Thermal conductivity - reference Y50.2010 •
- Thermal performance life expectancy
 - For plant design life reference Y50.2015A
 - Details reference Y50.2015B
- Restrictions on use of materials reference Y50.2020 •
 - Closed cell rigid phenolic foam (PF) preformed sections

 - Foil faced reference Y50.2110A
 - Reference Y50.2110B
- High density phenolic pipe and duct support foam Reference Y50.2130A Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Closed cell nitrile rubber preformed flexible sections
- Reference Y50.2140A
- Vapour barrier permeance
- Vapour barrier coatings
- Bitumen reference Y50.2180A
- Vinyl reference Y50.2180B
- Solvent polymers- reference Y50.2180C
- Bitumen emulsion- reference Y50.2180D

Polyisobutylene- reference Y50.2200A

Aluminium sheeting - reference Y50.2200E

Roofing felt - reference Y50.2200B

Canvas - reference Y50.2200G

- Adhesives reference Y50.2190
 - Protection Application

KJ TAIT ENGINEERS

٠

Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.

Flat aluminium-zinc coated steel - reference Y50.2200C Ribbed aluminium-zinc coated steel - reference Y50.2200D

Galvanized sheet steel - reference Y50.2200F

- Canvas with aluminium bands reference Y50.2200H •
- PVC - reference Y50.22001
- Laminated foil/film reference Y50.2200J
- Reinforcement
 - Aluminium bands
 - 300mm centres reference Y50.2210A
 - 450mm centres reference Y50.2210B
 - Wire netting
 - Valve and flange insulation
- Application
- Thickness table
- Insulation thickness calculation methods reference Y50.2285 •
- Non-domestic hot water service areas reference Y50.2300
- Non-domestic heating installations reference Y50.2320
- Chilled and cold water supplies to prevent condensation ٠
 - High emissivity reference Y50.2360
 - Low emissivity reference Y50.2380
- Chilled water services
 - Phenolic foam reference Y50.2400
 - Nitrile rubber reference Y50.2410
- Protection against freezing
 - Phenolic foam reference Y50.2430
 - Nitrile rubber reference Y50.2440
- Thickness of insulation

250.080 THERMAL INSULATION - PLANT:

- Type
- Application
- Manufacturer and reference
- Or approved equivalent
- Temperature of fluid in plant (°C)
- European Classification for Reaction to Fire Performance
- Class A1 reference Y50.1035A ٠
- Class A2 reference Y50.1035B •
- Class B reference Y50.1035C
- Class C reference Y50.1035D
- CFC's and HCFC's reference Y50.1040#
- Spread of flame as BS 476-7
- Reference Y50.1050A
- Smoke emission characteristics
- Reference Y50.1055A
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Materials
- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy
- For plant design life reference Y50.2015A
- Details reference Y50.2015B
- Restrictions on use of materials reference Y50.2020
- Mineral fibre duct insulation
 - Riaid
 - Foil faced reference Y50.2040A
 - Flexible
 - Foil faced reference Y50.2050A
 - Lamella duct insulation
 - Foil faced reference Y50.2060A
 - Kraft paper reference Y50.2060B

T71

T71/255

- Galvanized mesh
- One face reference Y50.2070A
 - Both faces reference Y50.2070B
 - Stainless steel mesh
 - One face reference Y50.2070C
 - Both faces reference Y50.2070D
- Closed cell rigid phenolic foam (PF) slab

 - Foil faced reference Y50.2120A
 - Reference Y50.2120B
- High density phenolic pipe and duct support foam Reference Y50.2130A
- Closed cell nitrile rubber elastomeric sheet
- Reference Y50.2140A
- Vapour barrier coatings
 - Bitumen reference Y50.2180A
 - Vinyl reference Y50.2180B
 - Solvent polymers- reference Y50.2180C
 - Bitumen emulsion- reference Y50.2180D
- Adhesives reference Y50.2190
- Protection

•

- Application
- Polyisobutylene- reference Y50.2200A
- Roofing felt reference Y50.2200B
- Flat aluminium-zinc coated steel reference Y50.2200C
- Ribbed aluminium-zinc coated steel reference Y50.2200D
- Aluminium sheeting reference Y50.2200E
- Galvanized sheet steel reference Y50.2200F
- Canvas reference Y50.2200G
- Canvas with aluminium bands reference Y50.2200H
- PVC reference Y50.22001
- Laminated foil/film reference Y50.2200J
- Reinforcement
 - Aluminium bands
 - 300mm centres reference Y50.2210A
 - 450mm centres reference Y50.2210B
 - Wire netting
- Protection for heat exchangers and other vessels
 - Aluminium
 - Reference Y50.2230A

Aluminium-zinc coated steel

Supply pre-insulated boiler flues

Supply cylinder jackets

Thickness table

KJ TAIT ENGINEERS

Mineral fibre insulation for boiler flues

With chest covers - reference Y50.2230B

Non-domestic hot water supply services

Mineral wool - reference Y50.2290

Mineral wool - reference Y50.2310

Non-domestic heating installations

• Phenolic foam - reference Y50.2300

Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.

Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.

With aluminium casing - reference Y50.2240A

Pre-insulated storage vessels - reference Y50.2260

Pumps and other irregular shapes - reference Y50.2280

Insulation thickness calculation methods - reference Y50.2285

- Phenolic foam reference Y50.2320
- Domestic central heating and hot water systems, mineral wool reference Y50.2330 •
- Chilled water services
- Mineral wool reference Y50.2390
- Phenolic foam reference Y50.2400
- Nitrile rubber reference Y50.2410
- Protection against freezing
 - Mineral wool reference Y50.2420
 - Phenolic foam reference Y50.2430
 - Nitrile rubber reference Y50.2440
- Environmental thickness on warm air ductwork reference Y50.2450
- Condensation control on chilled air ductwork
- Mineral wool reference Y50.2460
- Phenolic foam reference Y50.2470
- Thickness of insulation

250.090 WORKMANSHIP PIPEWORK INSULATION:

- General reference Y50.3010
- Installation of foil faced mineral wool insulation reference Y50.3020
- Installation of foil faced phenolic foam insulation reference Y50.3030
- Installation of insulation with canvas finish reference Y50.3040 ٠
- Installation of closed cell nitrile rubber insulation reference Y50.3050 •
- Installation of protection
 - Polyisobutylene (PIB) reference Y50.3120 ٠
 - Sheet metal finish
 - Reference Y50.3130A
 - Canvas reference Y50.3150 ٠
 - Roofing felt - reference Y50.3160
 - Aluminium sheeting reference Y50.3170 •
 - Aluminium-zinc coated steel reference Y50.3180 ٠
 - Rigid PVC reference Y50.3190
- Laminated foil/film reference Y50.3195
- Flanges and valves reference Y50.3210
- Liners reference Y50.3220 ٠
- Installation where insulation is carried through pipeline support
- Reference Y50.3230A
- Closed cell insulation reference Y50.3230B
- Installation where insulation is not carried through pipeline support reference Y50.3240 •
- Liquid vapour barriers reference Y50.3260
- Integrity of vapour barriers reference Y50.3270

250.100 WORKMANSHIP DUCTWORK INSULATION:

- General reference Y50.3010 •
- Installation of foil faced semi-rigid slab insulation reference Y50.3060
- Installation of foil faced flexible insulation reference Y50.3070
- Installation of foil faced lamella insulation reference Y50.3080 ٠
- Installation of protection •
 - Polyisobutylene (PIB) reference Y50.3120
 - Sheet metal finish ٠
 - Reference Y50.3140A
 - Reference Y50.3140#
 - Canvas reference Y50.3150
 - Roofing felt reference Y50.3160 •
 - Aluminium sheeting reference Y50.3170
 - Aluminium-zinc coated steel reference Y50.3180 ٠
 - Rigid PVC reference Y50.3190
 - Laminated foil/film reference Y50.3195

T71

- C0605LMB Revised Stage E Mechanical Specification Including Agreed VE COLD ROOMS
- Installation of ductwork fire protection insulation reference Y50.3200 •
- Installation where insulation is not carried through ductline support - reference Y50.3240
- Installation where insulation is carried through ductwork support reference Y50.3250
- Liquid vapour barriers reference Y50.3260
- Integrity of vapour barriers reference Y50.3270

250.110 WORKMANSHIP EQUIPMENT INSULATION:

- General reference Y50.3010
- Installation of insulation on tanks reference Y50.3090 •
- Installation of mineral wool insulation on vessels reference Y50.3100
- Installation of phenolic foam insulation on vessels reference Y50.3110
- Installation of protection •
 - Polyisobutylene (PIB) reference Y50.3120
 - Sheet metal finish
 - Reference Y50.3140A
 - Reference Y50.3140#
 - Canvas reference Y50.3150
 - Roofing felt reference Y50.3160
 - Aluminium sheeting reference Y50.3170
 - Aluminium-zinc coated steel reference Y50.3180
 - Rigid PVC reference Y50.3190 •
- Laminated foil/film reference Y50.3195
- Liquid vapour barriers reference Y50.3260
- Integrity of vapour barriers reference Y50.3270
- Water tanks reference Y50.3280

251,000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below.

Carry out testing and commissioning as specified in section

251.020 SPECIALIST:

- Use one of the following specialist commissioning engineers
- Or approved equivalent

251.040 COMMISSIONING:

- Type
- Application •
- Cleaning ductwork systems reference Y51.3010
- Commissioning codes reference Y51.3020
- Commissioning
 - Water distribution Including BSRIA pre-commissioning check list Reference Y51.3030A
 - Air distribution

Instruments and gauges

Commissioning records

• Distribution

KJ TAIT ENGINEERS

Reference Y51.3090A

- Including BSRIA pre-commissioning check list Reference Y51.3040A

Refrigerating systems - reference Y51.3060

Boiler plant - reference Y51.3050

Plant items - reference Y51.3080

VAV systems including BSRIA pre-commissioning checklist - reference Y51.3040B

Gas plant and systems - reference Y51.3055

Automatic control systems - reference Y51.3070

T71

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE COLD ROOMS

Reference Y54.2020

- 254.040 PLANT AND EQUIPMENT IDENTIFICATION:
- Type
- Application •
- Lettering

254.045 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416:

Reference Y54.2035

254.050 VALVE AND COCK IDENTIFICATION: Reference Y54.2040

254.060 MEDICAL GAS TERMINAL UNITS:

- Type

- Cylinders to BS EN ISO 407 reference Y54.2050B

254.070 LABORATORY OUTLETS:

- Type
- Application •
- To BS 1710 reference Y54.2060A •
- To BS EN 13792 reference Y54.2060B

254.080 AIR VOLUME REGULATING AND CONTROL DAMPER IDENTIFICATION: Reference Y54.2070

254,090 INSTRUMENT IDENTIFICATION: Reference Y54.2080

254.100 DANGER AND WARNING NOTICES: Reference Y54.2090

254.110 SYSTEM IDENTIFICATION INSTALLATION CHARTS:

- Type
- Application Perspex sheet glazing with frame - reference Y54.2100A

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL:

- Comply with work section general clauses reference Y90.1000 and those detailed below.
- Carry out fixing to building fabric as specified in work section

290.020 FIXINGS:

- Type
- Application
- Standards reference Y90.2010
- Pluas reference Y90.2020
- Screws reference Y90.2030
- Cast-in fixings reference Y90.2040 •
- Shot fired fixings reference Y90.2050
- Self adhesive fixings reference Y90.2060
- Proprietary channel inserts reference Y90.2070 •
- Non-penetrative support systems reference Y90.2080
- Manufacturer and reference

- For air systems To BSRIA Application Guide 3/89.3 - reference Y51.3100A • For water systems
- To BSRIA Application Guide 2/89.3 reference Y51.3100B
- BMS commissioning
- Control system specification details required for commissioning reference Y51.3110
- Pre-commissioning reference Y51.3120
- Plant ready for control system commissioning •
- Reference Y51.3130A
- Control system requirements for plant commissioning reference Y51.3140
- Commissioning reference Y51.3150

251.050 PERFORMANCE TESTING:

Type •

•

- Application
- System performance testing reference Y51.4010
- Testing of residential ventilation systems reference Y51.4015
- Environmental tests
 - Artificial loads reference Y51.4020A •
 - Ambient Air Quality reference Y51.4020B
 - Reference Y51.4020#
- Recorders reference Y51.4030
- Seven day space temperature recorders
 - Number
 - For (weeks)
- Relative humidity recorders
 - Number
 - For (weeks)
- Testing to specified conditions
- Rainwater Systems reference Y51.4040A
- Sanitary Systems reference Y51.4040B ٠
- Cold Water Systems reference Y51.4040C
- Fire Fighting Systems reference Y51.4040D •
- Hydraulic Systems reference Y51.4040E ٠ Requirements
- Medical Gas and Air Systems reference Y51.4040F ٠
- Laboratory and Industrial Systems Reference Y51.4040G Requirements
- Gas Systems reference Y51.4040H
- Silencers and Acoustic Treatment Reference Y51.4040I Noise criteria
- Acoustic Enclosures reference Y51.4040J ٠
- Reference Y51.4040#
- Performance test records reference Y51.4050
 - Distribution

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL:

Comply with work section general clauses reference Y54.1000 and those detailed below.

Provide identification - mechanical as specified in work section

254.020 PIPEWORK IDENTIFICATION: Reference Y54.2010

254.030 DUCTWORK IDENTIFICATION:

- Application
- To HTM 2022 reference Y54.2050A

Laminated plates, multi-coloured with outer layer removed for lettering - reference Y54.2030B

• Or approved equivalent

290.030 WORKMANSHIP:

- Type
- Application
- Drilling reference Y90.3010
- Proprietary fixings reference Y90.3020
- Fixing to reinforced concrete reference Y90.3030
- Fixing to brickwork reference Y90.3040 •
- Fixing to timber rails reference Y90.3050 •
- Fixing to hollow stud/tile/block wall
- Reference Y90.3060A
- Fixing to concrete, brickwork or blockwork
- Reference Y90.3070A
- Fixing to metalwork
- Reference Y90.3080A
- Fixing to structural steelwork and concrete structures
- Reference Y90.3090A
- Non-penetrative support systems for roof mounted equipment reference Y90.3100#

291.000 OFF-SITE PAINTING AND ANTI-CORROSION TREATMENT

291.010 GENERAL

Comply with work section general clauses reference Y91.1000 and those detailed below.

Carry-out off-site painting and anti-corrosion treatment as work section

291.020 PAINT MATERIALS:

- Type
- Application •
- Paint materials
- Reference Y91.2010A
- Paint quality reference Y91.2020
- Heat resistant paint reference Y91.2030

291.030 WORKMANSHIP

- General reference Y91.3010 •
- Weather and other conditions reference Y91.3020
- Cleaning and preparing for painting •
 - Steel surfaces reference Y91.3030A
 - Surfaces reference Y91.3030B
- Application off-site reference Y91.3040
- Application reference Y91.3050
- Cold galvanizing reference Y91.3060
- Protection of bright machine parts reference Y91.3070
- Special protective finishes

PART 3 SPECIFICATION CLAUSES SPECIFIC TO T71

300.000 GENERAL

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE COLD ROOMS

300.010 SPECIALIST:

Use a specialist to supply, install and commission cold rooms.

300.015 REFRIGERANTS:

- CFC and HCFC refrigerants are prohibited and must not be used.
- Leak detection system
 - · Provide an electronic gas detection system on the refrigerant circuit.

310.000 PRODUCTS/MATERIALS

310.010 PACKAGED COLD ROOMS:

- Type
- Application
- Manufacturer and reference •
- Or approved equivalent
- Duty •
- Size •
- Details •

310.020 PACKAGED WALK-IN FREEZERS:

- Type
- Application •
- Manufacturer and reference Or approved equivalent
- Duty •

•

- Size •
- Details •

310.030 PANELS/LININGS:

- Type
- Application
- Manufacturer and reference
- Or approved equivalent •
- Duty
- Ceiling panels
 - Size
 - Material
- Wall panels
 - Size
 - Material •

310.040 FLOORING SYSTEMS:

- Type
- Application
- Manufacturer and reference Or approved equivalent •
- Duty •
- Size
- Material
- Location
- External
- Internal ٠

310.050 DOORS AND DOOR MECHANISMS:

- Type
- Application •
- Manufacturer and reference •

• Provide a fluorescent dye leak detection system on the refrigerant circuit.

- Or approved equivalent
- Details

310.060 JOINTING MATERIALS:

- Type
- Application
- Manufacturer and reference
- Or approved equivalent
- Details

310.070 THERMAL CLADDING:

- Type
- Application •
- Manufacturer and reference
- Or approved equivalent
- Details

310.080 REFRIGERATION PLANT AND EQUIPMENT:

- Type
- Application
- Manufacturer and reference
- Or approved equivalent
- Duty •
- Details

310.090 EVAPORATORS:

- Type
- Application
- Manufacturer and reference
 - Or approved equivalent •
- Duty
- Details

310.100 LIGHTING:

- Type •
- Application
- Manufacturer and reference
- Or approved equivalent ٠
- Details

310.110 GENERAL LOW VOLTAGE POWER:

- Type
- Application •
- Manufacturer and reference
- Or approved equivalent
- Details

320.000 WORKMANSHIP

320.010 INSTALLATION: Install cold room equipment in accordance with manufacturer's recommendations.

320.020 ELECTRICAL INSTALLATION:

Install electrical equipment and materials in accordance with BS 7671 (IEE regulations) and manufacturer's recommendations.

BS APPENDIX

KJ TAIT ENGINEERS

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE COLD ROOMS

BS 1010-2:1973 Specification for draw-off taps and stopvalves for water services (screw-down pattern). Part 2 Draw-off

taps and above-ground stopvalves. Current, obsolescent BS 1710:1984

Specification for identification of pipelines and services

BS 21:1985 Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions). Partially superseded by BS EN 10226-1:2004

BS 476-7:1997 Fire tests on building materials and structures. Part 7 Method of test to determine the classification of the surface spread of flame of products

BS 5154:1991 Specification for copper alloy globe, globe stop and check, check and gate valves. Partially replaced by BS EN 12288:2003

BS 5158:1989 Specification for cast iron plug valves

BS 5163-1:2004 Valves for waterworks purposes. Part 1 Predominantly key-operated cast iron gate valves. Code of practice

BS 7671:2001 Requirements for electrical installations. IEE Wiring Regulations. Sixteenth edition

BS EN 10226-1:2004 Pipe threads where pressure tight joints are made on the threads. Part 1 Taper external threads and parallel internal threads. Dimensions, tolerances and designation

BS EN 1092-1:2002 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Part 1 Steel flanges

BS EN 1092-2:1997 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Part 2 Cast iron flanges

BS EN 1092-3:2003 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Part 3 Copper alloy flanges

BS EN 1171:2002 Industrial valves. Cast iron gate valves

BS EN 1213:2000 Building valves. Copper alloy stopvalves for potable water supply in buildings. Tests and requirements

BS EN 1254-1:1998 Copper and copper alloys. Plumbing fittings. Part 1 Fittings with ends for capillary soldering or capillary brazing to copper tubes. Replaces BS 864-2:1983 which remains current.

BS EN 1254-2:1998 Copper and copper alloys. Plumbing fittings. Part 2 Fittings with compression ends for use with copper tubes

KJ TAIT ENGINEERS

T71

U10 GENERAL VENTILATION

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES See System descriptions

100.020 DESIGN PARAMETERS

Ductwork materials, construction and installation shall comply with the relevant parts of the following publications.

HVCA DW/144	Specification for sheet metal ductwork - low, medium and
	high pressure/velocity systems.
HVCA DW/143	A practical guide to ductwork leakage testing.
HVCA DW/154	Specification for plastics ductwork.
HVCA DW/172	Guide to good practice for Kitchen ventilation systems.
HVCA DW/191	Guide to good practice for glass fibre ductwork.
HVCA TR/17	Guide to good practice, cleanliness of ventilation
	systems.
HVCA DW/TM2	Internal cleanliness of new ductwork installations.
BS8313	Accommodation of building services in ducts.

Fire rated ductwork to be Flamebar BW11 manufactured by Fire Protection Limited to comply with BS476 Part 24 (1987) and ISO 6944 (1985) for 4 2 hours stability, 4 2 hours integrity and 3 1 hours insulation. Ductwork to be rectangular construction, complying with Building Regulations Class "O" requirements. The duct to be a composite fire duct manufactured to Method 3 of BS5588 Part 9 factory produced or to an approved certified method to be agreed by the design team...

100.030 SYSTEM DESCRIPTION

Fume Extract Ductwork- Construction, Installation and testing of ductwork shall be fully in accordance with the Heating and Ventilating Contractors Association Guides DW144, DW143, DW154 DW191 and and British Standards BS7258, as appropriate.

Ductwork Construction – Negative Pressure

The fume extract ductwork within the interstitial floors shall be manufactured from a minimum standard of stainless steel grade 316S31. All ductwork and fittings shall be made to DW144 class C B. All riser and plant room ductwork can be manufactured from either stainless steel as per the interstitial floors or UPVC manufactured to DW 154.

Ductwork Construction - Positive Pressure:-

The fume extract ductwork from the fan discharges shall be manufactured from stainless steel grade 316S31 or UPVC- All ductwork and fittings shall be fully welded and made to either DW144 or DW 154 class C. All visible external ductwork from the top of the silencer shall be fully welded stainless steel.

All ductwork will be pressure tested in accordance with DW143 to Class C + 1/2 one and a half times the system working pressure and permissible leakage levels recorded on test reports. The Contractor is to ensure that leakage is minimised to the lowest levels that are achievable.

Please note that rooms CL2 & CL3 are required to be tested to the MRC standards provided under separate cover. meet the Canadian Room Integrity Guidelines. These guidelines require two consecutive tests with a minimum of 250 Pa loss of pressure from an initial 500Pa over a 20minute period. It is assumed that it will be carried out as a positive air pressure test, and all ductwork connected to these rooms shall meet this standard.

BS EN 1254-3:1998 Copper and copper alloys. Plumbing fittings. Part 3 Fittings with compression ends for use with plastics pipes

BS EN 13789:2002 Industrial valves. Cast iron globe valves

BS EN 13828:2003 Building valves. Manually operated copper alloy and stainless steel ball valves for potable water supply in buildings. Tests and requirements

BS EN 1984:2000 Industrial valves. Steel gate valves

BS EN 593:2004 Industrial valves. Metallic butterfly valves

BS ISO 9000-2:1997 Quality management and quality assurance standards. Generic guidelines for the application of ISO 9001, ISO 9002 and ISO 9003

U10

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE GENERAL VENTILATION

Fume Cupboard Testing/Validation - On completion of testing and commissioning of the fume extract systems the Contractor will employ the services of a specialist commissioning company Crowthorne Hi-Tech Services Limited to test and validate the correct operation of and containment of the fume cupboards. The Contractor will attend on the specialist as required Crowthorne as required.

Supply Systems - The LMB Building project will be served by central station air handling units located primarily in four external plant towers. Smaller specialty service air handling units will be located in roof plants and the interstitial ceiling voids. Air systems will be a combination of constant and variable air volume with terminal reheat batteries zoned to meet the scientific needs of the facility.

Laboratory Air Handling Systems - Laboratory supply air will be provided via three air handling units located in each plant tower, one tower for each building quadrant. These units will be stacked and arranged in banks supplying into a common vertical header duct. Each unit will supply approximate 18,500 litres per second of fully conditioned and filtered air at approximately 11°C with the coils sized to lower the temperature to 10°C.

Each unit will contain frost coil, preheat coils, total energy heat wheel, cooling coils, duct mounted clean steam humidifier, outdoor air dampers, pre filter to class G4 and after filters to class F9-MERV 16, supply fan with variable frequency controller and sound attenuators.

An upper level extract section will accommodate extract airflow through the heat wheel.

Outdoor air dampers, pre and after filters and supply fan sizing will be increased to handle approximately 10% more airflow to accommodate the heat wheel purge volume. Preheat coils, cooling coils and clean steam humidifiers will be sized to handle 18,500 litres per second of fully conditioned air with the heat wheel off line for service.

Lecture Hall Air Handling System - The Lecture Theatre air handling unit will be located in a dedicated plant room directly adjacent to the Lecture Theatre. The Lecture Theatre system will be constant volume displacement with a variable temperature supply to match the required heating and cooling load. The unit will supply approximately 1,995 litres per second of fully conditioned and filtered air at approximately 11°C 10°C.

A matching 1,995 litres per second extract fan will be packaged in the air handling unit. The system will employ a humidity control function to allow the supply temperature to increase as latent loads are reduced therefore achieving improved energy efficiency.

System reheat coils will be utilized to prevent space sub-cooling when high humidity conditions exist and system is in the dehumidification mode. The system will employ a modular total energy heat wheel unit to achieve optimal energy conservation while supplying the required ventilation air.

Outdoor air dampers, pre and after filters and supply fan sizing will be sized to handle 1,995 litres per second of fully conditioned air with.increased to handle approximately 10% more airflow to accommodate the heat wheel purge volume.

Preheat coils, and cooling coils and clean steam humidifiers will be sized to handle 1,995 litres per second of fully conditioned air with the heat wheel off line for service.

The unit will contain an outdoor air damper and plenum, pre filters to class G4 and after filters to class F6-MERV-9, supply fan, total energy heat wheel, chilled water cooling coil, sound attenuator and duct mounted reheat coils and clean steam humidifier.

The extract section will include a class G4 30% rough filter to MERV 6 and a variable constant speed extract fan and discharge isolation damper.

Kitchen Air Handling System - The food service air handling unit will be located in the southwest roof plant adjacent to the kitchen. The food service area design will be based on a traditional variable volume air supply with terminal reheat units.

The unit will supply approximately 8,190 litres per second of fully conditioned and filtered air at approximately 10.011.0 °C. Air will be either returned to the unit or extracted by one of three kitchen extract fans. Design return air capacity is approximately 3,230 litres per second.

Air handling unit will have an established supply air temperature of approximately 1011.0 °C which is centrally adjustable through the automation system. Individual food service and dining areas will have terminal reheat units for zone control of space temperature.

The unit will contain an outdoor air/mixing plenum with a return duct connection, pre filter to class G4 and after bag filters to class F6MERV 10, preheat coil, chilled water cooling coil, draw through variable speed supply fan and discharge sound attenuator. The unit will draw outdoor air from the roof level with a high relief discharge when the air side economizer is in operation. The specific configuration and layout of each unit is defined on the drawings.

Containment Air Handling System - A single containment unit is proposed to serve the CL2 and CL3 rooms and related support spaces. The unit will be located immediately above and adjacent to the containment suite in the enclosed northwest roof plant. The system will be constant volume / variable temperature controlled by individual terminal units.

The air handling system will be once through 100% outdoor air with an established supply air temperature of approximately 7.5 °C which is centrally adjustable through the automation system. Individual spaces will have terminal reheat units for zone control of space temperature. Supply air to each space will occur through ceiling mounted room side replaceable HEPA filter diffusers. The unit supply fan will be provided with a variable speed drive to vary fan pressure to accommodate constant volume under the variable filter loading / pressure drop states.

The unit will contain an outdoor air damper and plenum, pre filter to class G4 and after bag filters to class F9 MERV 16, preheat coil with coil circulating pump, clean steam humidifier, chilled water cooling coil, draw through variable speed supply fan and discharge sound attenuator. The unit will be served by essential power supply. Design airflow and balance will be set to achieve a negative pressure regime that cascades to the highest value for the most critical containment zone. Pressure monitoring and alarm will occur continuously through the building automation system and locally using gauges and audible alarm.CL2 room on level 1 will be served by the laboratory air system and isolated by bubble tight isolation dampers. This room will have a dedicated extract system as defined hereinafter.

Electron Microscope Air Handling System - Electron microscope rooms 3, 4 and 5 will be served by two (2) dedicated desiccant de-humidification air handling units. The units will be arranged for main and stand-by operation and be located above the EM Suite in the interstitial ceiling void. The system will be constant volume/variable temperature controlled by individual terminal units.

Ventilation air will be supplied to the units from the laboratory air system. Ventilation air is sized to off set offset desired extract air requirements and accommodate occupant ventilation load. Two (2) units are proposed to achieve N+1 redundancy. The air handling system will continuously circulate the EM Suite air to maintain the close temperature and humidity control tolerance.

Air will be supplied to spaces at approximately 10.3 °C DB/3.8 °C WB which is locally controlled through the automation system. The noted supply temperature allows nominal duct heat gain and a minimum room sensible heat ratio of 0.90 to achieve the peak design space condition of 20% relative humidity at the nominal 20 °C space temperature.

Individual spaces will have terminal reheat units for zone control of space temperature. Supply air to each space will occur through ceiling mounted room side replacement HEPA filter diffusers. The unit supply fan will be provided with a variable speed drive to vary fan pressure to accommodate constant volume under the variable filter loading/pressure drop states.

The units will contain a return air section, roughing filters, ceramic desiccant wheel, supply fan, reactivation heating coil and fan and secondary cooling coil. The units will be served by essential power supply. Airflow sound attenuation will be provided with the terminal units serving each room. The

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **GENERAL VENTILATION**

U10

units will draw re-activation air from the interstitial ceiling void and discharge heated air to the general extract system. The specific configuration and layout of the unit is defined on the drawings.

Design airflow and balancing for the EM room is neutral to support environmental control objectives. Adjacent support spaces will be negative with respect to adjacent access corridor. Pressure monitoring and alarm will occur continuously through the building automation system and locally using gauges and audible alarms.

Electron microscope rooms 1 and 2 and all other EM Suite support spaces will be served from the laboratory air system

NMR Air Handling System --

The NMR system has been shelved under VE M031

NMR and PC room will be served by a dedicated air handling unit located above the space in the interstitial ceiling void. The system will be constant volume/variable temperature controlled by individual terminal reheat units. Ventilation air will be supplied to the unit from the laboratory air system. Ventilation air is sized to off set desired extract air requirements and accommodate occu ventilation load.

The air handling system will continuously circulate the NMR Suite air to maintain the close temperature and humidity control tolerances. Air will be supplied to spaces at approximately 8.6°C which is locally controlled through the automation system. The noted supply temperature allows nominal duct heat gain and a minimum room sensible heat ratio of 0.95 to achieve the peak design space condition of 54% relative humidity at the nominal 17 °C space temperature. Individual spaces will have terminal reheat units for zone control of space temperature. Supply will occur through traditional ceiling diffusers.

The unit will contain a return air section, roughing filters, secondary cooling coil and draw through supply fan. The unit will be served by essential power supply. South attenuation will be provided with the terminal units serving each room. The specific configuration and lavout of the unit is defined on the drawings.

The PC room will be balanced positive relative to the adjacent corridor and NMR room. The NMR room will be negative and extract the required air from both the PC and NMR rooms. Pressure monitoring and alarm will occur continuously through the balancing automation system and locally using gauges and audible alarms.

Energy Centre System - The workshop/office air handling unit will be located on the second level above the generators. The conditioned area design will be based on traditional constant volume/ variable temperature controlled by a single room or return air thermostat. Supply air is distributed through traditional ceiling diffusers. Air will be either returned to the unit or extracted via the toilet extract fan.

Air unit will have a designed supply air temperature which is adjustable through the local thermostat.

The unit will contain an outdoor air / mixing plenum with a return duct connection, pre filter to class G4 and after bag filters to class F6 MERV 10, preheat coil, chilled water cooling coil, draw through supply fan and discharge sound attenuator. The unit will draw outdoor air from the roof level with a high relief discharge when the air side economizer is in operation. The specific configuration and layout of each unit is defined on the drawings.

Terminal Units - The LMB Project will utilise a wide range of terminal units for cooling / reheat, cooling only, general extract, fume cupboard extract, BSC extract and miscellaneous spot extracts. Generally, the supply terminals shall be from the same vendor and be pressure independent manufactured of galvanized steel with a reheat coil and downstream sound attenuator.

Terminal units will be variable or constant volume as required to achieve briefed performance criteria. Extract terminals will be varied based on the required control scheme and material requirement. Galvanized steel and stainless steel extract terminals will be used on the project.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE GENERAL VENTILATION

At a minimum stainless steel extract terminals will be provided for all containment areas, aquatics, fume cupboards, protein expression, radioactive labs and glasswash/autoclave units.

Local extract sound attenuators of the packless design with material matching terminal units will be required for most extract terminals.

All terminal units will be located in the interstitial ceiling void for ease of maintenance. Each enclosed laboratory and lab equipment room or single bay open laboratory zone will be provided with a supply and general extract terminal unit. Any fume cupboard, BSC or spot extract connection will have a separate extract terminal. Some spaces may have multiple extract terminals to meet the fundamental control criteria and balance requirements.

The acoustic performance of terminal units and the specific selection of local sound attenuators will be reviewed and challenged during the Stage E design phase. However, experience has shown that local attenuators are required when stringent acoustical criteria exist.

Specialist spaces with local supply HEPA filters will be provided with a booster fan sized to match the terminal unit peak capacity. The booster fans will be installed upstream of the terminal units and be provided with a variable frequency controller. Booster fans are currently planned for the following areas:-

•CL2 Live imaging rooms •CL2 Prokaryotic room •CL2 Prep rooms •CL2 Procedure rooms •Tissue culture prep area •Fly food store and prep area •Plate pouring room •Media prep area

Fly rooms in addition to supply terminal reheat units will have duct mounted clean steam humidifiers. All ductwork downstream of humidifiers to room outlets will be fully welded stainless steel with drain and access provisions.

Cold rooms will be provided with constant volume supply and extract terminal units to maintain required ventilation air quantity. Cold room refrigeration systems will be sized to handle the additional cooling load resulting from the ventilation air supplied at $\frac{10}{11.0}$ °C..

PROCESS SYSTEMS

General Laboratory Extract - General laboratory extract will range from 80 to 85% of the total supply air volume serving the building. General extract is typically clean without noticeable contaminates and does not include fume cupboard, MSC or other containment devices or high hazard extract volumes. General laboratory extract plant will be located within roof plant above the plant towers and zoned by building quadrant. The extract fans will be arranged in banks of three running from a common header duct to individual exhaust stacks. Each extract fan will discharge approximately 17,575 litres per second with 15.5 metres per second maximum stack velocity. The extract fans will have two (2) stage packless sound attenuators, variable frequency controller and inlet air provisions to maintain minimum discharge stack velocity.

General extract from each laboratory zone will be ducted to the heat recovery component in the plant towers. Panel filters to class G4 30% roughing filters to MERV 6 provide nominal protection for the heat recovery element. Extract from individual laboratory, lab equipment and specialists areas will be via VAV terminal units serving individual rooms, or in open plan areas one (1) modules in width (3.3 m). VAV terminal units and packless sound attenuators will be located in the interstitial ceiling void directly above the areas served. CAV units will be provided as required by programme function. Air will be exhausted from the rooms by means of ceiling mounted registers. General extract terminal units airflow will track supply terminal units with a fixed off set as designed and confirmed through commissioning. Local pressurization indication will not be provided for typical lab applications. Critical environments will have local indication of operating pressurization.

Containment Extract - CL2 areas will be ventilated and serviced in a similar fashion to the general laboratory areas, but connected to the containment supply and extract systems. CL2 space located on level 1 will be supplied from the lab system, but will have a dedicated extract system. They will however be set up to maintain negative pressure within the laboratories at all times when the plant is in operation. In addition motor operated bubble tight isolation dampers will be fitted in the supply and extract ductwork to each room, so as to allow positive shut off of the ventilation when individual room fumigation is required. Isolation dampers can be automatically opened when purging of the fumigant is required. It is assumed that all necessary sealing of the individual room envelope and penetrations will be carried out as necessary and verified through commissioning. A remotely operated switch will be provided for remote fumigant release and initiation of the fumigation cycle. A local fumigant circulation fan will also be provided to ensure fumigant penetration in all areas of the room. All CL2 rooms will be provided with pressure indication relative to adjoining areas by means of magnehelic gauges and digital indication through the BMS. Supply and extract airflows will be continuously controlled in response to pressurization controls and confirmed through commissioning.

Extract plant for CL2 room on level 1 will be provided with main and stand-by fans for N+1 capacity. Each containment extract fan is sized for 560 litres per second and will have packless sound attenuators, variable frequency controller and inlet air provisions to maintain minimum discharge stack velocity. The CL3 Suite which includes related CL2 spaces will be served by its own dedicated plant for security of operation. It will be designed so as to allow operation and fumigation of individual rooms on a regular and routine basis. The primary mechanical systems for this area will include dedicated supply and extract plant for the Containment Suite. The supply and extract plant will be located in the northwest roof plant with duct mains extending down to the interstitial ceiling void. The CL3 extract plant will be located in the northeast roof plant. Other mechanical systems (process chilled water, heating water, etc) will be derived from the main building distribution. All plant components serving the containment areas will be supplied with essential power. The general approach to the design of the ventilation system will be to supply to the support spaces with traditional ceiling diffusers and the CL2, CL3, and CL3 Lobby with HEPA filter supply diffuser. Extract from the CL2 and CL3 rooms will occur through the MSC's and ceiling mounted extract registers. Ceiling extracts from the CL2 and CL3 room will be room side replaceable HEPA filter devices. In addition there will be a local extract directly adjacent to the autoclave in the CL3 room to remove excess heat at source. Autoclave controls will be accessed and maintained from outside the suite.

Extract for the primary autoclave in the service support area will be ventilated through a canopy hood. Low level extracts will be provided in the service support area and CL3 lobby for LN₂ gas removal. To maintain containment, air will be transferred from the service support area into the CL3 laboratory via a secure lobby, and extracted through safety cabinets operating with a by-pass arrangement. Transfer air for CL2 rooms will come directly from the service support area. Extract plants for the containment suite will be provided with main and stand-by fans for N+1 capacity. The CL2 containment extract fans are sized for 3,700 litres per second while the CL3 extract fans are sized for 830 litres per second, both will have packless sound attenuators, variable frequency controller and inlet air provision to maintain minimum discharge stack velocity.

The containment extract systems will be constructed of stainless steel grade 316S31 within the interstitial service floors. All riser and plant room ductwork can be manufactured from either stainless steel as per the interstitial floors or UPVC manufactured to DW 154., The extract system and shall operate at a constant volume as MSC's are energized by local controllers. Extracts from MSC's will have terminal units and packless sound attenuators located in the interstitial ceiling void and a clear visible floor indication damper below the ceiling directly above the MSC. When required for fumigation, motor operated bubble tight isolation dampers will be provided at the room ceiling penetration point

Where there is a requirement for safe change HEPA filter housings these will be located within the laboratory for ease of access and room side replacement of elements. HEPA filter housings or the duct system will have bubble tight isolation dampers to allow fumigation of filter elements before they are removed.

External switching will be provided to allow remote automatic isolation of the individual laboratories for

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE GENERAL VENTILATION

fumigation by the closure of automatic bubble tight isolation dampers in supply systems, immediately after safe-change HEPA filter extract housings and immediately downstream of MSC's. Isolation dampers can be automatically opened when purging of the fumigant is required. A local fumigant circulation fan will also be provided in each room to ensure fumigant penetration in all areas of the room. All penetrations through the containment envelope will be specially detailed in order to ensure that the suite remains sealed during fumigation. Room containment pressure will be confirmed through commissioning. In particular this will require special detailing for all electrical fittings and penetrations.

All rooms within the containment area will have differential pressures monitored and alarmed from local control panels via the BMS with local indication by magnehelic gauges and digital readouts.

The entire suite will operate on a secure access arrangement, with door interlocks to prevent a direct route being open from laboratory to outside.

Glasswash/Autoclave Extract - Glasswash and autoclave extract air will be connected to the general extract system via canopy hoods above the units. Canopy hoods will surround the equipment being vented and be designed to capture steam as well as remove heat from the room. Glasswash/autoclave extracts are sized to handle 15 air changes per hour.

Ductwork serving these areas will be constructed of stainless steel grade to meet AISI 304 standards and must be pitched to drain towards the hood or canopy exhausting the specific equipment. Extracts from canopy hoods will have terminal units in the interstitial ceiling void. The rooms will have set-back provisions when the equipment is de-energized, but will not shut-off to zero to ensure continuous removal of latent heat and moisture.

Protein Expression Extract - Protein expression (fermentation) extract will be handled by a dedicated floor duct and riser running up through internal risers to the roof plant. PE riser is currently sized at 500 mm which can handle the normal running load and the 40 air changes purge volume. The protein expression room will have a local switch to initiate the purge cycle when required by users. Each PE extract fan is sized for 1,720 litres per second and provided with a matching stand-by fan for N+1 capacity. The extract fans will have packless sound attenuators, variable frequency controller and inlet air provisions to maintain minimum discharge stack velocity.

The PE extract systems will be constructed of corrosion resistant materials and operate at a constant volume as local equipment is energized by local controllers. Extracts from spaces and equipment will have terminal units and packless sound attenuators located in the interstitial ceiling void. When required for fumigation, motor operated bubble tight isolation dampers will be provided at the room ceiling penetration point or in the ductwork as indicated. Radioactive Extract - RE will be handled by a dedicated floor duct and riser running up through internal risers to the roof plant. RE riser is currently sized at 300 mm which can handle the current load at constant volume. Each RE extract fan is sized for 622 litres per second and provided with a matching stand-by fan for N+1 capacity. The extract fans will have packless sound attenuators, variable frequency controller and inlet air provisions to maintain minimum discharge stack velocity.

The RE extract systems will be constructed of corrosion resistant materials and operate at a constant volume as local equipment is energized by local controllers. Extracts from spaces and equipment will have terminal units and packless sound attenuators located in the interstitial ceiling void and a clear visible floor indication damper below the ceiling directly above fume cupboards. When required for fumigation, motor operated bubble tight isolation dampers will be provided at the room ceiling penetration point or in the ductwork as indicated.

Factory witness testing and certification of the Air Handling Units is required, and all costs shall be allowed by the contractor. The engineer shall witness the first plant tower AHU and subject to his complete satisfaction shall witness two others at his discretion. However if the first unit is unsatisfactory at the witness testing he shall reserve the right to witness as many units as deemed necessary.

Installation of the Air Handling Units in their final position shall be undertaken in conjunction with the manufacturer, with all units pressure tested on completion.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE GENERAL VENTILATION

- Material
 - Zinc-coated steel reference Y30.2040A ٠
- Mild steel reference Y30.2040B •
 - Stainless steel reference Y30.2040C
- Protective finishes
 - Galvanising reference Y30.2050A
- Construction
 - Rectangular reference Y30.2060A •
 - Circular reference Y30.2060B
 - Flat oval reference Y30.2060C

230.080 INSULATED DUCTWORK:

- Type Kingspan Industrial Insulation Ltd, Kool Duct System Application This may be used in risers at the contractors discression. Kool duct shall not be used below floors.
- Pre-insulated external thermal/acoustic ductwork Reference Y30.2130A
- Aluminium reference Y30.2130B

230.090 SUPPORTS:

- Hangers and supports
- Reference Y30.2140A
- Support of air terminal units
 - Reference Y30.2150A

230.100 ACCESSORIES:

- Construction and finishes reference Y30.3010
- Inspection/servicing access openings
- Metal ductwork reference Y30.3020A
- HVCA TR/17 reference Y30.3020D
- Test holes
- Metal ductwork reference Y30.3030A Holes for controls/instruments - metal ductwork Reference Y30.3040
- Installation of instruments and controls reference Y30.3042
- Cleaning access
- Level 2 reference Y30.3050A
- HVCA TR/17 reference Y30.3050C
- Flexible ducts
- PVC/Polyester laminate reference Y30.3100C
- Flexible joint connections
 - Reference Y30.3110A

230.110 REGULATING DAMPERS - METAL DUCTWORK:

- Type
- Stainless steel air balancing damper with adjacent, removable, hinged access door.
- Manufacturer and reference Actionair: Air/Shield; Access/Shield.
- Or approved equivalent

 - Steel multi-blade dampers reference Y30.3060B

- Type
- Stainless steel fire damper with adjacent, removable, hinged access door.

All services within the plant tower and energy centre shall be on spring vibration hangers to avoid structural borne vibration.

Contractors shall take due cognisance of the specification clause 520.030 Design Responsibilities.

Under the above clause the pipework and ductwork support system is a contractor's design responsibility, therefore the 2053-Z-(59)-500 series drawings shall be used as generic design intent drawings. VE M 006.

Contractors shall note that under VE M 018 aluminium protection within plant room areas is limited to 2.2 metres above finished floor level.

Please refer to Appendix A for the Preferred Manufacturers List and Appendix B for the Pipework Specification.

Please refer to the following clauses for the ductwork cleaning specification.

Y30.4090C INTERNAL CLEANLINESS -- INTERMEDIATE ADVANCED: Provide the intermediate advanced level of cleanliness and protection as defined in HVCA TM2.

Y30.4090D DRY METHOD OF CLEANING: (All Other Areas) Method of cleaning in accordance with HVCA TR/19, Table 6.

Y30.4090E WET METHOD OF CLEANING: (Laboratories) Method of cleaning in accordance with HVCA TR/19, Table 7.

100.040 CONTROL REQUIREMENTS

See System descriptions

100.050 SYSTEM SCHEMATICS

Please refer to RMF - KJ Tait Engineers drawings 2053-Z-(59)-440 441, 442, 443, 443A, 444, 444A, 445, 446, 450, 450A, 451, 453, 450, 451, 451A, 452, 452A, 453, 453A, 455, 456, 456A, 456B, 457, 457A, 458, 458A, 459, 460, 461, 462, 463, 464, 465, 501, 502, 504, & 505

100.060 SYSTEM DRAWINGS Please refer to RMF - KJ Tait Engineers Drawing Series 2053-Z-(57)

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

230.000 AIR DUCTLINES AND ANCILLARIES

230.010 GENERAL: Comply with Work Section general clauses reference Y30.1000 and those detailed below.

230.020 INSTALLER SELECTION:

Use a member of the HVCA specialising in the manufacturing and installing ductwork.

230.030 DUCTWORK AND FITTINGS:

- Electrical bonding terminal reference Y30.1030
- Design Information
- Class A, positive reference Y30.2010A
- Class A, negative reference Y30.2010B
- Ductwork strength and air leakage testing, circular sheet metal ductwork reference Y30.2035

230.040 SHEET METAL DUCTWORK:

•

- Balancing dampers

230.130 FIRE DAMPERS:

U10

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE GENERAL VENTILATION

- Manufacturer and reference Actionair: Fire/Shield; Access/Shield. •

Or approved equivalent

- Thermal actuating device setting (°C) 72 •
 - Folding curtain
 - Stainless steel
 - Out of air stream reference Y30.3070D
 - Fire damper accessories reference Y30.3070J
 - No. of spare fusible links 2

230.150 COMBINATION SMOKE AND FIRE DAMPERS:

Type •

- Stainless steel fire/smoke damper with adjacent, removable, hinged access door.
- Manufacturer and reference Actionair: Smoke/Shield; Access/Shield.

Or approved equivalent

Steel multi-blade - reference Y30.3090B

230.160 GUARDS:

- Application On all louvres
- Bird wire guards •
 - Finish ٠
 - Plastic coated wire reference Y30.3120A

230.170 PRESSURE CONTROL AND RELIEF DAMPERS:

- Type Pressure Stabilisers
- Application Operating Theatre Air Volume Control •
- Manufacturer and reference R&D Ventilation Systems Ltd
- Or approved equivalent
- Pressure control flaps
 - Stainless steel reference Y30.3140A •
 - Balance weight assembly control pressure Refer To Drawings
- Reference Y30.3140Z
- Pressure relief dampers
 - Wall mounted reference Y30.3150A
 - Reference Y30.3150#
- Shut off dampers
- Reference Y30.3160Z
- Non return damper reference Y30.3170

230.180 AIR DUCTLINES & ANCILLARIES WORKMANSHIP:

- General reference Y30.4010
- Ductwork supports reference Y30.4020
- Component support on pre-insulated aluminium ductwork • Reference Y30.4025
- Duct support for vapour seal continuity
- Reference Y30.4030A
- Drainage of ductwork reference Y30.4060
- Connections to builders work
- Metal ductwork reference Y30.4070A
- Internal cleanliness
 - Intermediate reference Y30.4090B
 - Method of cleaning
 - Dry method reference Y30.4090D
 - Wet method reference Y30.4090E

- Ductwork sleeves •
 - Plain reference Y30.4110A
- Flanged reference Y30.4110B
- Installation of control equipment • Reference Y30.4130
- Instrument connections reference Y30.4140
- Positions Fire precautions - reference Y30.4150
- Damper access reference Y30.4160 •
- Positioning reference Y30.4170

230.045 EXTERNAL KITCHEN SUPPLY DUCTWORK The external ductwork shall be Selkirk Europa code 174. stainless steel inner and outer with mineral wool insulation. Inspection lengths shall be installed at the top and bottom of the riser and duct drain at the bottom of the riser.

240.000 AIR HANDLING UNITS

240.010 GENERAL:

Comply with work section general clauses reference Y40.1000 and those detailed below. • Supply air handling units as schedule reference Please refer to RMF - KJ Tait Engineers Drawings

2053-Z-(59)-501, 502 & 704

240.020 AIR HANDLING UNITS DUTY AND CONSTRUCTION:

- Manufacturer and reference Refer to prefered manufacturers list

Or approved equivalent

240.130 ACCESSORIES:

- Drainage from air handling unit components
- Glass drainage reference Y40.3050A
- Control dampers
 - Reference Y40.3060A

240.140 WORKMANSHIP:

- Component assembly
 - Reference Y40.4010A
- Access reference Y40.4020
- Humidifier installation - reference Y40.4030
- Duct connections reference Y40.4040
- Services connections reference Y40.4050
- Isolation of units reference Y40,4060
- Drainage of free water reference Y40.4070
- Supports
 - Reference Y40.4080A

241.000 FANS

241.010 GENERAL:

 Supply fans as schedule reference Please refer to RMF - KJ Tait Engineers Drawings 2053-Z-(59)-501, 502, 705 & 706

241.050 WORKMANSHIP

- Location reference Y41.4010 •
- Attitude reference Y41.4020
- Alianment reference Y41,4030
- Testing reference Y41.4040
- Drain connections reference Y41.4050

KJ TAIT ENGINEERS

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **GENERAL VENTILATION**

242.000 AIR FILTRATION

242.010 GENERAL:

Supply air filters as schedule reference Please refer to RMF - KJ Tait Engineers Drawings 2053-Z-(59)-501, 502 & 706

243.000 HEATING/COOLING COILS

243.060 THERMAL WHEELS:

- Manufacturer and reference Please refer to RMF KJ Tait Engineers Drawings 2053-Z-(59)-501, 502 & 704
 - Or approved equivalent
- Duty as schedule reference

245.000 SILENCERS/ACOUSTIC TREATMENT

245.010 GENERAL:

Supply silencers as schedule reference Please refer to RMF - KJ Tait Engineers Drawings 2053-Z-(59)-501, 502, 707 & 707A

245.090 WORKMANSHIP

- General reference Y45.3010
- Acoustic enclosures reference Y45.3020
- Access to acoustic enclosures reference Y45.3030
- Supports reference Y45.3040
- Acoustic linings reference Y45.3050
- Sound power level readings reference Y45.3060
- Measure sound insulation of building elements reference Y45.3070

246.000 GRILLES/DIFFUSERS/LOUVRES

246.010 GENERAL:

Supply grilles as schedule reference Please refer to RMF - KJ Tait Engineers Drawings 2053-Z-(59)-710

246.070 GRILLES/DIFFUSERS/LOUVRES WORKMANSHIP:

- Grille/Diffuser location reference Y46.4010
- Louvre location reference Y46.4020
- Accessories reference Y46.4030
- Connection to ductwork reference Y46.4040
- Installation in builders work
- Reference Y46.4050A
- Transfer grilles
 - Reference Y46.4060A
 - With fire damper reference Y46.4060B
- Fixing reference Y46.4070

250.000 THERMAL INSULATION

250.010 GENERAL:

Comply with work section general clauses reference Y50.1000 and those detailed below.

250.020 INSTALLER SELECTION:

- Use a contractor specialising in the supply and installation of thermal insulation.
- Use thermal insulation materials supplied by a manufacturer assessed and registered in accordance with BS ISO 9000-2.

250.070 CLOSED CELL MATERIALS THERMAL INSULATION - DUCTWORK:

- Application Sheet metal ductwork •
- Manufacturer and reference Kingspan Industrial Insulation Ltd, Kooltherm Zero ODP. Or approved equivalent
- Temperature of fluid in ducts (°C)
- European Classification for Reaction to Fire Performance Class A1 - reference Y50.1035A
- CFC's and HCFC's reference Y50.1040Z
- Spread of flame as BS 476-7 • Reference Y50.1050A
- Smoke emission characteristics
 - Reference Y50.1055A
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090 •
- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy
- For plant design life reference Y50.2015A
- Details reference Y50.2015B
- Restrictions on use of materials reference Y50.2020
- Closed cell rigid phenolic foam (PF) slab •

 - Foil faced reference Y50.2120A
- High density phenolic pipe and duct support foam Reference Y50.2130A
- Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Closed cell nitrile rubber elastomeric sheet
- Reference Y50.2140A
- Vapour barrier coatings
- Vinyl reference Y50.2180B
- Adhesives reference Y50.2190
- Protection
 - Application Plantrooms shall be finished in ribbed aluminium, and the roof area shall be FR/UBV/GRAY/1.5 installed fully in accordance with the manufactureres instructions
- Ribbed aluminium-zinc coated steel reference Y50.2200D
- Reinforcement
 - Aluminium bands
 - 300mm centres reference Y50.2210A
- Thickness table
 - Environmental thickness on warm air ductwork reference Y50.2450
 - Condensation control on chilled air ductwork phenolic foam reference Y50.2470

250.080 THERMAL INSULATION - PLANT:

- Manufacturer and reference Kingspan Industrial Insulation Ltd, Kooltherm Zero ODP Or approved equivalent
- European Classification for Reaction to Fire Performance Class A1 - reference Y50.1035A
- CFC's and HCFC's reference Y50.1040Z
- Spread of flame as BS 476-7
- Reference Y50.1050A Smoke emission characteristics
- Reference Y50.1055A
- Electrical bonding terminal reference Y50.1080
- Inspection and testing reference Y50.1090
- Thermal conductivity reference Y50.2010
- Thermal performance life expectancy
- For plant design life reference Y50.2015A
- Restrictions on use of materials reference Y50.2020

Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.

finished with Fibre reinforced Plastic, as supplied by Fibaroll or approved equivalent Type

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **GENERAL VENTILATION**

Mineral fibre duct insulation •

Rigid

- Foil faced reference Y50.2040A
- Flexible
 - Foil faced reference Y50.2050A
- Closed cell rigid phenolic foam (PF) slab
- Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Foil faced reference Y50.2120A
- High density phenolic pipe and duct support foam Reference Y50.2130A
 - Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- High density phenolic pipe and duct support foam Reference Y50.2130B
- Closed cell nitrile rubber elastomeric sheet
- Reference Y50.2140A
- Vapour barrier coatings
- Vinyl reference Y50.2180B
- Adhesives reference Y50.2190
- Protection
 - Application Plantrooms and external
 - Polyisobutylene- reference Y50.2200A
 - Ribbed aluminium-zinc coated steel reference Y50.2200D
- Reinforcement ٠
 - Aluminium bands
 - 300mm centres reference Y50.2210A
 - Protection for heat exchangers and other vessels
 - Aluminium-zinc coated steel
 - Reference Y50.2230C
 - With chest covers reference Y50.2230D
- Pumps and other irregular shapes reference Y50.2280
- Thickness table

٠

- Environmental thickness on warm air ductwork reference Y50.2450
 - Condensation control on chilled air ductwork
 - Phenolic foam reference Y50.2470

250.100 WORKMANSHIP DUCTWORK INSULATION:

- General reference Y50.3010 •
- Installation of foil faced semi-rigid slab insulation reference Y50.3060
- Installation of foil faced flexible insulation reference Y50.3070
- Installation of foil faced lamella insulation reference Y50.3080
- Installation of protection
 - Polyisobutylene (PIB) reference Y50.3120
 - Sheet metal finish ٠
 - Reference Y50.3140A
 - Aluminium-zinc coated steel reference Y50.3180
- Installation of ductwork fire protection insulation reference Y50.3200
- Installation where insulation is not carried through ductline support reference Y50.3240
- Installation where insulation is carried through ductwork support reference Y50.3250
- Liquid vapour barriers reference Y50.3260
- Integrity of vapour barriers reference Y50.3270

250.110 WORKMANSHIP EQUIPMENT INSULATION:

- General reference Y50.3010 •
- Installation of insulation on tanks reference Y50.3090
- Installation of mineral wool insulation on vessels reference Y50.3100
- Installation of phenolic foam insulation on vessels reference Y50.3110
- Installation of protection

U10 / 279

Polyisobutylene (PIB) - reference Y50.3120

- Sheet metal finish
- Reference Y50.3140A
- Aluminium-zinc coated steel reference Y50.3180
- Liquid vapour barriers reference Y50.3260
- Integrity of vapour barriers reference Y50.3270
- Water tanks reference Y50.3280

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below.

251.020 SPECIALIST:

- Use one of the following specialist commissioning engineers Refer to prefered manufacturers list • Or approved equivalent
- The commissioning Specialist shall allow for revisiting the commissioning of the building over set up efficiently and meet the user's requirements.

251.040 COMMISSIONING:

- Cleaning ductwork systems reference Y51.3010 •
- Commissioning codes reference Y51.3020
- Commissioning
 - Air distribution Including BSRIA pre-commissioning check list Reference Y51.3040A
 - Plant items reference Y51.3080
- Instruments and gauges
- Reference Y51.3090A
- Commissioning records
 - For air systems To BSRIA Application Guide 3/89.3 - reference Y51.3100A

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL:

Comply with work section general clauses reference Y54.1000 and those detailed below. Services Identification drawings - reference Y54.2015

254.030 DUCTWORK IDENTIFICATION: Reference Y54.2020

254.040 PLANT AND EQUIPMENT IDENTIFICATION:

- Lettering
 - Engraved plates filled with paint reference Y54.2030A

254.045 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416: Reference Y54.2035

254.080 AIR VOLUME REGULATING AND CONTROL DAMPER IDENTIFICATION: Reference Y54.2070

254.090 INSTRUMENT IDENTIFICATION: Reference Y54.2080

254.100 DANGER AND WARNING NOTICES:

KJ TAIT ENGINEERS

the first 18 month occupied period to allow for seasonal adjustment, to ensure the systems are

254.110 SYSTEM IDENTIFICATION INSTALLATION CHARTS:

Plastic encapsulated chart - reference Y54.2100C

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL:

Comply with work section general clauses reference Y90.1000 and those detailed below.

290.020 FIXINGS:

- Standards reference Y90.2010
- Plugs reference Y90.2020
- Screws reference Y90.2030
- Cast-in fixings reference Y90.2040
- Shot fired fixings reference Y90.2050
- Proprietary channel inserts reference Y90.2070

290.030 WORKMANSHIP:

- Drilling reference Y90.3010 •
- Proprietary fixings reference Y90.3020
- Fixing to reinforced concrete reference Y90.3030
- Fixing to brickwork reference Y90.3040
- Fixing to timber rails reference Y90.3050
- Fixing to hollow stud/tile/block wall
- Reference Y90.3060A
- Fixing to concrete, brickwork or blockwork
- Reference Y90.3070A
- Fixing to metalwork
- Reference Y90.3080A
- Fixing to structural steelwork and concrete structures
- Reference Y90.3090A

U11 TOILET VENTILATION

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES

The toilet extract systems shall provide adequate ventilation to all toilet areas

100.020 DESIGN PARAMETERS

Ductwork materials, construction and installation shall comply with the relevant parts of the following publications:

HVCA DW/144	Specification for sheet metal ductwork - low, medium and high pressure/velocity systems.
HVCA DW/143	A practical guide to ductwork leakage testing.
HVCA TR/17	Guide to good practice, cleanliness of ventilation systems.
HVCA DW/TM2	Internal cleanliness of new ductwork installations.
BS8313	Accommodation of building services in ducts.

Fire rated ductwork to be Flamebar BW11 manufactured by Fire Protection Limited to comply with BS476 Part 24 (1987) and ISO 6944 (1985) for 4 hours stability, 4 hours integrity and 3 hours insulation. Ductwork to be rectangular construction, complying with Building Regulations Class "O" requirements. The duct to be a composite fire duct manufactured to Method 3 of BS5588 Part 9 factory produced.

100.030 SYSTEM DESCRIPTION

Toilet ventilation will be provided for each laboratory core toilets, the disabled toilets, reception and restaurant toilets by means of a ducted mechanical extract system with packaged duty/stand-by twinfan units located at roof level.

Individual risers will be provided for each area and integrated within the toilet area. Toilet extract will discharge through walls of the various roof plants.

100.040 CONTROL REQUIREMENTS

The fans and associated BMS controls will be powered and wired by the controls specialist from the associated HVAC control panel. Run and trip indication will be displayed at the BMS.

100.050 SYSTEM SCHEMATICS Please refer to RMF - KJ Tait Engineers drawings 2053-Z-(59)-444

100.060 SYSTEM DRAWINGS Please refer to RMF - KJ Tait Engineers Drawing Series 2053-Z-(57)

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

230.000 AIR DUCTLINES AND ANCILLARIES

230.010 GENERAL:

Comply with Work Section general clauses reference Y30.1000 and those detailed below. Supply and install ductwork as section U10

PART 3 CLAUSES SPECIFIC TO U11

U10

KJ TAIT ENGINEERS

300.000 GENERAL

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.010 TOILET EXTRACT UNIT:

- Application Toilet Extract •
- Manufacturer and reference refer to the prefered manufacturers list
- Or approved equivalent
- Duty as schedule reference Please refer to RMF KJ Tait Engineers Drawing Series 2053-Z-(59)-705A
- Operation
 - Twin with automatic changeover.
 - Automatic Changeover to be picked up on BMS
- Location
- Rooftop.
- Materials
 - Manufacturer's standard.
 - Electrical safety to BS EN 60335-2-80.
- Motor
 - Electrical supply to BS 7697
 - Single phase.
 - Three phase.
- Accessories
 - Access provide access via
 - Roof
 - Controls
 - Provide speed controller to match fan.
 - On/off, autochangeover.
 - Fans and autochangeover to be fully BMS compatible.
 - Silencers.
 - Back-draught dampers.
 - Anti-vibration mounts.
- Testina •
 - Where fans approved under CAME scheme are used provide certified data for type.
 - Where fans are not approved under CAME scheme provide results of aerodynamic performance tests in accordance with BS 848-1; noise tests in accordance with BS 848-2 and BS EN ISO 5136; and fan vibration tests in accordance with BS ISO 14695.

U15 SAFETY CABINET/FUME CUPBOARD EXTRACT

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES The microbiological safety cabinet (MSC's) and fume cupboard (FC's) extract systems shall ensure all contaminants from the MSC's & FC's are removed safely, and that the required sash velocities are maintained at the required levels.

The Contractor shall upon completion of testing and commissioning of the fume extract systems the Contractor shall employ the services of a specialist to test and validate the correct operation of and containment of the fume cupboards. The Contractor shall attend on the specialist as required to achieve optimum containment levels.

A full report shall be submitted to the engineer on completion.

100.020 DESIGN PARAMETERS Ductwork materials, construction and installation shall comply with the relevant parts of the following nublications:

publications.	
HVCA DW/144	Specification for sheet metal of
	high pressure/velocity system
HVCA DW/143	A practical guide to ductwork
HVCA DW/154	Specification for plastics ducty
HVCA DW/191	Guide to good practice for gla
HVCA TR/17	Guide to good practice, clean
	systems.
HVCA DW/TM2	Internal cleanliness of new du
BS8313	Accommodation of building se

Fire rated ductwork to be Flamebar BW11 manufactured by Fire Protection Limited to comply with BS476 Part 24 (1987) and ISO 6944 (1985) for 4 hours stability. 4 hours integrity and 3 hours insulation.

Ductwork Construction - Negative Pressure:-

The fume extract ductwork within the interstitial floors shall be manufactured from a minimum standard of stainless steel grade 316S31. All ductwork and fittings shall be made to DW144 class CB. All riser and plantroom ductwork can be manufactured from either stainless steel as per the interstitial floors or UPVC manufactured to DW 154

Ductwork Construction - Positive Pressure:-The fume extract ductwork from the fan discharges shall be manufactured from stainless steel grade 316S31 or UPVC. All ductwork and fittings shall be fully welded and made to DW144 or DW 154 class C. All visible external ductwork from the top of the silencer shall be fully welded stainless steel.

All ductwork will be pressure tested in accordance with DW143 to Class C + 1/2500 Pascal's and permissible leakage levels recorded on test reports. The Contractor is to ensure that leakage is minimised to the lowest levels that are achievable.

100.030 SYSTEM DESCRIPTION

Fume Cupboard Extract - Fume cupboard extract will be handled by a series of individual floor ducts running to the roof plants through internal building risers before combining into a dedicated header for each quadrant of the building.

ductwork - low, medium and leakage testing. work. ss fibre ductwork. liness of ventilation

ctwork installations. ervices in ducts.
C0605LMB Revised Stage E Mechanical Specification Including Agreed VE SAFETY CABINET/FUME CUPBOARD EXTRACT

Each fume cupboard extract fan is size for 3,735 litres per second and provided with a matching stand-by fan for N+1 capacity. The extract fans will have packless sound attenuators, variable frequency controller and inlet air provisions to maintain minimum discharge stack velocity.

Extracts from fume cupboards will have terminal units and packless sound attenuators located in the interstitial ceiling void and a clear visible floor indication damper below the ceiling directly above the fume cupboard.

Microbiological Safety Cabinet (MSC) Extract - MSC's extract will be handled by a series of individual floor ducts running to the roof plants through internal building risers before combining into a dedicated header for each quadrant of the building.

Each MSC extract fan is sized for 3,735 litres per second and provided with a matching stand-by fan for N+1 capacity. The extract fans will have packless sound attenuators, variable frequency controller and inlet air provisions to maintain minimum discharge stack velocity.

The MSC extract systems will be constructed of corrosion resistant materials and operate at a constant volume as MSC's are energized by local controllers. Extracts from MSC's will have terminal units and packless sound attenuators located in the interstitial ceiling void and a clear visible floor indication damper below the ceiling directly above the MSC.

When required for fumigation, motor operated bubble tight isolation dampers will be provided at the room ceiling penetration point.

All MSC's regardless of cabinet classification are assumed to be extracted with no potentially contaminated air re-circulated back to the room environment.

In addition where there is a requirement for safe change HEPA filter housings these will either be located within the roof plant, or within the interstitial ceiling void for ease of access, but in either case will be as close as possible to the source of contamination so as to minimise contaminated duct runs.

Fume Cupboard Testing/Validation - On completion of testing and commissioning of the fume extract systems the Contractor will employ the services of a specialist commissioning company Crowthorne Hi-Tech Services Limited to test and validate the correct operation of and containment of the fume cupboards. The Contractor will attend on the specialist Crowthorne as required.

100.040 CONTROL REQUIREMENTS Please refer to Section U10.

100.050 SYSTEM SCHEMATICS

Please refer to RMF - KJ Tait Engineers drawings 2053-Z-(59)-440 441, 442, 443, 443A, 444, 444A, 450, 450A, 451, 451A, 453, 450, 451, 452, 453, 455 &, 456

100.060 SYSTEM DRAWINGS Please refer to RMF - KJ Tait Engineers Drawing Series 2053-Z-(57).

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

230.000 AIR DUCTLINES AND ANCILLARIES

230.010 GENERAL: Comply with Work Section general clauses reference Y30.1000 and those detailed below.

230.020 INSTALLER SELECTION:

Use a member of the HVCA specialising in the manufacturing and installing ductwork.

230.030 DUCTWORK AND FITTINGS:

- Type Stainless steel ductwork with welded or flanged joints to serve all specialist fume extract systems.
- Application MSC & FC Extract Ventilation systems.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE SAFETY CABINET/FUME CUPBOARD EXTRACT

- Electrical bonding terminal reference Y30.1030 •
- Design Information
- Class B, positive reference Y30.2010C
 - Class B, negative reference Y30.2010D
- Special installations reference Y30.2020Z
 - Metal ductwork
 - Polluted air or exceptional conditions
 - Ductwork exposed to a hostile environment
- Ductwork air leakage testing
 - Medium pressure ductwork reference Y30.2030B Reference Y30.2030Z

230.040 SHEET METAL DUCTWORK:

- Type Stainless steel ductwork with welded or flanged joints to serve all specialist fume extract systems.
- Application MSC & FC Extract Ventilation systems.
- Material
- Stainless steel reference Y30.2040C
- Reference Y30.2040#
- Construction
 - Rectangular reference Y30.2060A
 - Circular reference Y30.2060B
 - Reference Y30.2060#

230.090 SUPPORTS:

- Hangers and supports
- Reference Y30.2140A
- Support of air terminal units
 - Reference Y30.2150A

230.100 ACCESSORIES:

- Construction and finishes reference Y30.3010
- Inspection/servicing access openings
- Metal ductwork reference Y30.3020A Holes for controls/instruments - metal ductwork
- Reference Y30.3040
- Installation of instruments and controls reference Y30.3042
- Cleaning access
 - Level 2 reference Y30.3050A
 - Level 3 reference Y30.3050B
 - HVCA TR/17 reference Y30.3050C •
 - Reference Y30.3050#

230.180 AIR DUCTLINES & ANCILLARIES WORKMANSHIP:

- General reference Y30.4010
- Ductwork supports reference Y30.4020
- Duct support for vapour seal continuity
 - Reference Y30.4030A
- External ductwork supports reference Y30.4040 • · External duct supports shall be agreed in advance, and shall not penetrate the roof membrane.
- Drainage of ductwork reference Y30.4060 •
- Connections to builders work
- Plastics ductwork reference Y30.4070B Internal cleanliness
- Basic reference Y30.4090A ٠
- Intermediate reference Y30.4090B

Ductwork strength and air leakage testing, circular sheet metal ductwork - reference Y30.2035

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE SAFETY CABINET/FUME CUPBOARD EXTRACT

- Advanced reference Y30.4090C
- Method of cleaning
 - Dry method reference Y30.4090D
 - Wet method reference Y30.4090E
- Ductwork sleeves
- Plain reference Y30.4110A
- Installation of control equipment
- Reference Y30.4130
- Damper access reference Y30,4160
- Positioning reference Y30.4170

241.000 FANS

241.010 GENERAL:

Comply with work section general clauses reference Y41.1000 and those detailed below.

Supply fans as schedule reference Please refer to RMF - KJ Tait Engineers Drawing 2053-Z-(59)-705

241.020 FAN:

- Application MSC & FC Extract systems
- Manufacturer and reference
 - Refer to prefered manufacturers list
 - Or approved equivalent
- Operating conditions
 - Supply fan to suit environment subject to
 - aggressive atmosphere.
 - contaminants. •
 - risk of impact.
 - non-overloading requirement.
 - condensation.
 - Installation arrangement
 - D: Ducted inlet ducted outlet.
 - Configuration
 - Parallel operation.
 - Normal conditions with CIBSE noise levels reference Y41.2010A
- Construction and handling
- Reference Y41.2020A
- Testing reference Y41.2030
- Variable air volume fans method reference Y41.2040Z
- Motor and drive
- Variable speed, direct drive.
 - Option
 - Suitable for inverter control.
- Accessories
 - Connections to duct
 - Reference Y41.3060Z
 - Airflow sensor reference Y41.3110
- Flow Measurement facility reference Y41.3115 •
- Access •
 - Reference Y41.3120A
- Mounting reference Y41.3130
- Speed controller reference Y41.3140

241.050 WORKMANSHIP

- Location reference Y41.4010
- Testing reference Y41.4040
- Drain connections reference Y41.4050 All fans to be fitted with condensate drain traps to discharge to roof.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE SAFETY CABINET/FUME CUPBOARD EXTRACT

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

U15

Comply with work section general clauses reference Y51.1000 and those detailed below. Carry out testing and commissioning as specified in section

251.020 SPECIALIST:

- Use one of the following specialist commissioning engineers Crowthorne Hi-Tech Services Limited
- Or approved equivalent
- The commissioning Specialist shall allow for revisiting the commissioning of the building over set up efficiently and meet the user's requirements.

251.030 STATIC TESTING:

- Application All Fume extract systems to be tested in accordance with DW143 to 500 Pa for a 20 minute duration.
- Pressure testing
- General reference Y51.2010
- Testing records reference Y51.2110

251.040 COMMISSIONING:

- Cleaning ductwork systems reference Y51.3010
 - Commissioning codes reference Y51.3020
 - Commissioning
 - Air distribution Including BSRIA pre-commissioning check list
 - Reference Y51.3040A
 - Automatic control systems reference Y51.3070 • Plant items - reference Y51.3080
 - Instruments and gauges
 - Reference Y51.3090A
 - Commissioning records
 - For air systems
 - To BSRIA Guide 3/89 reference Y51.3100A
 - BMS commissioning
- Control system specification details required for commissioning reference Y51.3110
- Pre-commissioning reference Y51.3120
- Plant ready for control system commissioning Reference Y51.3130A
- Control system requirements for plant commissioning reference Y51.3140
- Commissioning reference Y51.3150

251.050 PERFORMANCE TESTING:

- Testing to specified conditions
 - Medical Gas and Air Systems reference Y51.4040F
 - Laboratory and Industrial Systems Reference Y51.4040G Requirements See verification requirements earlier in document
- Performance test records reference Y51.4050

254.000 IDENTIFICATION - MECHANICAL

254.010 GENERAL:

Comply with work section general clauses reference Y54.1000 and those detailed below. Provide identification - mechanical as specified in work section U10. Include for labelling all fume extract containment ductwork in accordance with the British Standards (Hazardous Contaminants.

the first 18 month occupied period to allow for seasonal adjustment, to ensure the systems are

U15

290.000 FIXING TO BUILDING FABRIC

290.010 GENERAL:

Comply with work section general clauses reference Y90.1000 and those detailed below.

Carry out fixing to building fabric as specified in work section U10

291.000 OFF-SITE PAINTING AND ANTI-CORROSION TREATMENT

291.010 GENERAL

Comply with work section general clauses reference Y91.1000 and those detailed below.

Carry-out off-site painting and anti-corrosion treatment as work section U10

PART 3 SPECIFICATION CLAUSES SPECIFIC TO U15

300.000 PRODUCTS/MATERIALS

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.015 FUME CUPBOARDS:

- Manufacturer and reference Refer to prefered manufacturers list •
 - Or approved equivalent
- Provide pre-plumbed and pre-wired fume cupboards.
 - Number required Please refer to RMF KJ Tait Engineers Drawings 2053-Z-(59)-701, 702 & 703
 - Position Please refer to RMF KJ Tait Engineers Drawing Series 2053-Z-(57)
- Testing To BS 7258

300.020 MICROBIOLOGICAL SAFETY CABINETS:

- Manufacturer and reference Refer to prefered manufacturers list
- Number required Please refer to RMF KJ Tait Engineers Drawings 2053-Z-(59)-701, 702 & 703
- Standard
 - BS EN 12469 (design, construction and performance prior to installation and performance ٠ after installation).
- Details in accordance with BS 5726-2. •
 - Specific requirements Please refer to RMF KJ Tait Engineers Drawings 2053-Z-(59)-701, 702 & 703
 - Services
 - As drawing number Please refer to RMF KJ Tait Engineers Drawings 2053-Z-(59)-701, 702 & 703
 - Safety cabinet
 - Provide facility to vary the set extraction volume flow rate, range required
 - Provide safety cabinet extraction system to run
 - continuously.
 - intermittently.
 - Carry out commissioning tests as BS EN 12469
- Details
- Cabinet classification
 - Class I, open fronted exhaust.
 - Class II, unidirectional (laminar open fronted).
 - Class III, enclosed exhaust.

310.000 WORKMANSHIP

310.010 INSTALLATION OF GENERAL PURPOSE LABORATORY FUME CUPBOARDS: Install general purpose laboratory fume cupboards to BS 7258 in accordance with BS 7258-2 section 3 and manufacturer's recommendations.

310.015 INSTALLATION OF FUME CUPBOARDS: Install fume cupboards in accordance with manufacturer's recommendations.

310.017 INSTALLATION OF OUTLETS FOR SERVICES TO RECIRCULATION FILTRATION FUME CUPBOARD:

Install outlets for services to recirculation filtration fume cupboards in accordance with manufacturer's recommendations.

- Water
- Gas •
- Drain
- Outlets supplied by
- Fume cupboard manufacturer.

310.020 INSTALLATION OF MICROBIOLOGICAL SAFETY CABINETS: Install safety cabinets in accordance with BS EN 12469 and manufacturer's recommendations.

U41 FAN COIL AIR CONDITIONING

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES Refer to Section T 61 for all technical information

100.030 SYSTEM DESCRIPTION

Specialist areas and those areas with high internal heat gains will be provided with recirculation fan coil units in addition to normal ventilation provisions.

Fan coil units will be located in either the interstitial ceiling void or wall mounted within the specialist area. Fan coils are currently planned for the following rooms:

- Confocal rooms all types
- -85°c freezer rooms all types ٠
- Centrifuge rooms – all types
- Crystal growing rooms •
- Main and local telecom rooms ٠
- Computer hardware room ٠
- Crystallization room •
- Lecture theatre control room

Fan coil units are packaged incremental units consisting of a finish cabinet with supply fan, cooling coil with condensate pan and pump, heating coil in the reheat position, replaceable roughing filter and industrial guality controls to achieve close tolerance temperature and humidity control. Units will be served by process chilled water, heating water when required and essential power supplies. Certain specialist areas will require two (2) fan coil units for N+1 redundancy.

Each fan coil unit will be fitted with a BMS outstation to control the functions of the unit and connect to the BMS LAN. Heating and cooling functions shall be controlled by motorised 2 port valves. Controls will include local start/stop with failure alarm, local temperature and humidity set-point control and continuous digital indication of both temperature and humidity conditions within the space. Controls must achieve temperature and humidity tolerances as defined previously under design criteria. Heating coil in the reheat position will be utilized to achieve close tolerance humidity control. Additional humidification is not feasible with packaged fan coil systems.

100.050 SYSTEM SCHEMATICS

Please refer to RMF - KJ Tait Engineers Drawings 2053-Z-(59)-433, 434, 435 & 503

100.060 SYSTEM DRAWINGS Please refer to RMF - KJ Tait Engineers Drawing Series 2053-Z-(55)

PART 3 SPECIFICATION CLAUSES SPECIFIC TO U41

300.000 PRODUCTS/MATERIALS

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS: All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 97/23/EC, implemented in the UK through the Pressure Equipment Regulations 1999, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies. Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.030 FAN COIL UNITS:

- Type
- Application
- Manufacturer and reference refer to preferred manufacturers list
 - Or approved equivalent

- Duty as schedule reference Please refer to RMF KJ Tait Engineers Drawing 2053-Z-(59)-708 •
- Duty
 - Number required Please refer to RMF KJ Tait Engineers Drawing 2053-Z-(59)-708
 - Water temperature
 - Heating flow (°C) 48.9°C
 - Heated return (°C) 43.3°C
 - Chilled water flow (°C) 3.3°C
 - Chilled water return (°C) 10°C
 - Electrical supply to BS 7697
 - Single phase.
 - Three phase.
- Casings
 - fixing lugs. Protect against corrosion internally and externally.
 - Obtain consent for use of self tapping screws.
 - Provide space within casing for pipework, ductwork and valves.
 - Supply unit
 - with purpose made casing
- Mounting
 - Vertically.
 - Horizontally.
- Finish
- Stoved primer.
- Insulation

Use thermal and acoustic insulation with surface finish to protect against product migration and all edges positively sealed.

- **Ductwork Connections**
- Upstream Suitable for attachment of circular flexible ducting.
- Downstream Flanged.
- Access Provide ready access to filter, fan and motor and any valves and controls.
- Fan coil unit components
 - Fan Double inlet, double width centrifugal fan with direct coupled motor. ٠ Motor
 - Three speed motor.
 - Variable speed motor.
 - Filter
 - BS EN 779.
 - Coils •
 - Form heating and cooling batteries of copper tube with aluminium fins.
 - Form heating and cooling batteries
 - Fix heating/cooling batteries to prevent air leakage around coil.
 - Drip-tray

Drip-tray under coil and under control valve where fitted, fabricated from non-corrosive material or protected against corrosion with external faces insulated to prevent condensation. Drain Connections

- Ensure connection to drip tray is flush with bottom of drip tray.
 - Fit a screwed plug connection to drip-tray.
 - Fit a drain line

U41

• Performance - Ensure manufacturer's ratings comply with BS 4856.

Fabricate from galvanized mild steel sheets and stiffeners without sharp edges. Incorporate

Return air filter of nylon or glass fibre with minimum efficiency of 60 per cent when tested to

W60

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE CENTRAL CONTROL/BUILDING MANAGEMENT

W60 CENTRAL CONTROL/BUILDING MANAGEMENT

PART 1 SYSTEM OBJECTIVES

100.010 PERFORMANCE OBJECTIVES:

The Controls Specialist shall carry out the design and installation of the controls system, including all equipment, power wiring from the local distribution boards and motor control centres and all controls wiring required to achieve the various control requirements. The control system shall be capable of being maintained by specialist controls companies other than the installer/manufacturer.

The electrical contractor shall supply all packaged equipment control panels, inverters and local distribution panels as indicated on the drawings 2053-Z-(61)001 to 018 inclusive.

The BMS contractor shall supply all local essential and non essential controls power wiring to all other mechanical services equipment that is indicated on the drawings and within the schedules.

The system will be based on the Trend IQ3- an open protocol control system or equal approved that can interface with the existing client system.

100.030 SYSTEM DESCRIPTION:

A complete Building Management Control System (BMS) of the Direct Digital/Pneumatic Control (DDC) type will be installed for the New LMB Building Project. The new BMS system will provide complete interoperability with the LMB's existing BMS.

The control system logics and points schedules are indicated on each set of system schematics, these are detailed on drawings 2053-Z-(59)-400 series. System descriptions are found at clause 100.300 in each section of the specification these should be read in conjunction with the (59) 400 series drawings.

All VAV supply or extract boxes indicated on the layout drawings or equipment schedule that does not have a specific control schematic shall be deemed to be a generic unit. All generic shall have local area control, and shall be identified within the tender bid.

The BMS will monitor and control all plant equipment including the air handling units, fans, chillers, boilers, pumps, building heating, air terminal units, domestic water and all miscellaneous mechanical equipment associated with the building. The BMS will also provide alarm monitoring for plant failures in areas such as cold rooms, freezers, tissue culture, containment, etc.

Control for the building systems will be DDC (Direct Digital Controlled) based with pneumatic actuators for large valves and dampers, and digital electronic actuators for other components. Equipment in the Energy Centre will be provided with industrial grade and guality controls and building components will be commercial grade and guality.

All specialists' areas such as: containment, electron microscopy, NMR, aquatics, mass spec, etc. will also have industrial grade controls. Central computer stations will monitor the various DDC panels and be provided at the building maintenance office. All control points will be tied back to the central computer. Generally terminal unit control is local only with monitoring through the BMS.

Control system. shall be a Trend Control System or equal approved. Terminal units will be provided with electronic controls. Safety equipment for the building includes smoke detectors to de-energize supply and return fans only, integrated fire alarm system and miscellaneous fire suppression systems. Control system will be provided with a LAN based interface that can be accessed through a data port within the building by a portable PC. The user that interfaces the DDC at that point will be able to receive all diagnostic information from system and modify all user input set-points.

A single controls contractor will provide a complete system for the project capable of stand-alone operation within the building that can meet criteria.

All laboratory areas will have local controllers which control the supply and extract airflow for general

KJ TAIT ENGINEERS

use labs as well as for fume cupboards, MSC's and miscellaneous extract devices. Such controllers will be capable of stand-alone operation and be linked to the main BMS to enable reduction of energy consumption when minimum extract rates occur or during night set back periods. Individual laboratory modules or zones may have independent occupancy schedules to further enhance energy consumption.

The BMS system will have a complete package of energy conservation features including optimized start-up of systems, peak shaving, night set back facilities for HVAC systems with compensated control and temperature reset optimization.

The BMS central computer and file server will be located within the maintenance offices in the energy centre with a second server in a location agreed by the MRC. The file server will be connected to a number of remote DDC panels by a dedicated network system. DDC panels will be located within plant rooms and interstitial ceiling voids in agreed accessible positions. Each DDC panel will be capable of stand-alone operation and be fully accessible and programmed in plain English. BMS wiring will be incorporated into the structured cabling system using master controllers acting as network interfaces. In the event of a network communication failure each of the remote DDC panels will operate as intelligent stand-alone units controlling equipment linked to them and reporting back to the main and secondary servers once network communication has been restored. The entire BMS system will be supplied with essential power and have local UPS units for workstation, file servers and DDC panels.

The BMS controls system contractor shall make due allowance for all interfaces between the BMS system and the package equipment control panels. The following is a schedule of the main packaged equipment, however the contractor shall check the drawings and schematics for all packaged control systems.

Mechanical Services Packaged Control Systems:-

- Main chillers
- Process chillers
- Ground source heat pump systems
- Heating Boilers
- Steam Boilers
- HWS heaters Cat 5 & domestic.
- Cold room control system interfaces.
- Fume cupboard and MSC control system interfaces.
- RO/DI Water treatment.
- Water Softeners. •
- Water Boosters. •
- Sump Pumps.
- Condensate return pump sets. •
- Steam trap monitoring system.
- Heat Wheel control and health & safety control systems. •
- Desiccant dehumidifiers. •
- Air compressors.
- Gas suppression systems.
- Leak detection.
- Carbon monoxide gas detection.
- Oxygen depletion systems. •
- Bulk lab gas system. •
- Local lab gas system alarms. •

MRC Supplied Packaged Equipment Control Systems

- Electron Microscope chillers
- Fermentors

Allowance will be made within the system for the monitoring and recording of electricity usage at the BMS, via kWh meters located within the switchboards. The meters will be supplied and fitted by others, but the wiring between them and the BMS will be by the controls specialist. In addition to the Main Incoming utility meter, and the main building meter, the contractor should allow for all meters indicated on the HV/LV distribution Schematics (61) Series.

Allowance will be made within the system for the monitoring and recording of the following gas and water meters:-

- •Mains Incoming Gas.
- •Gas Supply to Heating Boilers.
- •Gas Supply to Clean Steam Generators.
- •Gas Supply to Industrial Water Heaters.
- •Gas Supply to Domestic Water Heaters.
- •Gas Supply to Building Systems.
- •Gas Supply to Kitchen.
- •Mains Incoming Water.
- •Drinking Water Supply.
- •RO/DI Water Supply.
- Mains Water to Bain Water Harvester Softener
- •Mains Water to Industrial Water Softener.
- Mains Water to Domestic Water Softener.
- •Electrical meters as indicated on the (61) series drawings.

The meters will be supplied and fitted by others, but the wiring between them and the BMS will be by the controls specialist.

The following other systems shall be interfaced into BMS:-

- •Lighting control system head end at reception area security control room, serial connection.
- •Security system head end at reception area security control room, serial connection.
- •Fire Alarm system head end at reception area security control room, serial connection.
- •Facade control system head end, serial connection.
- •Standby generator system, allow 20 outputs.
- •UPS system, allow 20 outputs
- •Gas suppression system, allow 20 outputs.
- •Switchgear auto transfer switches, 3 2 in the energy centre 4 in the building & 2 1 in each of the-in the 4 plant towers.
- •Primary switchgear change over switches, 21 in the energy centre and 21 in the building.

Note:-

Wiring for each service or system shall be c/w a unique sheath colour for ease of identification, e.g. red for fire, etc. The colour of each system's cabling shall be agreed with the CA prior to implementation. The Services Contractor shall ensure that all sub-contractors recognise and implement the agreed colour coding system.

Contractors shall take due cognisance of the specification clause 520.030 Design Responsibilities.

100.040 CONTROL REQUIREMENTS:

100.050 SYSTEM SCHEMATICS: Please refer to RMF - KJ Tait Engineers Drawing Series 2053-Z-(59) (all drawings)

100.060 SYSTEM DRAWINGS:

KJ TAIT ENGINEERS

Please refer to RMF - KJ Tait Engineers Drawing Series 2053-Z-(59)-600 to 608 400 to 475 inclusive Please refer to RMF - KJ Tait Engineers Drawing Series 2053-Z-(61)001 to 018 inclusive for electrical power distribution.

Please refer to RMF - KJ Tait Engineers Revised Stage E report

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

251.000 TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

Comply with work section general clauses reference Y51.1000 and those detailed below. The Controls Specialist shall allow for revisiting the commissioning of the building over the first 18 month occupied period to allow for seasonal adjustment, to ensure the systems are set up efficiently and meet the user's requirements.

251.030 STATIC TESTING:

Testing records - reference Y51.2110

251.040 COMMISSIONING:

- Commissioning codes reference Y51.3020
- Commissioning •
 - Automatic control systems reference Y51.3070
- Instruments and gauges
- Reference Y51.3090A
- BMS commissioning
- Control system specification details required for commissioning reference Y51.3110 •
- Pre-commissioning reference Y51.3120
- Plant ready for control system commissioning Reference Y51.3130A
- Control system requirements for plant commissioning reference Y51.3140
- Commissioning reference Y51.3150

260.000 CONDUIT AND TRUNKING

260.010 GENERAL:

Comply with work section general clauses reference Y60.1000 and those detailed below. Supply conduit and cable trunking as specified in section V20. All primary and secondary containment within the plantrooms associated with the HVAC installation will be carried out by the controls specialist. The electrical contractor will install main containment routes throughout the building which can be utilised by the controls specialist for sensor, network cables etc. Secondary containment for HVAC cables run in the building primary containment will be the responsibility of the controls specialist.

Where primary containment does not run near items served by the HVAC control system, this will again be the responsibility of the controls specialist.

•Where containment (cable tray) is required on the roof (ie to serve roof mounted plant), this will be the responsibility of the controls specialist.

261.000 HV/LV CABLES AND WIRING

261.010 GENERAL:

- Comply with work section general clauses reference Y61.1000 and those detailed below. Supply HV/LV cables and wiring as work section
- Refer to Electrical Specification, Section V20.

Supply HV/LV cables and wiring as schedule reference Y61-Cables

KJ TAIT ENGINEERS

W60

W60

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE CENTRAL CONTROL/BUILDING MANAGEMENT

290,000 FIXING TO BUILDING FABRIC

290.010 GENERAL:

Comply with work section general clauses reference Y90.1000 and those detailed below. Carry out fixing to building fabric as specified in work section

Refer to Electrical Specification, Section V20.

291.000 OFF-SITE PAINTING AND ANTI-CORROSION TREATMENT

291.010 GENERAL

Comply with work section general clauses reference Y91.1000 and those detailed below. Carry-out off-site painting and anti-corrosion treatment as work section

- Refer to Electrical Specification, Section V20.

PART 3 SPECIFICATION CLAUSES SPECIFIC TO W60

300.000 GENERAL

300.010 SYSTEM REQUIREMENTS:

Select control components and equipment, suitable to meet system objective requirements. Ensure that system safety complies with BS EN 954-1.

Where necessary comply with BS EN 61508.

300.020 CONTROL SYSTEM:

Supply and install control equipment to provide a means of controlling and indicating the performance of other systems within set criteria and varying their criteria as required from a central location.

300.030 CONTROLS SPECIALIST:

Use a controls specialist to design, supply, install, test and commission complete controls installation.

Or approved equivalent.

300.040 CONTROL MODE:

Provide a control system utilizing the mode of control, as follows:-

• electric/electronic. • electric/pneumatic.

300.050 COMPRESSED AIR:

Ensure compressed air is available to pressure, quantity and cleanliness requirements indicated.

300.060 CONTROL COMPONENTS MANUFACTURER: Unless otherwise indicated use control components and equipment from one manufacturer throughout.

300.070 BUILDING MANAGEMENT SYSTEMS:

- Application Phase1
 - Provide a building management system, including
 - equipment design.
 - development of design.
 - supply.
- installation.
- commissioning.
- setting to work. Operation
- Building services control.

300.080 BUILDING MANAGEMENT SPECIALIST:

KJ TAIT ENGINEERS

263.000 SUPPORT COMPONENTS - CABLES

263.010 GENERAL:

Comply with work section general clauses reference Y63.1000 and those detailed below. Supply support components as specified in section

Refer to Electrical Specification, Section V20.

271.000 LV SWITCHGEAR AND DISTRIBUTION BOARDS

271.010 GENERAL:

Comply with work section general clauses reference Y71.1000 and those detailed below.

- Supply switchboards and distribution boards as schedule reference
- Refer to Electrical Specification, Section V20.
- Location

272.000 CONTACTORS AND STARTERS

272.010 GENERAL:

Comply with work section general clauses reference Y72.1000 and those detailed below.

- Supply contactors and starters as specified in work section
- Refer to Electrical Specification, Section V20.

274.000 ACCESSORIES FOR ELECTRICAL SERVICES

274.010 GENERAL:

Comply with work section general clauses reference Y74.1000 and those detailed below.

- Supply accessories for electrical services as section
- Refer to Electrical Specification, Section V20.

280.000 EARTHING AND BONDING COMPONENTS

280.010 GENERAL:

Comply with work section general clauses reference Y80.1000 and those detailed below.

- Supply earthing and bonding components as specified in section
- Refer to Electrical Specification, Section V20.

281.000 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES:

281.010 GENERAL:

Comply with work section general clauses reference Y81.1000 and those detailed below. Carry out testing and commissioning of electrical services as section

Refer to Electrical Specification, Section V20.

282.000 IDENTIFICATION - ELECTRICAL

282.010 GENERAL:

Comply with work section general clauses reference Y82.1000 and those detailed below.

- Supply identification electrical as specified in section
- Refer to Electrical Specification, Section V20.

Engage a specialist to develop design, supply, install, commission and set to work the building management systems.

300.090 FINISHES:

Application

- Ensure all monitoring equipment is designed to common installation practices.
- Provide all equipment as a matching suite.

300.100 ELECTROMAGNETIC COMPATIBILITY:

Ensure all monitoring system equipment is compatible, and does not adversely affect any other equipment installed in the same location. Ensure all monitoring system equipment meets the requirements of:

BS 7671 (IEE Wiring Regulations).

300.120 DATA COMMUNICATIONS PROTOCOLS:

Arrange the digital data interchange systems using open system protocol.

- Standard
 - BS EN 61030. •
 - BS EN 61158-2.

300.130 INTEGRATED SYSTEM:

Provide integrated system in accordance with BS 7807 the following sub-systems:

- Building management system.
- Heating and ventilation.
- Energy management.

310.000 SYSTEM

310.010 GENERAL REQUIREMENTS:

Refer to the requirements of draft document prEN 13646 Building control systems - equipment characteristics.

Refer to the requirements of prEN ISO 16484-2 Building control systems - Part 2 HVAC control system functionality.

310.020 GENERAL REQUIREMENTS - ELECTRICAL SAFETY: Ensure that the BMS complies with the following EC Directives

- Low Voltage Directive 73/23/EEC and amendments 93/68/EEC.
- Construction Products Directive 89/106/EEC.
- General Product Safety Directive 92/59/EEC.

Ensure that the BMS installation complies with BS 7671 Electrical Installations in Buildings. Ensure that control panels comply with BS EN 60439-1 Low-voltage Switchgear and Control Assemblies.

310.030 GENERAL REQUIREMENTS - ELECTRICAL SUPPLY:

Ensure that the BMS can operate when supplied with electricity conforming to BS EN 50160 - Voltage characteristics of electricity supplied by public distribution systems.

310.040 GENERAL REQUIREMENTS - EMC:

Ensure that the BMS complies with the Electromagnetic Compatibility (EMC) Directive (89/336/EEC). Ensure that the BMS complies with BS EN 61000-6-3 Generic emission standard, BS EN 61000-6-1 and BS EN 61000-6-2 Generic immunity standard. Ensure that the BMS meets the EMC requirements of prEN 13646.

310.070 GENERAL REQUIREMENTS - TIME SYNCHRONISATION:

Ensure that all time-dependent BMS components are time synchronised via the operator workstation. Ensure that the BMS can automatically change between British Summer Time (BST) and Greenwich Mean Time (GMT).

Ensure that the BMS can accommodate leap years.

310.080 GENERAL REQUIREMENTS - SYSTEM SECURITY:

- Provide, as a minimum, password-protected operator access for the following levels. • Level 1 - Ability to display all point data. Level 2 - Ability to display all point data and to initiate data logging functions.
- and time schedules.
- time schedules; and to change control strategies and schematic/graphics functions and password assignment.
- controllers which have an operator interface.
- Ensure that passwords permit at least 6 alpha/numeric characteristics.
- Ensure that the BMS software is protected from unauthorised entry.
- Ensure that the BMS, and its operation performed under any maintenance contract, complies with • BS 7799-2 Information security management, Part 2 Specification for information security management systems and BS ISO/IEC 17799 Code of practice for information security management.

310.090 GENERAL REQUIREMENTS - SYSTEM SOFTWARE: Ensure that IT industry standard operating systems are used. Ensure that copies of all BMS vendor-specific software are held by an independent third party and that this software can be released to the client. Ensure that the ESCROW Agreement is completed and signed. Ensure that licences to use software applications are owned by the Client. Provide application software written in accordance with BS 7649.

310.100 GENERAL REQUIREMENTS - SYSTEM SUPPORT: Ensure that a viable strategy is in place to fully support the BMS for a minimum of 10 years from the date of practical completion.

310.110 OPERATOR WORKSTATION - OPERATIONAL CHARACTERISTICS:

- Ensure that the control of plant is independent of the operator workstation.
- Ensure that no data of a control nature is transferred between field controllers via the operator workstation, i.e. data relating to control strategies.
- Ensure that the operator workstation can communicate with all addressable field controllers.
- Provide complete system integrity such that the network of field controllers will continue to fully operate following a failure of the operator workstation.
- Ensure that the appropriate control strategy configuration data can be downloaded to all addressable field controllers.
- Provide a means of displaying and modifying each addressable field controller's control strategy. time schedules and set-points via the operator workstation.
- Allow the operator to re-schedule plant operation times. Ensure that re-scheduling can be applied globally to a number of items of plant at one or more sites (or one or more controllers on one site) as selected by the operator.
- Ensure that the operator workstation incorporates a data storage management system that warns line non-volatile media. Ensure that the operator is prompted at pre-defined intervals to carry out the data archiving procedure.
- Ensure that it is possible to perform a complete backup of the operator workstation comprising control strategies, set-points and logged data.
- Provide an electronic data archival device that uses readily available non-volatile media that is appropriate for long term storage of system software, configuration data and logged data (including alarm data). Note that the use of multiple 3.5 inch disks is not acceptable.
- Allow the transfer of data from the system memory and other storage devices to the archive mediums, and vice versa for the preparation of reports.
- Ensure that the backup data can be fully re-loaded.
- Ensure that selected files from the backup data can be re-loaded.

310.120 OPERATOR WORKSTATION EQUIPMENT:

W60

Level 3 - Ability to display all point data; to initiate data logging functions; and to change set points

Level 4 - Ability to display all point data; to initiate data logging functions; to change set points and

Ensure that password-protected operator access is set up for both operator workstations and field

against impending on-line storage overflow and allows for data archiving to, and retrieval from, off-

- Application Provide an industry standard desktop PC with a minimum specification as follows: •
- Intel Pentium 4 or Centrino dual core processor 2.8Ghz
- 120Kb Hard Drive
- 2kb RAM
- CD/RW Drive
- Qwerty Keyboard •
- Mouse
- Provision of spare USB ports •
- 2 Spare PCI slots
- 2 Stereo Speakers •
- Windows XP professional Software
- 19" Flat Panel Monitor (or larger if required to view system graphics) •
- Internal 56K Modem ٠
- ٠ System Sound Card
- Ethernet port
- Colour Inkjet Printer (suitable for system alarm printing tasks)
- BMS system supervisor software (server version) installed and operating, including calendar tasks, alarm tasks, full graphical interface, system graphs, record & restore facility etc.
- Supervisor UPS (capable of running both PC and screen for a minimum of 15 minutes)
- Full set of system graphics as described in Section 310.140
- Processor •

Ensure that the processor speed of each operator workstation meets the data processing requirements.

- Monitor •
 - Use a colour monitor with an image guality no less than 1024x768
- Printer •

Ensure that the printer can print all monitored and logged data (including graphs of logged data); all point data (hard and soft); control logic diagrams and plant/building; schematics in colour; alarm data/text; and system help text.

Ensure that the automatic printing of alarm data can be switched on/off. Ensure that the printer has a minimum output of four pages per minute.

310.130 OPERATOR WORKSTATION - MONITORING AND LOGGING FUNCTIONS:

- Application The system outstations will be capable of the following functions without depending on the network or system supervisor being available:
- Logging and storing alarm conditions (detailing date and time of alarm)
- Logging and storing of alarm cleared conditions (detailing date and time) ٠
- Logging and storing of alarm accepted functions (detailing date, time and who accepted) •
- Logging and storing temperature/humidity/pressure graphs etc. (minimum of 1000 points per • graph)
- Graph logging to be variable duration between points from 1 minute to 1 hour minimum. (duration to be selected to suit area during commissioning).
- Logging and storing of operator changes (detailing time, date, who changed parameter, previous value and new value).
- Data record facility for all/any system parameters, also incorporating restore/view facility. •
- Ability to automatically or manually run data record facility. •
- Ability to generate alarm if timed data record fails for any reason.
- Ability to prioritise system alarms.
- Ability to retransmit alarms to other supervisors, pagers, mobile phones, and e-mails.
- Monitoring of all plant status ie run, trip, fail.
- Monitor and alarm if necessary all plant item hours run.
- Monitoring and recording of all necessary utilities usage, displaying rate, daily and total ٠ consumption.

- plant status, valve position etc.
- Ensure that all monitored point data can be displayed at the operator workstation. Ensure that analogue, digital and soft-points can be displayed simultaneously.
- Ensure that all changes made by the operator (eg set-point changes) can be logged and identified by both operator and date/time stamp.
- Provide a facility to allow the display, at the operator workstation, of 'real time' data superimposed on plant schematics with a refresh rate not exceeding 20 seconds.
- Ensure that a minimum of four 'real time' data points can be displayed simultaneously, in the form of data plots, with a time delay not exceeding 20 seconds.
- Ensure that logs can be set up from the operator workstation and that logging times and logging intervals are user adjustable between 1 second and 24 hours.
- Ensure that the operator workstation has sufficient data storage capacity to accommodate the defined amount of logged data and that the data can be backed up.

Amount of logged data

- Provide a facility to allow the simultaneous display of different logged data. Ensure that this function is operator adjustable.
- Provide a facility to allow the export of logged data to other software packages. Ensure that the format of the exported data can be fully defined.

310.140 OPERATOR WORKSTATION - GRAPHICAL OPERATOR INTERFACES:

- Application The system graphic will be custom designed to suit this particular system and not generic graphics.
 - Graphics will be designed in a layered format with a 'top to bottom' design (ie starting with a building layout, then to floors/plantrooms, then to specific plant etc).
- Access to each layer/graphic will be via 'click boxes'.
- Graphs, access to utility, setpoints etc will also be available via each relevant graphic.
- Graphics supplied will not be limited to, but a minimum of the following:
- Main building layout •
- Individual floor level
- Multiple floor levels sections of not less than 4 per floor (detailing temperatures etc).
- Individual plantrooms/areas (detailing temperatures etc).
- Individual plant graphics (such as 1 AHU/primary heating plant/secondary heating distribution • etc). These graphics will show all relevant information such as temperatures, valve positions, plant status etc.
- It will not be acceptable to 'overload' graphics with information. Busy graphics should be split over 2 or more pages to assist speed of operation.
- Each fan coil unit, close control unit etc. will have a dedicated graphic.
- The graphics will capable of displaying dynamic items such as fail and trip conditions in a different manner (ie different colour) and shall also have an audible warning facility.
- etc.
- New graphics will be able to be generated by the software on site. There will also be a 'quick find' menu graphic generated which can also be used to navigate
- the graphics.
- We envisage no fewer than 80 graphical pages being provided.
- Spare capacity should be allowed within the system to allow a minimum of 20% space capacity. Provide a software library of plant schematics and symbols, the format/contents of which should be confirmed with the specifier based on samples.
- Provide a facility to allow the operator to generate additional schematics and symbols. Ensure that the system can accommodate the addition of 20% extra graphics 'pages'.

Monitoring and displaying of all instantaneous analogue and digital values such as temperature,

The system will be capable of utilising pictures, CAD drawings and bitmaps as backgrounds

W60

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE CENTRAL CONTROL/BUILDING MANAGEMENT

- Provide a facility to allow the operator to modify plant schematics and to generate new ones. •
- Ensure that graphics can be displayed in a layered approach (building layout graphics down to plant subsystems and components). Ensure that the operator can modify the structure of the layered approach.

310.150 OPERATOR WORKSTATION - HELP AND ASSISTANCE:

Provide a facility to allow the display of help text covering all operator functions and system fault conditions.

Provide a facility to allow the display (including a hard copy) of points list (hard and soft-points) and control strategy logic schematics.

310.160 OPERATOR WORKSTATION - INTEGRATION WITH THIRD PARTY MANAGEMENT SOFTWARE:

- Application The system will be capable of integrating with and using information provided by the following software/systems.
- MIFARE access control system. This system will provide information on occupancy level of main lecture theatre. Allowance should be made to interface this system either via software or hardware depending on system requirements.
- Microsoft excel via text file (this allows all dynamic information to be manipulated and transferred to other packages).
- Maintenance management software.

Energy monitoring and targeting software

Provide a facility to allow the direct transfer of recorded energy consumption and external air temperature readings from the BMS to the monitoring and targeting software. Ensure that the format of the exported data can be fully defined.

310.170 OPERATOR WORKSTATION - SYSTEM ALARMS:

- Application The system will be capable of displaying and logging the following alarm types:
- Sensor fail alarms ٠
- Sensor outside limit alarms
- Plant readback/mismatch alarm
- Plant fail alarms ٠
- Plant trip alarms ٠
- High temperature trip alarms •
- High/low water level
- Leak detected
- Duct frost condition •
- Dirty filter condition ٠
- Building fire condition
- Gas detected
- Fume cupboard fault/sash alarm
- Hours run maintenance alarm
- The supervisor software will be capable of fully managing all alarms, by the process of prioritising and categorising alarms and types. Alarms will also be able to carry out other specific tasks automatically such as displaying a page with maintenance details for plant items. Displaying and information/task sheet on procedures to follow. Enable data recording to be initiated. Forward the alarm to a specific place or person (ie e-mail etc).
- All alarms created will be logged and stored as will alarm cleared conditions and alarm acknowledged conditions.
- Ensure that alarms are displayed on a rolling basis in chronological order.
- Ensure that the operator can acknowledge alarms, including muting of audible or flashing annunciators.

- Provide a facility to silence audible alarms or inhibit flashing annunciators without performing • alarm acknowledgement.
- - Ensure that the BMS can be configured to avoid fleeting alarms, i.e. ensure that alarms can accommodate start-up and shutdown delays.
 - Ensure that the operator can alter the limits at which the measured values cause alarms to be triggered.
 - Ensure that alarm limits can accommodate sliding limits, e.g. set-point changes.
 - Ensure that alarms can be differentiated by means of alarm type and identification. •
 - Ensure that visual, audible and printed annunciation of alarms, or any combination of these, can • be selected by the operator.
 - Ensure that the reception and acknowledgement of alarms can take precedence over other operations. However, ensure that the reception of alarms does not hinder user log-in.
 - include muting or flashing annunciators.
 - Provide distinction between active alarms whose conditions are not cleared and unacknowledged alarms.
 - Ensure that alarm data provides condition identity; condition value; alarm source; alarm time and • date; and acknowledgement status.
 - Ensure that the alarm file can be sorted by the above criteria.
 - Allow alarms to be automatically redirected to other user interfaces.
 - Provide sufficient data storage capability for the storage of alarms.
 - Ensure that any stored alarm data can be analysed in conjunction with other monitored conditions or stored logged data.
 - Ensure that an alarm review facility is available.
 - Allow the display of stored alarm data based on user definable selection criteria. •
 - Ensure that the operator can define the requirement for acknowledgement of alarms; a time programme for annunciation of alarms to different destinations; and text messages associated with alarm conditions.

310,180 FIELD CONTROLLERS - MODES OF OPERATION:

- Ensure that the field controllers perform all control actions independently of the operator workstation.
- BMS communication network.
- Ensure that field controllers can operate with the loss of shared data through the use of default values and final data reading before the loss of network communications.

310.190 FIELD CONTROLLERS - PHYSICAL CONSTRUCTION:

- For internal plant room applications, construct field controller enclosures to give a minimum degree of protection to IP54 in accordance with BS EN 60529. Where the field controller is fitted inside a control panel that is protected to IP54 then the field controller protection can be reduced to IP41. For external applications, construct field controller enclosures to IP65.
- Where an enclosure is to be provided ensure that field controller enclosures are lockable.
- Ensure that modular construction is used for field controllers. Ensure that this allows the removal and replacement of devices without the need for rewiring of field wiring.

310.200 FIELD CONTROLLERS - TERMINATIONS: Use terminals of the screw down clamp-type fixed to purpose made mountings. Segregate into groups terminals carrying different voltages (in accordance with BS 7671).

310.210 FIELD CONTROLLERS - FUTURE EXPANSION: Make provision for a future 20% increase.

310.220 FIELD CONTROLLERS - CONTROLLER INPUTS: Ensure that the interfaces for the field controllers are appropriate for gathering data from sensors and devices. Ensure that the following requirements are met.

- Analogue input
 - Variable currents (4-20 mA), variable voltages (0-10V) or variable resistances.

Ensure that alarms can be inhibited for reasons of time and/or priority as selected by the operator.

Allow the user to acknowledge alarms individually and on a group basis. Acknowledgement should

Ensure that all field controllers can operate independently and in real time following a failure of the

W60

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE CENTRAL CONTROL/BUILDING MANAGEMENT

- Ensure that the routines necessary to process analogue inputs are resident at the field ٠ controller.
- Ensure that a minimum and maximum limit value can be defined for each analogue input. ٠ Ensure that each limit is associated with a configured response.
- Ensure that the field controller can detect open or closed circuit faults and raise an alarm on the operator workstation.
- Ensure that non-linear inputs can be calibrated/scaled.
- Ensure that it is possible to define a relationship between an analogue point threshold value and a digital point status.
- Digital inputs •
 - As derived from volt-free contacts (max 24 volts/20mA). Allow the interface to be selected to monitor a normally open or normally closed circuit.
 - Ensure that the routines necessary to process the digital inputs are resident at the field controller.
- Pulsed inputs

•

•

- As derived from volt-free contacts (max 24 volts/20mA) at a pulse frequency of up to 32Hz. •
- Ensure that the routines necessary to process pulsed inputs are resident at the field controller.
- Ensure that the field controller has the following capabilities.
 - Storage of cumulative totals daily; weekly; monthly; yearly; and continuously.
 - Operator re-set facility of cumulative totals via the operator workstation.
 - Facility to combine counts from separate pulsed inputs.
 - Ability to calculate the number of pulses per unit time through addition and/or subtraction.
 - Ability to compare the number of pulses with preset limits on the basis of total number of pulses per unit time and the time required for a total number of pulses.
 - Ability to convert pulsed readings into guantifiable values.
 - Alarm facility based on a user-defined limit being exceeded.
- Ensure that the inputs which are used to monitor fluctuating pulse rate (eg maximum demand meter for electricity) have operator adjustable limits.
- Ensure that when data for pulsed inputs is recorded, the record includes both the pulse count and logging intervals for cumulative counts.
- Run-time totals
- Include run-time totalling routines to enable the operator to record cumulative run-time for each item of plant selected.
- Provide the operator with the option to set a different maximum run-time for each item of plant selected.
- Ensure that when the maximum run-time has been reached an alarm is signalled to the operator.
- Ensure that the operator workstation can be used to interrogate field controllers for a point-bypoint summary of run-time totals and run-time limits.
- Ensure that it is possible for the user to set an initial value of hours run other than zero.
- General •
 - Ensure that all inputs can be scanned at intervals not exceeding 1 second.
 - Ensure that all inputs are protected against spurious out-of-range signals including those • caused by contact noise or bounce.
 - Ensure that errors introduced by the analogue to digital conversion of inputs do not exceed 0.1% of the analogue value.

310.230 FIELD CONTROLLERS - CONTROLLER OUTPUTS:

- Ensure that isolation between controllers and networks meet the requirements of prEN 13646.
- Ensure that the field controllers' interfaces are capable of providing control signals to actuators and switching devices.
- Ensure that routines are configurable, such that one or more events may be enabled in direct response to any defined logical relationship between the status of a number of physical or softpoints.
- Ensure that in the event of power failure, output devices can be driven to their preset, fully open/closed position.
- Provide the following interface characteristics:

- controlled items of plant.
- Digital output. Ensure that digital outputs can be selected as 'normally closed' or 'normally • open'.
- Ensure that errors introduced by the digital to analogue conversion of outputs do not exceed 0.1% of the digital value.
- Ensure that the field controller is capable of receiving feedback signals which allow the comparison between an output signal to a controlled device and its actual condition.

310.240 FIELD CONTROLLERS - POSITIVE FEEDBACK:

- Ensure that the field controllers can include routines necessary to confirm that specific items of plant are functioning correctly. Ensure that this can be performed by monitoring physically separate but functionally related sensors, switches or transducers.
- Ensure that an alarm is raised if the expected response has not been established by a pre-set time following switching on of plant. Ensure that it is possible to operate any specified standby plant. Provide the operator with a facility to adjust the pre-set time delay.
- to give a percentage open reading.

310.250 FIELD CONTROLLERS - DATA MONITORING AND LOGGING: Ensure that hard and soft-points associated with a field controller can be logged. Ensure that the BMS operator can set the start/stop times and logging frequency at the operator

- workstation.
- Ensure that logging is selectable between fixed periods or on a rolling basis. •
- Ensure that each log can be defined in terms of log identification (point identification); units; and date/time stamp.
- Ensure that the operator can select all physical and soft-points for logging.
- Ensure that the field controller has sufficient memory to log the equivalent of seven days data at 15 minute intervals for 50% of the total number of physical points on the field controller.
- Ensure that when the logging capacity of a field controller is exceeded, the data can be automatically downloaded to the operator workstation and archived.

310.260 FIELD CONTROLLERS - ENVIRONMENTAL CONDITIONS: Temperature 0 to 50°C

Relative humidity 10% to 90% non-condensing.

- Ensure that the field controllers will operate in the electrical environment associated with building services plant rooms.
- Ensure that the EMC requirements specified in W60.310.100 are met. •
- Ensure that the field controllers are protected against the effects of moisture, dust, dirt and gases.

310.270 FIELD CONTROLLERS - INTERNAL POWER BACKUP:

- Provide internal power backup 72 Hours •
- a period of two years.
- Ensure that the battery is easily replaceable.
- Ensure that the interval between battery maintenance inspections is not less than 12 months. •
- Ensure that any battery monitoring functions defined in the Particular Inspection can be met.

310.280 FIELD CONTROLLERS - MEANS OF CONFIGURATION:

- Ensure that the field controllers can be fully configured directly via a laptop type computer and via the operator workstation.
- full upload and download capability.
- Ensure that configuration details can be easily altered by system operators.
- Ensure that access to make configuration alterations is restricted to operators with access authority through the use of passwords.

310.290 FIELD CONTROLLERS - USER INTERFACES:

• Analogue output. As variable currents (4-20mA) or as variable voltages (0-10V). Ensure that it is possible to characterise analogue outputs in order to obtain a near linear response from the

Ensure that the field controllers are capable of using measured feedback from an actuator position

Ensure that a non-rechargeable battery, if specified, can maintain the controller's clock function for

Ensure that the field controllers can be configured through the use of a configuration interface with

- Ensure that all field controllers can be accessed through the use of portable computers. •
- Ensure that access allows the display of all configuration details associated with the field controller • along with:
- Password protection for access with a minimum of two access levels. Ability to display all point data (both hard and soft). Ability to initiate and display logged data.
- Ability to display and alter set-points and time schedules.
- Ability to make alterations to control strategies.
- Ensure that field controllers incorporate a panel-mounted operator interface. Ensure that the interface includes the ability to:
- Provide password protection for access with a minimum of two access levels. Display all physical point data.
- Display and alter set-points and time schedules.
- Display the current date and time.
- Review and acknowledge alarms.
- Access logged data.

310.300 OCCUPANT CONTROLS - GENERAL:

- Ensure that the specified occupant controls can be linked to, and communicate over, the BMS communications network.
- Ensure that the occupant controls can control the relevant items of plant.
- Ensure that the status of each occupant controller can be viewed and overridden via the operator workstation.
- Ensure that the occupant controls allow: Adjustment by the occupants of the set-points. Definition, and adjustment by the BMS operator, of high and low limits for each set-point control.
- Provide a facility to allow the global alteration of set-point and high/low limits via the operator • workstation.
- Provide an override facility to allow plant operation during out of hours occupation.
- Ensure that the occupant controls are intuitive to use and clearly labelled.
- For temperature control ensure that hot/cold and/or red/blue indication is used for the occupant interface.
- For fan speed control ensure that fan fast/slow indicators are used.
- Ensure the +/- symbols are not used without clarification of the controlled function. •

310.310 OCCUPANT CONTROLS - TELEPHONE-BASED:

- Ensure that the PABX can be integrated with the BMS.
- Ensure that the occupant control functions can be performed via occupants' telephones. •
- Ensure that an alpha/numeric code can be used to change each specified control set-point.
- Ensure that the database relating specific telephones to specific items of plant can be easily altered and expanded.

310.320 OCCUPANT CONTROLS - OFFICE IT/INTRANET BASED: Ensure that the occupant controls are TCP/IP compatible.

310.330 CONTROL FUNCTIONS AND ROUTINES - GENERAL:

Provide a facility to automatically cycle selected actuators through their full range of movement outside normal operating periods with a periodicity set by the operator (in addition to normal automatic or manual control). Ensure that the cycle finishes as one complete operation. Ensure that any alarm conditions raised during the operation are inhibited as necessary.

Provide a facility to drive actuators to their open or closed positions at the end of plant operating periods.

310.340 CONTROL FUNCTIONS AND ROUTINES - BASIC CONTROL FUNCTIONS:

- Ensure that configuration routines necessary for direct digital control (DDC) are resident at the field controllers.
- Provide DDC of plant through algorithms giving proportional plus integral plus derivative control (PID).
- Provide two-position control.

• Provide raise-lower or three-point control.

- Allow the selection of either proportional control (P) or proportional and integral control (P+I) or • proportional and integral plus derivative control (P+I+D) modes independently for each relevant item of plant. Ensure that proportional, integral and derivative action times can be adjusted by the user.
- Allow the combination of more than one control loop by 'cascading', i.e. using the output signal from one control loop as the input signal to another control loop.
- Provide logic modules covering Logical combination of digital variables. Logic timer module. Logic readback module. Logic counter module. Logic delay module. Logic hours run module.
- Provide the following logic functions: AND. NOT AND (NAND).
- NOT OR (NOR).
- OR.
- Provide the following function modules as a minimum: Filter (applies exponential filter with gain to input signal). Rescale from (rescales an input of 0 to 100 to a user defined output and limits at these values). Rescale to (rescales the input to the output of 0 to 100 and limits at 0 and 100). Limit at (limits the output at user specified values). Limit to (limits the output to 0 or 100 percent at values specified by the user). Logarithm of input: Square root of input: Add to input: Multiply by input: Divide by input. Minimum (to select the minimum value from two or more inputs):
 - Maximum (to select the maximum value from two or more inputs); Average (to calculate the average value from two or more inputs).
- Comparator (to compare two inputs, when input X is greater than input Y output of one is produced otherwise the output is zero).
- Enthalpy (to calculate the enthalpy value from a temperature input and humidity input). Hysteresis (changes a digital state if the input changes outside a defined band). Analogue to digital converter (to change analogue value to binary).

310.350 CONTROL FUNCTIONS AND ROUTINES - CONTROL INTERLOCKS:

Frost protection

Provide frost protection routines to operate plant and pumps in order to protect building services systems and their components from frost damage.

- Provide the following two stages of protection: temperature, the selected pumps start and circulation is established through pipework The automatic standby plant is to operate on failure of the duty plant. that specified protective devices activate for other liquid systems. Provide a facility to allow frost protection to be logged together with data and time.
- Building/plant protection
 - Provide protection routines to operate the plant in order to protect the building fabric and its contents against the effects of low internal temperatures and of condensation.
 - heating system and related plant is turned on and heat supplied to maintain the air temperature at or above the protection set-point temperature.
 - Ensure that the building/plant protection routine overrides other control functions unless otherwise specified.
 - Ensure that protection operates whenever the normal heating is switched off.
- Safety interlocks

Analogue gate (digital signal switches output between two analogue input signals).

Ensure that when the outside temperature falls to the operator set minimum frost-protection systems and their components. Allow the operator to pre-select which plant is to be started.

Ensure that when the return temperature falls below the operator pre-set minimum, the full frost-protection facility is initiated. Ensure that for heating systems, the heat source is turned on and operated to maintain the return flow temperature above the pre-set minimum. Ensure

Ensure that if the internal air temperature falls below the pre-set protection temperature, the

- Ensure that all safety interlocks are hardwired and have precedence over all other control functions.
- Ensure that safety interlocks can only be reset manually and locally (not from the operator workstation).
- Ensure that all hardwired safety interlocks have corresponding software interlocks to prevent cascading nuisance alarms.

310.360 CONTROL FUNCTIONS AND ROUTINES - TIME SCHEDULES:

- Ensure that each field controller is capable of enabling plant according to multiple pre-set time programmes. Ensure that it is possible to schedule each item of plant for a minimum of three separate switching periods per 24 hours. Ensure that separate schedules can be defined for each day of the week.
- Ensure that individual time schedules can be grouped to form global time schedules. •
- Ensure that time schedules can be defined on a weekly basis on a single 'page/screen'.
- Ensure that time schedules can be defined 12 months in advance. •
- Provide a time schedule override facility to accommodate holiday periods, etc. •
- Allow fixed extensions and contractions to time schedules. Ensure that the time schedule reverts to the 'normal' switching periods following the extension/contraction period.
- Allow time schedules to be copied from existing schedules.
- Ensure that time schedules can be linked to optimum start/stop control facilities.
- Provide an optimum start/stop override facility for user-defined override days. Ensure that optimum start/stop control is enabled following the override period.
- Provide automatic switching between BST and GMT and back. Provide an operator override facility.
- Ensure that time schedules can accommodate leap years.

310.370 CONTROL FUNCTIONS AND ROUTINES - PLANT START/STOP CONTROL:

- Ensure that field controllers are capable of starting and stopping plant according to the sequences detailed as described.
 - Including any specific requirements for 'off' position or status of plant items, valves and dampers, etc.
- Ensure that field controllers are capable of automatically enabling standby plant on failure of duty • plant. Ensure that the field controllers can automatically report plant failure alarms at the operator workstation. Ensure that the failure of a flow switch or other device does not continuously cycle plant.
- Ensure that if a flow switch fails the operator has the option to force either the duty or standby • plant to come on.
- Provide the operator with the option to override any start/stop action configured within the field controllers. When reverting to normal automatic control, ensure that the original program is automatically reinstated and updated to the correct time.
- Provide delayed plant-starting facilities in order to reduce power surges. Ensure that it is possible to start plant sequentially by adjusting the delay period for each item of plant.
- Ensure that delayed plant-starting occurs following power failure/re-instatement and plant shut down/restart on fire/fireman override.
- Provide the operator with a facility to specify minimum on/off cycle times and/or the maximum number of starts per hour for specified items of plant.
- Provide a plant protection routine that enables the operator to select and automatically run items of plant for short periods during out of season shut-down. Ensure that the run periods are operator adjustable.

310.380 CONTROL FUNCTIONS AND ROUTINES - SEQUENCE CONTROL:

- Provide sequence control routines to automatically sequence the operation of multiple items of plant by monitoring load parameters and efficiently matching the plant to the load.
- Ensure that it is possible to define different automatic sequences of control.
- Provide the operator with a facility to override the automatic sequence and define an alternative sequence.
- Ensure that the set-point values for each control action are variable and adjustable by the operator. Ensure that associated alarm limits are modified automatically.
- Allow the operator to adjust switching control differentials to prevent short cycling.

- Ensure that the routines also include a facility to operate all plant ancillaries associated with • sequence control unless they have been specifically excluded.
- Ensure that the routines include the facility to proceed with the defined sequence when one of the otherwise). Ensure that failed items of plant are removed from the sequence.

310.390 CONTROL FUNCTIONS AND ROUTINES - PLANT ROTATION CONTROL:

- Ensure that the rotation control can be provided on the basis of run hours, elapsed time and calendar basis.
- Provide routines to ensure that when the maximum number of start/stop cycles for a particular or changing the lead machine.
- Ensure that each item of plant operated under rotation control can operate at any stage of the rotation sequence.
 - 1-2-3.
 - 2-1-3.
 - 3-2-1.
- Ensure that the plant rotation control can accommodate a plant failure condition, in such a way that a failed item of plant is 'replaced' by the next in the rotation cycle. Ensure that an alarm condition is raised in response to plant failure.
- Ensure that rotation control can be initiated outside normal operating periods.

310.400 CONTROL FUNCTIONS AND ROUTINES - OPTIMUM START/STOP FOR HEATING SYSTEMS:

- Provide an optimum-start routine for the heating system to compute the daily minimum pre-heat period necessary to achieve target comfort conditions at the start of occupation. Provide an optimum-stop routine to compute the earliest time for the heat source to be shut down in order to retain minimum target comfort conditions in the zone at the end of occupation.
- Ensure that the optimum start/stop routines have access to the system real time clock, calendar facility and time programme to define the occupation periods.
- Ensure that it is possible to apply optimum start/stop control both to individual zones and overall plant operation.
- Ensure that the routines operate the heating and ventilation plant as necessary to achieve the required target conditions, and that the heating and cooling systems do not conflict in any controlled zone.
- Provide independently adjustable start and stop comfort conditions.
- Ensure that weather compensation control can be inhibited during pre-heat periods. •
- Ensure that the heating plant goes into full heating mode with full re-circulation of air (if relevant). Ensure a return to normal fresh air control following the optimum start period.
- Provide the optimum start/stop routines with an automatic self-learning process that seeks to reduce any error in achieving the target conditions at the target time.
- Provide the operator with the facility to adjust the following parameters: Target temperature for optimum start. Maximum pre-heat period.
- Target temperature for optimum stop.
- Minimum space temperature for out-of-hours periods.
- Enable/disable the self adaption function.

The default limit time for handover to the weather compensation routines after the start of occupation.

Ensure that the internal and external air temperature sensors associated with the optimiser are positioned correctly in order to provide representative readings.

310.410 CONTROL FUNCTIONS AND ROUTINES - OPTIMUM START/STOP FOR COOLING SYSTEMS:

• Provide an optimum-start routine for the cooling system to compute the daily minimum pre-cool period necessary to achieve target comfort conditions at occupation start time. Provide an optimum stop routine to compute the earliest time for the cooling system to be shut down in order to retain minimum comfort conditions in the space at the end of occupation.

items of plant in the sequence is isolated or fails to operate (unless the safety requirements dictate

plant is reached, then its schedule is automatically modified, eg by rotating the standby equipment

Provide an ISDN link. •

310.460 SYSTEM COMMUNICATIONS - COMMUNICATIONS PROTOCOLS:

- Field-level protocols
 - Ensure that the selected protocol can: Run on the required communications media. Provide a communications throughput sufficient for the intended application. Provide appropriate network topology options. Allow sufficient maximum physical segment length. Provide sufficient maximum distance between nodes. Make use of off-the-shelf network devices such as repeaters, bridges and routers.
- Ensure that the protocol is compatible with fully developed network configuration and management tools.

310.470 SYSTEM COMMUNICATIONS - DIRECT INTEROPERABILITY: Ensure that each of the protocol's objects and attributes are consistent with the achievement of the specified level of direct interoperability.

Ensure that each of the protocol's arrangements for physical connection, data packaging, network management and error detection/correction are the same.

310.480 SYSTEM COMMUNICATIONS - GATEWAYS: Ensure that the gateway can

Transfer the specified maximum number of points. Limit loss of functionality to the level specified. Add functionality where specified.

Ensure that the specified contingency and alarm measures in response to a failure of the gateway are met.

Ensure that the gateway can be modified in response to any future changes relating to the type and amount of data transferred over it.

Clearly define who has contractual responsibility for the implementation of the gateway.

310.490 SENSORS AND DETECTORS - GENERAL: Ensure that all signals are compatible with interfaces fitted to associated field control devices. Ensure that the performance of the sensors and detectors are not adversely affected by the following variations in power supply conditions: 230V+10%, -6%. Ensure that connections to sensors and detectors are of a screw down clamp type or self-locking

Ensure that sensors, detectors and meters are installed in accordance with the manufacturer's instructions and recommendations.

Ensure that calibration conditions for meters are fully documented in the O&M manuals and clearly marked on or adjacent to the meters.

Ensure that any calibration and maintenance requirements for sensors, detectors and meters are documented in the O&M manuals.

310.500 SENSORS AND DETECTORS - TEMPERATURE SENSORS: Ensure that temperature sensors comply with the minimum requirements of the following table. Table 1 Temperature sensors - minimum requirements Fluid Temperature range °C Sensor accuracy °C

Air -10 to + 40 +/- 0.5 Flue gas +30 to + 850 +/- 3.0 (0.75% of FSD above 450° c) Chilled Water -10 to +30 +/-0.25Water -10 to +150 +/- 0.5

310.510 SENSORS AND DETECTORS - HUMIDITY SENSORS: Ensure that humidity sensors comply with the minimum requirements of the following table. Table 2 Humidity sensors - minimum requirements Sensor Humidity range Sensor accuracy

- Humidity 10 to 90% +/- 5% RH
- **KJ TAIT ENGINEERS**

- Ensure that the optimum start/stop routines have access to the system real-time clock, calendar • facility and time programme to define the occupation periods.
- Ensure that routines are capable of operating the ventilation system for building purging prior to optimum start of cooling plant.
- Ensure that it is possible to apply optimum start/stop control both to individual zones and overall plant operation.
- Provide routines to operate chillers and ventilation plant as necessary to achieve the required target conditions while ensuring that heating and cooling systems do not conflict in any controlled zones.
- Provide the operator with the facility to adjust the following cooling system optimum start/stop parameters.

Target temperature for optimum start.

Maximum pre-cool period.

Earliest time for building purging during out of hours period.

Inside and outside temperature limits for building purging.

Separate time/temperature relationships for optimum start and optimum stop. Minimum space temperature during building purging.

 Ensure that the internal and external air temperature sensors associated with the optimiser are positioned correctly in order to provide representative readings.

310.420 CONTROL FUNCTIONS AND ROUTINES - WEATHER COMPENSATION:

- Provide weather compensation routines to control the heating system in relation to external weather conditions. Provide the operator with the option to adjust temperature and flow-rate settings for the heating system to re-define the weather compensation.
- Provide automatic adjustment to the weather compensation by comparing measured and required space temperatures with the outside conditions, and provide the facility to correct the compensation where a significant difference between the two space temperatures occurs.
- Ensure that abrupt changes in the heating system performance or space temperature shall not adversely affect the automatic adaptive compensation process.
- Provide a single weather compensation curve for each zone irrespective of the number of temperature sensors provided in the zone.
- Ensure that the routines respond to the reset signals arranged to achieve boost, night set-back and boiler safety.
- Ensure that air temperature sensors associated with the compensator are positioned correctly in order to provide representative readings.

310.430 CONTROL FUNCTIONS AND ROUTINES - LIGHTING CONTROL:

- Ensure that the appropriate field controllers can control lighting in the following ways:
 - On/off switching of external and internal lights at fixed times in accordance with the weekly schedules defined by the operator.
 - The dimming and switching of internal lights based on the signals from external and internal photo sensors. This is to incorporate a user-adjustable delay.
 - Switching internal lights off according to occupancy detectors.
 - The on/off switching of external lighting based on signals from an external photo sensor.
- Ensure that the automatic control of lighting by the BMS is capable of being overridden by local switches and by the operator at the operator workstation.
- Ensure that the lighting control system can be manually controlled in the event of failure of the BMS.
- Provide a facility to monitor, but not control, the emergency lighting.

310.440 SYSTEM COMMUNICATIONS - GENERAL:

- Ensure that the system communications allows the full transfer of monitored, logged, alarm, backup and configuration data between the operator workstation and addressable field controllers.
- Ensure that the communication protocol selected seeks to achieve error-free data transfer. Ensure that the protocol includes an error detection check; includes an error correction and/or re-try technique; limits re-transmission; and raises an alarm condition on failure.

310.450 SYSTEM COMMUNICATIONS - COMMUNICATION DEVICES:

Ensure that connections to telecommunication systems complies with BS 6701.

connectors.

Allow sufficient maximum number of nodes for each physical segment and the logical network.

310.520 SENSORS AND DETECTORS - AIR VELOCITY SENSORS:

W60

Ensure that air velocity sensors comply with the minimum requirement of the following table. Table 3 Air velocity sensors - minimum requirements Sensor Sensor range Sensor accuracy Pitot static tube 3 to 80 m/s +/- 2% of reading Thermo-electric 0 to 20 m/s +/- 3% of reading or anemometer +/- 0.1 m/s whichever is greatest 310.530 SENSORS AND DETECTORS - AIR PRESSURE SENSORS: Ensure that air pressure sensors comply with the minimum requirements of the following table. Table 4 Air pressure sensors - minimum requirements Sensor Sensor range Sensor accuracy Air pressure - +/-2% of reading 310.540 SENSORS AND DETECTORS - FLOW METERS: Ensure that meters comply with the minimum requirements of the following table. Table 5 Flow meters - minimum requirements Meter Meter range Meter accuracy

Fuel flow meter 0 to 10 Hz 3% of reading Water flow meter >> 5:1 2% of reading Electricity meter - 1.5% of reading

310.550 SENSORS AND DETECTORS - SENSOR TIME CONSTANTS: Ensure that the following sensor time constants are met. Table 6 Sensor time constants Measure medium Time constant

Space/outside air temperature 300s still air Duct air temp 120s @ 1m/s Water 30s @ 1m/s Flue gas 60s @ 1m/s Relative humidity 300s @ 1m/s Light Instantaneous Flow - water 5s Flow - liquid fuel or gas 5s

320.000 DESIGN AND INSTALLATION:

320.010 CHOICE OF CONTROL STRATEGY:

Ensure that the selected control strategies are appropriate for the building services systems and their intended application.

Ensure that selected control strategies are robust and not over complex.

Where a novel control strategy is to be implemented, ensure that testing/evaluation is performed to confirm its suitability.

Ensure that wherever possible selected control strategies are those provided in the BSRIA Library of Control Strategies: AG 7/98.

320.020 DESIGN FOR COMMISSIONABILITY:

Ensure that the BMS specification details required for commissioning are made available to the BMS commissioning engineer.

Ensure that all field controllers, sensors and controlled devices are easily accessible and can be removed for testing and future maintenance.

Liaise with the mechanical contractor to ensure that air handling units are provided with appropriate access doors.

Ensure that access is available to all control devices.

Ensure that the requirements of the following documents are met:

Space and weight allowances for building services plant - inception stage design. TN 9/92. BSRIA Space allowances for building services distribution systems - detailed design stage. TN 10/92. **BSRIA**

Ensure that sensors are installed correctly in order to give representative readings. Ensure that reference labels are attached to each control device.

320.030 FUTURE SYSTEM EXPANSION: Ensure that the BMS is capable of dealing with a future 20% increase in the number of points without compromising the system's functionality or speed of operation.

320.040 DESIGN FOR MAINTAINABILITY:

Ensure that a full O&M manual is prepared which reflects any system changes made during the installation and commissioning stages.

Ensure that adequate access to BMS equipment and components is provided. Ensure that all components and wiring are identified by a consistent numbering system.

- General
 - This part of the specification covers extra-low voltage wiring (as defined by BS 7671), i.e. signal and data communications wiring.
 - All cabling must be adequately protected from the environment through which it passes to avoid the possibility of mechanical damage or electromagnetic interference.
 - Install cabling and conduits associated with sensors in a manner that prevents spurious transfer of moisture and heat etc from external sources to sensing devices.
 - Ensure that all wiring is carried out in a neat manner by skilled operatives. Clip wiring to form a loom and route it to avoid interference with the correct operation or maintenance of other components.
- Cable type and application
 - Ensure that the type of cables, installation and planning comply with the BMS manufacturers recommendations and the project's electrical specification.
 - Ensure that the types of cable installed do not prejudice satisfactory operation of the BMS. • Ensure that the cross-sectional area of cables is sufficient to ensure that sensor circuit
 - resistance limits are not exceeded.
 - Ensure that the method of installation and routing of cables does not compromise the satisfactory operation of the BMS.
 - Ensure that the following minimum separation distances (in mm) between data/analogue signal cables and power cables are adhered to (not required if data/signal cables are in steel conduit or trunking).
- Table 7 Minimum separation distances between signal cables and power cables Signal cable Power cable Power cable

Unscreened Armoured steel wire

Plain 150 mm 125 mm

Unscreened

twisted pair 75 mm 50 mm

- Screened 0 mm 0 mm
- Identification
 - Ensure that all cables have identification sleeves at their terminations which combine the requirements of BS 7671 with those for specific circuit identification. Ensure that the identification is consistent with the relevant wiring diagrams.

- 320.060 FIXING AND CONNECTION USE OF EXISTING CABLE AND WIREWAYS: Confirm by testing or obtain appropriate certificates from original suppliers that any existing means of network communication is of a suitable standard for satisfactory operation of the BMS. Ensure that any tests performed comply with BS EN 50174.
- Ensure that the potential corruption of data cannot arise from: Other installations not connected to, but in close proximity to, the route of existing cabling Other electrical services using existing cabling Other adjacent cabling.
- State in writing at the time of tender whether or not existing cabling is suitable.

320.070 FIXING AND CONNECTION - CONNECTION TO PLANT AND CONTROL EQUIPMENT:

- General •
 - Provide all devices and terminals necessary to connect the BMS to items of plant and control equipment.

- 320.050 FIXING AND CONNECTION CABLING INSTALLED AS PART OF THE BMS CONTRACT:

- Take account of any existing services that have to remain in continuous operation. Agree with the Project Supervisor the method by which the BMS equipment can be installed without disrupting the operation of the building services.
- Where plant and control equipment are supplied by others, provide the Project Supervisor with adequate details of installation requirements. Provide this information in time and in sufficient detail to enable any other installers and their suppliers to incorporate the BMS connection facilities before delivering their equipment to site.
- Where plant is subject to warranty by others, obtain clearances in writing from those ٠ concerned that the proposed modifications do not invalidate the warranties.
- Ensure that modifications carried out as a result of the contract are fully documented and do not affect the satisfactory operation of safety devices connected to any plant or systems affected directly or indirectly by the BMS works. Carry out proving tests to the satisfaction of the Project Supervisor.
- Ensure that the use of existing relays, contactors, starters and switches as part of the BMS • installation is fully documented.
- Safety interlocks •
 - Provide interlocks as scheduled to establish and maintain safe/pre-determined plant conditions under all modes of operation including loss, reduction and restoration of power.
 - Ensure that all safety hard-wired interlocks are wired to failsafe on loss of power, or on relay coil failure, or on open circuit, eg cable breakage.
 - Ensure that all interlocks use voltage-free contacts and 24v AC or DC relays and field wiring.
 - Complete all wiring and testing of all hard-wired safety interlocks to ensure safe and/or sequenced operation of the plant before the BMS is set to work. Arrange interlocks to prevent unsafe or out of sequence operation of the plant by the BMS.
 - Ensure that plant does not operate using the BMS until all interlocks have been tested to the satisfaction of the Project Supervisor.
- Manual control •
 - Provide manual control facilities to enable plant maintenance/facilities staff to operate essential plant in the event of BMS failure and for routine test purposes. Ensure that the facilities include:
 - Start/stop operation of the plant.
 - Automatic operation of motorised control devices such as valves and dampers, etc if the BMS is operating.
 - Manual setting of motorised control devices such as valves and dampers, etc if the BMS has failed.
 - Ensure that the manual control facilities do not override safety devices or hard-wired interlocks.
- Volt-free contacts
 - Ensure that the contact materials are suitable for use in the installation and at the required • voltages and currents.
 - Use screw down or locking spade terminals for electrical connections to volt-free contacts.
- Relays
 - Use demountable relays of the totally enclosed type.
 - Use screw down clamp or locking spade-terminals, and ensure they are shrouded.
- Control equipment
 - Obtain advice from the relevant supplier when additional facilities are to be fitted to control • equipment supplied by others.
 - Use the knockouts, cable routes and terminals, etc incorporated into the design of control devices.
- Packaged plant •

Ensure that connections to packaged plant are made within the packaged plant control panel. Fit an additional enclosure where this is not possible. Ensure that all connections between the BMS and packaged plant are 24v maximum.

320.080 FIXING AND CONNECTION - ADDITIONAL PROVISIONS FOR RETROFIT INSTALLATIONS:

Arrange for any necessary control modifications to existing plant to be carried out by the original supplier (with the exception of starter panels). Give the supplier details of the requirements for

connection of equipment to the BMS. State the name of the supplier in the Tender together with a priced schedule for the necessary work.

- Where details of existing plant are not available from the original supplier or from record documents, provide a specialist conversant with the particular type of plant to carry out any necessary modifications. Provide the specialist with the details of the BMS connections required. State the name of the specialist in the Tender together with a priced schedule for this work. Advise the Project Supervisor of any difficulties with connections.
- Advise in writing at the time of tender of any potential delay to the contract arising from the difficulty of providing the necessary BMS connections to the plant.
- Use existing relays and volt-free contacts where feasible.
- Fit auxiliary contacts to contactors, etc where adequate space is available. Install additional relays if the space is not adequate.
- Obtain advice from the original supplier when additional facilities are to be fitted to existing control equipment.
- Use the control manufacturer's standard accessories to provide any additional contacts, limit switches and potentiometers, etc.
- Use the knockouts, cable routes and terminals, etc incorporated into the design of control devices wherever possible. Obtain approval from the Project Supervisor for ad hoc fixings and modifications to control devices before action is taken on site.

320.090 FIXING AND CONNECTION - CABINETS FOR BMS EQUIPMENT:

- Construct BMS equipment enclosures to give the minimum degree of protection to IP54 in accordance with BS EN 60529. Where the enclosure is fitted inside another panel (eg a motor control centre) the protection can be reduced to IP41.
- Ensure that access doors are of a rigid construction and mounted on stout metal hinges capable • of supporting the full weight of the open door. Ensure that doors will not sag or drop when open. Fit doors with stout locking handles to prevent access by unauthorised personnel.
- Allow safe access to the BMS equipment where the BMS equipment is incorporated into another control panel without having to isolate the panel.

320.100 FIXING AND CONNECTION - CONTROL PANELS:

- Control panel design
 - Ensure that the requirements of prEN 13646 are met.
 - Ensure that the layout of control panels reflects the layout of the plant being served. Ensure that indicators and controls for associated plant are grouped.
 - Ensure that all doors on panels containing exposed dangerous voltages are provided with interlocked isolators such that the door cannot be opened except with the isolator in the 'off' position. Ensure that isolation complies with BS 7671.
 - Ensure that equipment that requires on-line adjustment and testing by non-electrically qualified personnel is accessible and usable without interrupting the supply or overriding safety interlocks. Ensure that in general, field controllers are not located within control panels where isolation is necessary to gain access.
 - Design panels to maintain all components within their environmental tolerance limits taking into account ambient environmental conditions. Install fans with thermostatic control and air extract grilles and air intake grilles with replaceable filters where mechanical ventilation is required to control the environmental conditions. Ensure that the specified ingress protection (IP) ratings are maintained.
- Control panel construction
- Construct control panels to IP54. Construct the panels using sheet steel, folded and seam welded to form a rigid self-supporting structure. Ensure that bracing and stiffening is used as necessary to take the weight of internal components and control assemblies. Ensure that no sharp corners are present.
- Ensure that control panels weighing more than 50 Kg including installed components are fitted with evebolts to facilitate delivery and installation.
- Ensure that panels are provided with adequate undrilled and/or detachable gland plates of sufficient size and strength to accept glands for all types of cable conduits and cable trunking intended for termination within the panel.
- Arrange all wiring within the panel in looms and/or perforated trunking. Ensure that all cables are run continuously from terminal to terminal without intervening joints.

W60

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CENTRAL CONTROL/BUILDING MANAGEMENT**

- Ensure that all terminations are fully shrouded, recessed or otherwise protected against ٠ accidental contact.
- Ensure that where live equipment cannot be isolated it is covered with a perspex shield ٠ carrying appropriate warning labels in addition to specified shrouding.
- Ensure sufficient spare capacity in cable ways and trunking to comply with BS 7671.
- Ensure that flexible looms are used to connect door mounted to interior-mounted components such that wires will not weaken or break with repeated door openings. Arrange the loom to avoid pinching or looping when the door is closed and ensure that it is fully supported at each end.
- Control panel labelling
 - Ensure that all panels and individual panel sections are provided with exterior labels to BS • 5499-5 indicating the voltage within the panel along with clear warnings of risk and instructions for isolation. Display requirements for informing the BMS supervisor and/or disabling alarms prior to isolation of control circuits.
 - Label all switches, controls and indicators on control panels as to function and associated plant.
 - Fix a notice to the front of the panel warning of the need for isolation elsewhere if the panel does not totally control the electricity supply to associated plant.
 - Identify all cables with permanently fixed ferrules. Ensure that the numbering corresponds to the numbers fixed to the terminals. Ensure that identification and coding matches that used on the design drawings, schematics and schedules.

320.110 SENSORS - GENERAL:

- Ensure that sensors can be removed for testing and maintenance.
- Ensure that a tight-sealing test hole is provided adjacent to every duct sensor. Ensure that Binder test points, or similar, are provided for pipe sensors.
- Provide a sufficient length of spare cable so that the sensor can be removed without disconnecting the wiring.
- Mark and record the location of concealed sensors (e.g. in false ceilings and shafts, etc).
- Provide a labelling plate for each sensor.
- Take account of the active and inactive sections of a sensor probe.
- Take into account the effects of orientation on the functioning of the sensor. •
- Take into account: • Minimum/maximum ambient temperature. Ambient humidity. Vulnerability to spray water and/or vibration. Explosion protection. External influences.

320.120 TEMPERATURE SENSORS:

- Pipe-mounted immersion sensors
- Ensure that the full active length of the sensor is immersed in water.
- Install sensors against the direction of flow.
- Install at the correct angle.

The sensor should be installed diagonally in a bypass pipe or in a bend if the active length of the sensor probe is longer than the diameter of the pipe.

Allow an adequate space between the sensor and the obstruction so that the sensor can be removed from the immersion pocket.

Ensure that immersion pockets are made from stainless steel of the appropriate pressure rating. Ensure that immersion pockets are filled with a heat conducting compound.

A test point or an additional immersion pocket, adjacent to the sensor, should be provided for test purposes.

An adequate distance (10 x pipe O) between the mixing point and the sensor should be provided when mixing water at different temperatures to take account of stratification.

- Surface temperature sensor water Ensure a smooth clean contact surface and fill the space between the sensor and the pipe with a heat conductive compound to improve thermal conductivity.
- Immersion sensors for air (ducts) The full active portion of the sensor probe should be exposed to the air flow.

Ensure that the active portion of the probe is located central to the airflow. A test hole should be provided adjacent to every sensor with plug when not in use. Probe-type sensors should not be used in areas where stratification can occur, eg downstream of heating and cooling coils, etc (see averaging sensors). Sensors which are positioned near to coils should be shielded against the radiative heat transfer. Return air duct sensors should be located near to the occupied space to avoid heat gain or loss and radiant effects influencing readings. Sensors must be positioned in an area of representative air flow. This applies to all duct sensors

but particularly the return air sensor which may be located in the ceiling plenum. The likely cleanliness of the air should be considered when selecting sensors. Sensors representing zone temperature should be offset to account for heat gains e.g. space temperature stratification or if light fixtures are used as the return air path. Sensors should only be used in return air ducts where air is continuously extracted.

- Capillary sensors with probes The device head must be higher than the sensor probe. The sensor probe should be tilted downwards. The ambient temperature at the device head must always be higher than the temperature to which the sensor probe is exposed. The sensor element must always point downwards. The capillary should not form a U-shape. The capillary should not be bent too tightly (radius of bend >50mm).
- Averaging sensor (for use in ducts/AHU) Allow a distance of at least 50 mm between any heat exchanger and the sensor. The entire length of an averaging sensor must be fully inside the air-duct. The sensor element must be evenly distributed over the full cross-section and adequately secured to prevent vibration.

washers are used for humidification.

•

- Frost protection thermostat Leave a spare capillary loop of 20 cm to enable sensor testing outside the duct/unit. The measuring head and the test loop of the thermostat must be located inside the ductwork and downstream of the heat exchanger if the ductwork is outdoors or in an unheated space. The capillary should be installed in the air flow, downstream of the first heating coil exposed to frost. The capillary must be installed diagonal to the heat exchanger pipes or in a serpentine manner at right angles to the pipes.
- Room sensor Sensors should be installed at a height of 1.5 m in occupied spaces and at least 50 cm from any adjacent walls.

The sensor should be located in an area representative of the entire control zone. The sensor should be located away from heat sources, e.g. office IT equipment. The sensor should be located in the area it controls. Sensor locations near air currents generated by diffusers or openable windows, for example, should be avoided.

The sensor must not be exposed to direct solar radiation. Avoid external walls except were unavoidable. Use insulated backplates. Avoid recesses and alcoves.

The conduit entry points to the sensor wall box should be sealed where there is a risk of air from another zone flowing over the sensor element.

Do not install near or under lamps or above radiators. Avoid chimney walls.

Ensure accessibility for inspection/verification

- Do not install directly adjacent to doors.
- Do not install behind curtains.
- Do not fit to walls concealing hot-water pipes.
- Outdoor air temperature sensors Do not install on facades affected by significant rising heat, or facades which will be heated by solar radiation (fix sensors to a north-facing wall or use solar shields). Avoid chimney walls and other walls subject to high internal heat gains.
- Do not install under eaves. Do not install above windows.
- Do not install above ventilation extracts.

The sensor element should be installed in the air flow, downstream of the eliminator plate when air

An alternative to an external mounting is to locate the sensor in the AHU intake duct. This should ideally be upstream of the intake damper. Where this is not possible it must be a suitable distance before re-circulated air and mechanical devices to avoid their effects.

320.130 HUMIDITY SENSORS:

Humidity sensor/stat. - duct

The air velocity in the vicinity of the sensor must not exceed 10 m/s (a perforated steel plate cover can be used).

The sensor must not be located in deadlegs (super-saturation can occur in areas where there is no air flow).

A test hole must be provided downstream of the sensor, plugged off when not in use.

The sensor should be positioned beyond the spray distance of humidifiers.

Humidity sensor/stat. - room

The sensor should be installed at a height of approximately 1.5 m in the occupied space and at least 50 cm from the adjacent wall.

Avoid locations where the sensor will be exposed to direct solar radiation.

- Avoid external walls except were unavoidable. Use insulated backplates.
- Avoid alcoves and recesses.

Do not install near lamps or above radiators.

Do not fit to chimney walls.

Do not fit directly adjacent to doors.

320.140 PRESSURE SENSORS:

Pressure - general •

Pressure sensors are affected by orientation.

The pressure tubes must be provided with a binder point near the device head for test purposes. The connection must be fitted with a bypass with a stop valve to avoid overload on one side when manipulating the sensors and to enable zero calibration. Isolating valves should also be fitted. The sensor should be installed on a vibration-free surface or vibration-proof base. The pressure-tapping point must not be located in turbulent air flow. Provide 6 x O/D upstream

and 6 x O/D downstream of straight duct or pipe without obstructions.

Pressure - air •

Probes for measuring static pressure should be installed parallel to the flow. The differential pressure measuring tube should be correctly sized.

The tapping point should not be located where it will be affected by obstructions to the flow.

Pressure - liquids

Use a damping coil to avoid transferring vibrations (horizontal loops to avoid trapped air bubbles and condensate).

The device must always be installed in a location which is lower than the sensing point.

- Do not measure at the top of a pipe (trapped air, bubbles) or at the bottom (dirt).
- Pressure gases

When measuring vapour gases the device must always be installed in a location which is higher than the sensing point.

Measure at the top of the pipe to prevent condensate from entering the pressure tube.

320.150 FLOW VELOCITY/FLOW RATE SENSORS:

Differential pressure for flow monitoring - liquids • There should be no stop valves or balancing valves between the sensing points on the pipework.

Differential pressure for flow monitoring - air Ensure a steadying zone upstream and downstream of the orifice plate/flow grid, etc. The flow or differential pressure must not be monitored where there is a variable resistance such as a filter or fan, etc.

- Velocity sensors • Sensors should be positioned at an adequate distance from bends, tees, fans and coils such that the centre line velocity is representative of the average velocity. A single point sensor should be located at a distance from the centre of the duct equal to 0.25 x the duct radius.
- Wilson flow grid

Averaging velocity sensors across the duct, e.g. Wilson flow grid or multi-point averaging pitot tubes, should be used where the minimum separation distance from a flow disruption is not available. Ensure that the Wilson flow grid is sized correctly for each duct size.

320.160 INDOOR AIR QUALITY SENSORS:

- CO₂ and mixed-gas sensors room mounted Ensure that the sensor is located in a representative location, e.g. on an open wall 1.5 to 3 m above the floor.
- Ensure that the sensor is not mounted in niches or bookshelves or behind curtains. Ensure that the sensor is not located where people are continuously present (within 1 or 2 metres).
- CO₂ and mixed-gas sensors duct mounted Ensure that the sensor is located in the return air duct as close as possible to the room extract point(s).

Ensure that the sensor is located in the vertical position. Ensure the correct orientation of the duct probe with respect to the airflow. Ensure that the sensor is not installed in a vertical position with the head at the bottom.

320.170 ACTUATORS:

- Ensure that actuators and linkages for valves and dampers operate smoothly from fully open to fully closed without binding and with adequate torgue to overcome the resistance of the actuator mechanism and the flow and to provide the specified close off ratings.
- Ensure that linkages are clearly marked with the clamping position such that after maintenance or replacement the mechanism is able to operate correctly.
- Fit actuators with visual position indication. •
- Ensure that there is sufficient space above the actuator so that it may be removed for testing or • maintenance.
- Include position feedback devices suitable for connection to the BMS. •
- damper in the event of actuator failure.
- Ensure that actuators are electrically and mechanically protected from the effects of valve or damper seizure.
- of isolation by manual isolator or plug and socket connection.
- Ensure that, during commissioning, valve actuators are fitted in a fully closed/bypass position where they are being fitted to valves which push against a spring.

320.180 VALVES:

- General
 - Ensure that valves have the correct authority without excessive pressure drop.
 - fluid system.
 - Ensure that valves will pass the required flow at a pressure drop within the maximum differential pressure rating of the valve.
 - Check for out-of-balance forces, particularly during operation of a three-port valve.
 - Where possible ensure that valves are not installed with their spindles in the horizontal • they are as near as possible to the vertical.
 - Ensure that valves are not installed with the actuator at the bottom.
- Modulating valves
 - The following additional considerations apply for modulating valves:
 - Ensure system operating pressures, test pressures, pump heads and pressure drops through heat exchangers and associated pipework are known before control valves are selected.
 - applications.
 - Select valves with port characteristics appropriate for the intended function.
 - Ensure that all modulating control valves are selected for equal percentage or linear valve position and heating/cooling power as delivered to the air or water-based system.

W60

Ensure that actuators incorporate a disconnection device to allow manual operation of the valve or

Use 24v actuators wherever possible. Where line voltage actuators are used, provide local means

• Ensure that valve bodies are suitable for the medium, the temperature and the pressure of the

position. If valves cannot be installed with their spindles in the vertical position ensure that

Select valves to provide an authority of 0.3 to 0.5 for diverting applications and 0.5 for mixing

characteristics according to system type, to provide near linear characteristics between the

Ensure that the rangeability of the selected valves is large enough to provide stable control under low load conditions.

320.190 VALVE SIZING REQUIREMENTS:

- All types of valves and applications Parameter - Body pressure rating. Requirements - To exceed system test pressure.
- All 2-port valves • Parameter - Close-off pressure rating. Requirements - To exceed pump or system full differential pressure.
- All 3-port valves Parameters - Close-off pressure rating. Requirements - To exceed out of balance pressures
- All types of valves and applications Parameters - Maximum leakage coefficient. Requirements - 0.05% kv.
- 2-port isolation valves Parameters - Pressure drop at full flow. Requirements - Select at line size for minimal pressure drop.
- 2-port modulating valves Parameters - Pressure drop at full flow. Requirements - Select kv value for pressure drop within an agreed range.
- 3-port modulating valves Parameters - Pressure drop at full flow. Requirements - Select kv value for 30% - 50% authority against coil or circuit pressure drop.
- Isolation valve Parameter - Characteristic.
- Modulating valves (plant valves and zone reheater coil valves) Parameters - Characteristic. Requirements - Equal percentage.
- Modulating valve (fan coil units) Parameters - Characteristic. Requirements - Equal percentage (preferred) or linear.
- Modulating valves (independently pumped mixing and injection circuits) Parameter - Characteristic. Requirements - Linear.

320.200 DAMPERS:

Provide visual position indicators on all damper actuators installed so that they can be seen from the plantroom floor.

Ensure that damper characteristics are as linear as possible.

Ensure that modulating dampers are sized correctly to give adequate authority.

320.210 COMMUNICATION NETWORKS - GENERAL:

- Ensure that all addressable control devices can be addressed over the communications network. •
- Ensure that no cross corruption of data occurs when the BMS shares a communication network with other IT-based systems. Ensure that permission has been given by the IT manager to connect BMS components onto the IT network.
- Ensure that network testing, identification and documentation comply with BS EN 50174.
- Ensure that all network devices such as routers and bridges are compatible with the network and are capable of operating such that the required throughput of data is achieved.

320.220 COMMUNICATION NETWORKS - STRUCTURED CABLING:

- Application The controls specialist will be responsible for the installation of the BMS network to allow commissioning works to be completed. This network will then be added to the clients network upon completion of works.
- Ensure that the selected BMS components are suitable for operating on the structured cabling system.

- Ensure that the selected BMS topology (star wired, chained or bus-based) is appropriate for the • structured cabling system.
- Ensure that each addressable BMS device can be addressed over the structured cabling system.
- Where BMS components are specified to be powered from the structured cabling system ensure that the power available is sufficient. Ensure that overheating of the structured cabling system will not occur.
- Ensure that any changes to the structured cabling system are reflected in updated documentation.

320.230 COMMUNICATION NETWORKS - INTRANET AND INTERNET APPLICATIONS: Ensure that the BMS devices to be directly connected onto the Intranet/Internet are TCP/IP compatible.

Ensure that the data security requirements of BS 7799-2 and BS ISO/IEC 17799 are met.

320.240 COMMUNICATION NETWORKS - MAINS-BOURNE SIGNALLING: Comply with the requirements of BS EN 50065-1. Provide the necessary equipment to ensure that there is no mutual interference between the signalling system of the electricity utility and mains-borne signalling of the BMS.

320.250 COMMUNICATION NETWORKS - RADIO COMMUNICATIONS:

- Ensure that the radio transmitter/receiver and the BMS components are adequately powered.
- Ensure that radio communications devices and associated BMS components are easily accessible to allow the change of batteries.
- Ensure that the attenuation of radio signals does not hinder effective data communications.

320.280 INTEGRATION WITH FIRE DETECTION SYSTEMS - INTEGRATION FOR CONTROLS:

- Provide fail-safe, hard-wired interlocks using volt-free contacts between the BMS field controllers and items of plant listed and as described.
- Use volt-free contacts and 24v AC or DC interlocks.
- Use relay logic and/or microprocessor-based logic.
- Ensure that building services control actions operate correctly in response to the status of the fire detection system.

320.300 INTEGRATION WITH SECURITY DETECTION SYSTEMS - ACCESS CONTROL SYSTEMS:

Application Provide occupancy level information for the main lecture theatre, to the BMS and display on BMS graphics.

330.000 PRODUCTS/MATERIALS:

330.020 MOTORISED VALVES:

- Standard
- BS EN 60730-2-8.
- Type
 - Single seat.
 - Double seat. ٠
 - Three-way mixing.
 - Three-way diverting.
 - Butterfly.
 - Multi-port.
 - Low flow.
 - Pilot operated. •
 - Material Brass to BS EN 12163, BS EN 12164 or BS EN 12167.
 - Copper alloy to BS EN 1982.
 - Cast iron to BS EN 1561.
 - Cast steel to BS EN 10213.
- Connections •

•

- Screwed to BS 21.
- Flanged to BS EN 1092-3 PN

W60

W60

- Cast steel only, flanged to BS EN 1092-1 ٠
- ٠ Cast iron only, flanged to BS EN 1092-2
- Aluminium alloy only to BS EN 1092-4 •
- Ancillaries ٠
 - Position indicator. ٠
 - Locking device. ٠
 - Control device and linkage mechanisms.
- Actuating motive power •
 - Solenoid.
 - Electric motor.
 - Pneumatic. •
 - Magnetic. ٠

330.025 CONTROL BALL VALVES:

- Valve
 - Control valve.
 - Open/Close valve. •
 - Two way.
- Three way.
- Rotary Actuator ٠
 - Open/close.
 - Modulating.
 - 3-point.
- Material
 - Nickel-plated brass.
 - Stainless steel ball. •
 - Seal PTFE. ٠
 - Stainless steel spindle.
 - Spindle seal EPDM.
- Connections ٠
 - Threaded to BS 21.
 - Ancillaries

•

•

•

Lever for manual operation.

330.030 MOTORISED DAMPERS:

Use motorised control dampers manufactured and installed in accordance with DW 144.

- Actuating motive power •
 - High torque-electronic. •
 - Electric motor. •
 - Pneumatic. ٠

330.040 MOTORISED SHUTTERS:

Use motorised shutters manufactured and installed in accordance with DW 144.

- Actuating motive power
- Electric Motor •
- Pneumatic ٠

330.050 ACTUATORS - SOLENOID TYPE:

- Standard
- BS EN 60730-2-8.
- Control mode
- Linear.
- Proportional.
- Operation
- Normally open.
- Normally closed. ٠
- Modulating.
- Ancillaries ٠

W60 / 323

- Spring return. • ٠ Power failure return.
- Positioners. •
- Manual control failures.

330.060 ACTUATORS - ELECTRONIC TYPE:

- Standard
 - BS EN 60730-2-8.
- Use low voltage, high torque, electronic type actuators, including mounting brackets, adjustable linkages and necessary attachment devices.
- Control mode
 - Linear.
 - Proportional.
 - Compensating.

330.070 ACTUATORS - ELECTRIC MOTOR:

- Operation
 - Unidirectional
 - Reversible. •
 - Synchronous. ٠
 - Asynchronous
 - Provide thermal overload protection with manual reset option.
 - Spring return.
- Control mode
 - Linear.
 - Proportional.
 - Compensating.
- Operation
 - Two-position (ON-OFF).
 - Continuous. •
 - Modulating.
- Electrical requirements •
 - Integral terminal strip or DIN plug and socket connections.
- Mechanical requirements
- Self locking gear train.
- Manual override, geared to prevent backdrop.
- Travel stops in each direction.
- •
- Position indicator. •
- Enclose to IP65 minimum. •

Speed adjustment modules.

Ancillaries

•

٠

٠

•

•

•

•

Standard

- Auxiliary switches.
- Heater. ٠
 - Potentiometers. Proportional current feedback modules.

Integral controllers.

Power failure return.

330.090 TEMPERATURE SENSORS:

Manual control facilities.

Positioners.

Spring return.

• BS EN 60730-2-9.

330.080 SENSORS:

KJ TAIT ENGINEERS

• Two end of travel limit switches, with adjustable cam operation for motor de-energisation.

Interface sensors with controllers and indicators via amplifiers or transmitters, where necessary.

- Use thermocouple assemblies consisting of element, sleeve and connector. •
- Connect thermocouple assemblies to •
 - a digital indicator/control unit.
 - an analogue indicator/control unit.
- Method
 - Directly.
 - Indirectly.
- Sensor
 - Enthalpy.
 - Ductline. ٠
 - Surface. ٠
 - Room. •
 - Immersion. ٠
 - Outside air.

330.100 HUMIDITY SENSORS:

- Standard BS EN 60730-2-13.
- Measurement
 - Relative humidity.
 - Absolute humidity.
- Indicator •

Provide indicator capable of showing measured value at sensor. Calibrate indicators as required

330.110 PRESSURE SENSORS:

- Use pressure transducers manufactured in stainless steel. •
- Connect pressure transducers, via matched transmitters to
- single way display/alarm/control unit.
- multi-way display/alarm/control unit.

Indicator Provide indicator capable of showing measured value at sensor. Calibrate indicators as required

330.120 FLOW SENSORS:

- Standard BS EN 60730-2-18. •
- Sensor

•

- Venturi. ٠
- Differential pressure transducer. ٠
- Electro-magnetic meter. ٠
- Computed mass flow. •
- Turbine flow. •
- ٠ Oscillating vane.
- Paddle wheel. ٠
- Nozzle. •
- Magnetic flow. ٠
- ٠ Vortex.

330.130 LEVEL SENSORS:

- Provide liquid level detectors and connect, via matched amplifiers, to
- single way display/alarm/control units.
- multi-way display/alarm/control units.
- Sensor
 - Use capacitance electrodes manufactured from stainless steel and with PTFE insulation for use on conductive liquids with a minimum conductivity of 0.01 S/m.
 - Use conductivity electrodes manufactured from stainless steel, either single or multi-tipped.
 - Float type to BS EN 60730-2-16.

330.140 OTHER SENSORS:

Type

•

Smoke.

- C0605LMB Revised Stage E Mechanical Specification Including Agreed VE CENTRAL CONTROL/BUILDING MANAGEMENT
 - Specific gravity. ٠
 - Quantity. ٠

W60

- CO₂.
- CO.
- BS EN 50291.
- BS EN 50292
- Combustible gases and oxygen
 - BS EN 50271
- Turbidity.
- Flame ignition failure. •

330.150 AIR THERMOSTATS - ROOM TYPE:

- Standard
- BS EN 60730-2-9.
- Position
 - Wall mounted.
- Ancillaries
 - Built in set point potentiometers.
 - Heat anticipators. •
 - Night set-back. ٠
 - Range inserts, when using thermostats in series. ٠
 - Fixed set points.
 - Tamper-proof cover.
 - Remote set point adjustment.
 - Time switch.
 - Controller. ٠
 - ٠ Reverse Action.
 - Combined humidistat

330.160 AIR SENSOR - INSERTION TYPE:

- Use proportional type insertion sensor. •
- Sensor
 - in ductwork adjacent to a heating coil.
 - or distribution ductlines.

330.170 AIR THERMOSTATS - SURFACE TYPE:

- Standard
- BS EN 60730-2-9.
- Use surface type thermostats on

Solar collector detector.

Insertion detector.

Immersion detector and pocket.

- pipelines.
- windows.

330.190 AIR THERMOSTATS - MASTER TYPE:

 Provide master type thermostats to measure conditions at one point and reset the point of another (sub-master) thermostat or controller.

330.200 AIR THERMOSTATS - REMOTE BULB TYPE:

- Connect via
 - cable.

٠

capillary.

KJ TAIT ENGINEERS

 Ancillaries Clamp-on detector for pipelines.

Averaging type temperature sensor for mounting overface of air flow in an air-handling unit or Thermistor type temperature sensor, minimum stem length 200mm for mounting in the air flow

W60

330.210 AIR THERMOSTATS - FROST PROTECTION TYPE:

- Standard •
- BS EN 60730-2-9. ٠
- For space mounting use frost protection thermostats with temperature range of 0-20°C and with SPST switching action and electrical rating of 20 amps resistive.
- For heater battery protection use frost protection thermostats consisting of a gas filled sensing element and a bulb, a directly adjustable set point and switching differential.
- For compensated systems use external frost type thermostats with proportional type sensor, the whole unit being weather-proofed.
- Ancillaries •
 - Clamp-on temperature detector.
 - Immersion type temperature detector. •
 - Controller.
 - Start-up switching and indication.
 - Manual or automatic reset facility.

330.220 WATER IMMERSION THERMOSTATS:

• Standard

•

BS EN 60730-2-9.

Use proportional type immersion thermostats with rigid sensing elements ensuring 50mm minimum length is immersed. Use separable pockets, screwed 15mm BSP.

- Pocket material
- Copper.
- Corrosion resistant bronze.
- Stainless steel.

330.230 HUMIDISTATS:

Use wall mounted resistance element type humidistats.

- Room humidity.
- Enthalpy.

330.250 CONTROLLERS:

Use controllers with facility for remote control point adjustment. Provide integral or separate receiver and controller devices for pressure amplification with means of adjustment for setting desired values and proportional/integral ranges.

- Mounting •
- In control panel.
- Casing material
- Rigid plastic.
- Rigid plastic with die cast aluminium finish.
- Control mode
 - Proportional.
 - Single input.
 - Proportional plus integral control.
- Function
- Reset.
- Stop/Stage.
- Integral sensor.
- Pneumatic.
- Features
- Local control. •
- Local indication.
- Local adjustment of
- Set Point Position.
- Zero Band. •
- Dead Band.
- Proportional Band. •
- Reset schedule.

W60 / 327

KJ TAIT ENGINEERS

Night set back.

Solar compensation.

- Local Switching.
- Direct. •
- Reverse.
- Local rate/reset facilities.
- Local timer.
- Local alarm.
- Local lamps.
- Remote control.
- Remote indication.
- Remote adjustment of
- Set Point Position.
- Zero Band.
- Dead Band.
- Proportional Band.
- Reset schedule.
- Solar compensation.
- Night set back.
- Remote Switching.
 - Direct. •
- Reverse.
- Remote rate/reset facilities.
- Remote timer.
- Remote alarm.
- Remote lamps.
- Internal sensor.
- Internal thermistor.

330.260 LIGHTS AND ALARMS:

• Lights

Use 12 volts low wattage filament type indicator lights. Where required for electronic equipment use high intensity neon-type indicator lights. Colours

Use lens colours in accordance with BS EN 60073.

- Audible alarms •
 - Ensure that operation of any starter trip lamp, safety circuit lamp or alarm lamp operates a
 - alarm indicator lamps, whilst the push button is depressed.

330.270 TRANSMITTERS:

Use transmitters to interface between sensor and controller, utilizing only one sensor. Use transmitters capable of connection to the number of controllers

330.290 OPTIMISERS:

Standard - BS EN 12098-2.

330.300 COMPENSATORS:

- Standard
 - BS EN 12098-1.
 - BS EN 12098-3 •

W60

common audible alarm with mute and test facilities and terminals for remote alarm signal. When an alarm condition has had the audible alarm muted, ensure that terminals for a remote 'alarm accepted' light are energized. The audible alarm circuit and terminals for remote alarm signal must still be capable of indicating another fault occurring even though original fault has not been cleared. The test facilities are to test momentarily both the audible alarm and all

Use alarms that interface with a sensor or controller to sense set-point and measured value. Provide adjustable upper and lower limits on face of unit. Provide unit with indicating lamps to show which limit has been exceeded. Provide each unit with connections for remote alarm.

W60

W60 / 329

Analogue

- RS 232 C. ٠
- CCITT V24/V28.
- RS 422.
- CCITT V35.
- RS 485.
- BS EN 60870.
- To relay control system.
- To electronic control system.
- To processor control system.
- Arrangement
- Single plate. •
- Sectionalised.
- Tile.
- Mosaic.
- Enclosure degree of protection to BS EN 60529
- Display

•

- General
- Engraved.
- Screen printed. •
- Software facilities
- Windowing.
- Zooming.
- Panning.
- Reset.
- Item selection.
- Measured parameter display.
- Control action initiation.
- Control action display.
- Simulation off line
- Integral apparatus
- Status lamps •
- Status LED's •
- Flow direction indicators.
 - Valve position indicators.
- Switch/circuit breaker position indicators.
- Automatic updating.
- Manual updating.
- Rotary set point controllers.
- Thumb wheel set point controllers.
- Set point controllers
- Remote meters and indicators
- Chart recorders •
- Control action initiation.
- Push buttons
- Toggle switch

330.380 LOCAL OR REMOTE MONITOR TERMINAL UNITS:

- Input
 - Direct from transducers •
 - Analogue ٠
 - BCD ٠
 - RS 232 C.
 - CCITT V24/V28.
 - RS 422.
 - CCITT V35. ٠
 - RS 485. ٠

330.310 TIME SWITCHES:

- Standard BS EN 60730-2-7. •
- Provide time switches with minimum of 24 hours mains failure reserve facility. ٠

330.320 TRANSDUCERS:

Use transducers to receive 0-20V DC signal from controller and to convert it to proportional 0-15 psi output. When using transducers use electromagnetic actuators.

- Transducer
 - Electro-pneumatic.
 - Electro-hydraulic.

330.330 CONTROLS CIRCUITS:

Supply Voltage

Ensure control circuits are 230 volt AC or DC or 230 volt AC single phase connected one single phase to neutral only.

Circuit Voltage

Where control circuits are taken outside the panel

- Use 24 volt operating supply.
- Use 230 volt operating supply. ٠

330.340 CONTROL CIRCUITS TRANSFORMERS:

Provide control circuit transformers to supply power at voltages to suit control components. Standard

Use transformers in accordance with BS EN 61558-2-9, BS EN 61558-2-23 or BS EN 61558-1

and provide an external label of approved type and size.

Protection - Primary and secondary fuses.

330.360 ENCLOSURE FOR PNEUMATIC AND HYDRAULIC CONTROLS:

- Provide compartment within electrical enclosure for pneumatic controls.
- Provide enclosure for pneumatic controls. •
- Provide compartment within electrical enclosure for hydraulic controls.
- Provide enclosure for hydraulic controls.

330.370 MONITORING DISPLAYS AND MIMIC DIAGRAMS:

- Style
 - Plan. ٠
 - Schematic diagram. •
 - Indicators. •
 - Controls.
 - Physical display.
 - Software generated display. ٠
- Hybrid.
- Input

٠

•

٠

٠

Output

٠

- Direct from transducers ٠
- Analogue ٠
- BCD •
- RS 232 C. ٠
- CCITT V24/V28. • RS 422. •

CCITT - V35.

BS EN 60870.

Direct to transducers

From relay control system.

From electronic control system.

From processor control system.

RS 485.

KJ TAIT ENGINEERS

- BS EN 60870. •
- From relay control system.
- From electronic control system. ٠
- From processor control system.
- Output •
 - Direct to transducers •
 - Analogue ٠
 - RS 232 C. ٠
 - CCITT V24/V28. ٠
 - RS 422. ٠
 - CCITT V35. ٠
 - RS 485. ٠
 - BS EN 60870. ٠
 - To relay control system. ٠
 - To electronic control system. ٠
 - To processor control system. ٠
 - To monitoring display.
- Arrangement •
 - Enclosure degree of protection to BS EN 60529 ٠

330.390 TRANSMITTERS:

- Input
 - Input span ٠
 - ٠ Zero offset
 - DC ٠
 - AC ٠
 - ٠ True rms
 - ٠ Voltage
 - Current •
 - Frequency ٠
 - Pulse rate ٠
 - On/off. ٠
 - ٠ Resistance
 - RTD to BS 1041-3 ٠
 - RTD to BS EN 60751. ٠
 - Thermocouple BS EN 60584 type
 - Strain gauge ٠
 - Lead resistance ٠
 - ٠ Bandwidth
 - Bias current
 - Input resistance
- Output
- + or 1 V
- + or 2 V ٠
- 0 5 V dc. ٠
- 0 10 V dc. ٠
- 0 1 mA. ٠
- ٠ 4 - 20 mA.
- 10 - 50 mA.
- Source. ٠
- Sink. ٠
- ٠ Compliance
- 2 wire. •
- 4 wire.

•

- Local control outputs
- Number of set points
- Value of set point ٠

KJ TAIT ENGINEERS

- C0605LMB Revised Stage E Mechanical Specification Including Agreed VE CENTRAL CONTROL/BUILDING MANAGEMENT
 - Relay contact rating
 - Proportional output ٠
 - BCD •

W60

- Local display •
 - LED
 - LCD •
 - Number and type of digits ٠
 - A/D conversion •
 - Signal integration •
 - Sampling rate •
 - Analogue ٠
- Characteristics
 - Common mode noise rejection ٠
 - Normal mode noise rejection ٠
 - Common mode voltage protection ٠
 - Normal mode voltage protection •
 - Reverse polarity output protection
 - Open lead indication ٠
 - Repeatability error ٠
 - •
 - Stability
 - Temperature error •
 - Power supply error ٠
 - Operating temperature range ٠
 - Operating humidity range ٠
 - Degree of enclosure protection to BS EN 60529 •

330.420 DIGITAL TO ANALOGUE CONVERTERS:

Analogue to Digital

•

•

- Input
- 4 20 mA.
- 0 1 mA
- 2 wire.
- 4 wire.
- 0 10V. •
- On/off. •
- Modulated •
- Output
 - CCITT V24/V28. •

CCITT - V35. RS 422.

Synchronous.

Polling rate

Bi-directional

CCITT - V24/V28.

CCITT - V35.

Asynchronous.

 Continuous, sampling speed • Output when addressed

RS 232 •

RS 485.

• Bit rate

Parity

Digital to Analogue

• RS 232

• RS 422.

•

•

•

•

Input

•

Mode

•

•

•

٠

- RS 485.
- Bit rate
- Synchronous. •
- Asynchronous.
- Parity.
- Output
- 4 20 mA.
- 0 1 mA
- 0-10V. •
- Source. •
- Sink. •
- On/off.
- Modulated •
- Number of outputs.
- Mode
 - Continuous.
 - Sampling rate
 - Output when addressed
 - Polling rate
 - Bi-directional
- Characteristics
 - Integral with other equipment
 - Separately mounted
 - Mounting
 - BS 5954
 - BS EN 60917
 - Power supply
 - Analogue interface connectors
 - Digital interface connectors

340.000 WORKMANSHIP:

340.010 GENERAL:

Install pipeline control components in accordance with manufacturer's instructions. Install ductline control components in accordance with DW 144 and manufacturer's instructions. Install control components in accordance with manufacturer's recommendations, in positions indicated.

340.020 APPEARANCE:

Arrange, support and clip all control wiring, pneumatic tubes and capillaries to present a neat appearance, with other services and the building structure.

340.030 INSULATION:

Where control components are incorporated in insulated pipelines, ductlines or equipment, provide details for approval of method proposed to insulate component.

340.040 SUPPORTS:

Arrange supports for control components to ensure no strain is imposed on components.

340.050 ACCESS:

Arrange control components to ensure adequate access for operation and maintenance.

340.080 POWER OPERATED CONTROLS:

Install power operated controls in accordance with manufacturer's instructions and relevant standards.

340.090 ELECTRIC MOTOR ACTUATORS:

Securely mount actuators to rigid members, free from vibration or distortion in accordance with manufacturer's recommendations. Select mounting positions to require minimum linkages, and to avoid angular drive to operating levers. Allow access for servicing and replacement.

KJ TAIT ENGINEERS

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **CENTRAL CONTROL/BUILDING MANAGEMENT**

340.100 SENSORS/CONTROLLERS: Install sensors/controllers in accordance with manufacturer's instructions, in accessible locations. Install wall mounted components, where indicated.

340.105 TEMPERATURE SENSOR LOCATION:

- Internal
 - reach of direct sunlight; not in partitioned offices; approximately 1500 mm from the floor; in a position which will not be covered.
- External
- tamperproof location.

340.110 ANCILLARIES:

Install ancillaries in accordance with manufacturer's instructions.

340.120 ENCLOSURES:

Install enclosures where indicated, providing space for access and maintenance.

340.130 BUILDING MANAGEMENT SYSTEM INSTALLATION: Install commission and set to work building management system in accordance with the manufacturer's recommendations.

340.140 BUILDING MANAGEMENT SYSTEM CABLE INSTALLATION: Plan and install all building management monitoring systems cables in accordance with the cable manufacturer's recommendations. Label and record all monitoring cables in accordance with,

340.150 BUILDING MANAGEMENT SYSTEM QUALITY CONTROL: Handle, store and install equipment and components of the building management system in accordance with the manufacturer's recommendations. Inspect all equipment and components on delivery, before fixing and after installation and reject and replace any which are defective.

Record all commissioning tests and site modifications to hardware or software, and revise operating and maintenance instructions accordingly.

340,160 CONTROL SYSTEM FUNCTION CHARTS:

Prepare function charts for the control system in accordance with BS EN 60848. Obtain approval of function chart before design of system hardware or writing control software.

- Function chart format.
 - Combined function chart/circuit diagram.
 - Function chart only.

Install temperature sensors out of sources of draughts; away from sources of heat; out of the

Out of the reach of direct sunlight; away from any heat sources, exhaust, open windows; in a safe,

Y10 PIPELINES

Y10.1000 GENERAL

- Supply pipes and fittings as specified in work section
- Supply pipes and fittings as schedule reference N13-Sanitary appliances and fittings
- Location •
- As schedule reference •

PRE-FABRICATED PIPEWORK: 1010

Supply pre-fabricated pipework in accordance with relevant materials and workmanship clauses. 1020 FITTINGS:

For changes in direction use centreline radius/nominal bore of not less than 1.5 unless otherwise directed. For reductions and enlargements use easy transition type with inclined angle not exceeding 30 degrees.

1030 FABRICATED FITTINGS:

Use only with approval, if manufacturer's standard fittings are not available.

1040 PIPE JOINTS:

Obtain approval from Local Water Authority or Water Research Centre for materials used in water supplies.

Y10.2010# STEEL TO BS EN 10255:

- Material Steel.
- Standard BS EN 10255.
- Dimensions
- Light. ٠
- Medium
- Heavy.
- Random single lengths, 4m to 7m.
- Ends
 - Screwed to BS 21 and BS EN 10226-1, taper thread.
- Plain. ٠
- Grooved for mechanical joints.
- Finish •
 - Unvarnished.
 - Varnished.
 - Galvanized.

Y10.2010A HEAVY BLACK STEEL PIPES TO BS EN 10255: Material - Steel Standard - BS EN 10255 Dimensions - Heavy. Random single lengths, 4m to 7m. Ends - Screwed to BS 21 and BS EN 10226-1, taper thread or plain. Finish - Varnished.

Y10.2010B MEDIUM BLACK STEEL PIPES TO BS EN 10255: Material - Steel Standard - BS EN 10255 Dimensions - Medium. Random single lengths, 4m to 7m. Ends - Screwed to BS 21 and BS EN 10226-1, taper thread or Plain. Finish - Varnished.

Y10.2010C MEDIUM GALVANISED STEEL PIPES TO BS EN 10255: Material - Steel Standard - BS EN 10255 Dimensions - Medium. Random single lengths, 4m to 7m. Ends - Screwed to BS 21 and BS EN 10226-1, taper thread. Finish - Galvanised.

Y10.2010D HEAVY GALVANISED STEEL PIPES TO BS EN 10255: Material - Steel

KJ TAIT ENGINEERS

Y10.2010E HEAVY BLACK STEEL PIPES TO BS EN 10255 - GROOVED ENDS: Material - Steel Standard - BS EN 10255 Dimensions - Heavy. Random single lengths, 4m to 7m. Ends - Grooved for mechanical joints. Finish - Varnished.

Y10.2010F MEDIUM BLACK STEEL PIPES TO BS EN 10255 - GROOVED ENDS: Material - Steel Standard - BS EN 10255 Dimensions - Medium. Random single lengths, 4m to 7m. Ends - Grooved for mechanical joints. Finish - Varnished.

Y10.2010G HEAVY GALVANISED STEEL PIPES TO BS EN 10255 - GROOVED ENDS: Material - Steel Standard - BS EN 10255 Dimensions - Heavy. Random single lengths, 4m to 7m. Ends - Grooved for mechanical joints. Finish - Galvanised.

Y10.2010H MEDIUM GALVANISED STEEL PIPES TO BS EN 10255 - GROOVED ENDS: Material - Steel Standard - BS EN 10255 Dimensions - Medium. Random single lengths, 4m to 7m. Ends - Grooved for mechanical joints. Finish - Galvanised.

Y10.2020# STEEL FITTINGS, SCREWED BENDS AND SPRINGS TO BS EN 10255:

- Material
- Steel grade, seamless.

Standard - BS EN 10255

Finish - Galvanised.

- Steel grade, welded.
- Standard BS EN 10255.
- Size range 6mm to 150mm.
- Dimensions
- BS EN 10255 medium weight.
- BS EN 10255 heavy weight.
- Ends Screwed to BS 21 and BS EN 10226-1.
 - Finish

•

- Unvarnished.
- Varnished.
- Galvanised.

Y10.2020A STEEL FITTINGS - SCREWED BENDS AND SPRINGS TO BS EN 10255: Material - Steel grade, seamless. Standard - BS EN 10255. Size range - 6mm to 150mm. Dimensions - BS EN 10255, medium weight. Ends - Screwed to BS 21 and BS EN 10226-1. Finish - Galvanised.

Y10.2030# NON-ALLOY SEAMLESS STEEL TUBES TO BS EN 10216-1:

- Material Non alloy steel.
- Grade P195TR1.

Dimensions - Heavy. Random single lengths, 4m to 7m. Ends - Screwed to BS 21 and BS EN 10226-1, taper thread.

- Grade P195TR2.
- ٠ Grade P235TR1.
- Grade P235TR2. ٠
- Grade P265TR1.
- Grade P265TR2.
- Standard BS EN 10216-1.
- Dimensions •

•

- BS EN 10255, table 2. ٠
- BS EN 10255, table B.1. ٠
- BS EN 10255, table B.2. •
- BS EN 10255, table B.3. ٠
- BS EN 10220. ٠
- BS 1600, table 1. ٠
- BS EN 10216-1, table 5.
- Ends ٠
- Plain. ٠
 - For compression couplings.
- Grooved for mechanical joints. •
- Finish •
 - Uncoated.
 - Standard mill protective coating.
- Option •

Y10.2040# NON-ALLOY AND ALLOY SEAMLESS TUBES TO BS EN 10216-2:

- Material Non-alloy and alloy steel. •
 - Grade P195GH. ٠
 - Grade P235GH. ٠
 - ٠ Grade P265GH.
 - Grade 20 MnNb6. •
 - Grade 16Mo3. ٠
 - Grade 8MoB5-4. ٠
 - Grade 14MoV6-3. ٠
 - Grade 10CrMo5-5. ٠
 - Grade 13CrMo4-5. ٠
 - Grade 10CrMo9-10. •
 - Grade 11CrMo9-10.
 - Grade 25CrMo4. ٠
 - Grade 20CrMoV13-5-5. ٠
 - ٠ Grade 15NiCuMoNb5-6-4.
 - Grade X11CrMo5+I.
 - Grade X11CrMo5+NT1. ٠
 - Grade X11CrMo5+ NT2. ٠
 - Grade X11CrMo9-1+I. ٠
 - Grade X11CrMo9-1+NT. ٠
 - Grade X10CrMoVNb9-1. •
 - Grade X20CrMoV11-1.
- Standard BS EN 10216-2. ٠
- Dimensions
 - BS EN 10255, table 2. ٠
 - BS EN 10255, table B.1. ٠
 - BS EN 10255, table B.2, ٠
 - BS EN 10255, table B.3. ٠
 - BS EN 10220. •
 - BS 1600, table 1. •
 - BS EN 10216-2, table 6. •
- Ends •
 - Plain.

KJ TAIT ENGINEERS

Uncoated.

- C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINES
 - For compression couplings.
 - ٠ Grooved for mechanical joints.
- Finish •
 - Uncoated. •
 - Standard mill protective coating.
- Option

Y10

Y10.2050# NON-ALLOY WELDED STEEL TUBES TO BS EN 10217-1:

- Material Non alloy steel.
 - Grade P195TR1.
 - Grade P195TR2.
 - Grade P235TR1. •
 - Grade P235TR2. •
 - Grade P265TR1. ٠
 - Grade P265TR2.
- Standard BS EN 10217-1.
- Dimensions
 - BS EN 10255, table 2. ٠
 - BS EN 10255, table B.1. •
 - BS EN 10255, table B.2. •
 - BS EN 10255, table B.3. •
 - BS EN 10220. •
 - BS 1600, table 1. •
 - BS EN 10217-1, table 5.
- Ends •
- Plain. ٠
- For compression couplings. ٠
- Grooved for mechanical joints. •
- Finish

•

- Uncoated. ٠
- Standard mill protective coating. •
- Option

Y10.2055# NON ALLOY AND ALLOY WELDED STEEL TUBES TO BS EN 10217-2:

- Material Non alloy and alloy steel.
 - Grade P195GH.
 - Grade P235GH.
 - Grade P265GH.

BS EN 10220.

BS 1600, table 1.

- Standard BS EN 10217-2.
- Dimensions •

•

٠

•

٠

٠

٠

•

Option

•

•

Ends

Finish

• Plain.

• BS EN 10255, table 2.

BS EN 10255, table B.1.

BS EN 10255, table B.2.

BS EN 10255, table B.3.

BS EN 10217-1, table 6.

For compression couplings.

Grooved for mechanical joints.

Standard mill protective coating.

Y10.2060# CARBON STEEL FITTINGS, BUTT WELDED TO BS 1965-1:

- Material
 - Carbon steel, grade 430 •
 - seamless.
 - electric resistance welded.
- Standard BS 1965-1.
- Size range 25mm to 400mm.
- Dimensions
 - BS 1965-1 Heavy.
 - BS 1965-1 Medium. •
- Ends •
 - Plain. •
 - Bevelled as BS 1965-1. ٠
 - Grooved for mechanical joints.
- Finish
 - Unvarnished.
 - Varnished.

Y10.2060A HEAVY WEIGHT CARBON STEEL FITTINGS, BUTT WELDED TO BS 1965-1: Material

Carbon steel, grade 430, electric resistance welded. Standard - BS 1965-1. Size range - 25mm to 400mm. Dimensions - BS 1965-1 Heavy Ends - Bevelled. Finish - Varnished.

Y10.2060B MEDIUM WEIGHT CARBON STEEL FITTINGS, BUTT WELDED TO BS 1965-1: Material Carbon steel, grade 430, electric resistance welded. Standard - BS 1965-1. Size range - 25mm to 400mm. Dimensions - BS EN 10253-1 Medium. Ends - Bevelled. Finish - Varnished.

Y10.2070# MALLEABLE CAST IRON FITTINGS, SCREWED:

- Material Malleable cast iron to BS EN 1562.
- Standard •
 - BS 143 and 1256.
 - BS EN 10242.
- Size range 10mm to 164mm.
- Dimensions
 - BS 143 and 1256.
 - BS EN 10242.
- Ends Screwed to BS 21 and BS EN 10226-1.
- Finish •
 - Black.
 - Galvanized.

Y10.2070A MALLEABLE CAST IRON FITTINGS, SCREWED: Material - Cast iron to BS EN 1562. Standard - BS 143 & 1256 or BS EN 10242. Size range - 10mm to 164mm. Dimensions - BS 143 & 1256 or BS EN 10242. Ends - screwed to BS 21 and BS EN 10226-1. Finish - Black

Y10.2070B GALVANISED MALLEABLE CAST IRON FITTINGS, SCREWED: Material - Cast iron to BS EN 1562.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINES

Standard - BS 143 & 1256 or BS EN 10242. Size range - 10mm to 164mm. Dimensions - BS 143 & 1256 or BS EN 10242. Ends - screwed to BS 21 and BS EN 10226-1. Finish - Galvanized.

Y10.2080# CAST IRON AND STEEL FITTINGS, GROOVED MECHANICAL JOINTS:

- Material
 - Malleable cast iron to BS EN 1562.
 - Ductile cast iron to BS EN 1564.
 - Steel fittings to BS 1965-1.
- Standard Manufacturer's.
- Size range 20mm to 600mm. •
- Dimensions Manufacturer's standard. •
- Ends Grooved for mechanical joints. •
- Finish •
 - Black. •
 - Galvanized. •
 - Painted.

Y10.2080A CAST IRON FITTINGS, GROOVED FOR MECHANICAL JOINTS: Material- Ductile cast iron to BS EN 1564. Standard - Manufacturer's. Size range - 20mm to 600mm. Ends - Grooved for mechanical joints. Finish - Black.

Y10.2080B BLACK STEEL FITTINGS, GROOVED FOR MECHANICAL JOINTS: Material - Steel fittings to BS 1965-1. Standard - Manufacturer's. Size range - 20mm to 600mm. Ends - Grooved for mechanical joints. Finish - Black.

Y10.2080C PAINTED CAST IRON FITTINGS, GROOVED FOR MECHANICAL JOINTS: Material- Ductile cast iron to BS EN 1564. Standard - Manufacturer's. Size range - 20mm to 600mm. Ends - Grooved for mechanical joints. Finish - Painted.

Y10.2080D GALVANISED STEEL FITTINGS, GROOVED FOR MECHANICAL JOINTS: Material - Steel fittings to BS 1965-1. Standard - Manufacturer's. Size range - 20mm to 600mm. Ends - Grooved for mechanical joints. Finish - Galvanized.

Y10.2090# STEEL FITTINGS, SCREWED TO BS EN 10241:

- Material
 - Steel, welded. •
 - Steel, seamless. •
- Standard BS EN 10241.
- Size range 6mm to 150mm.
- Dimensions BS EN 10241.
- Ends Screwed to BS 21 and BS EN 10226-1.
- Finish • Black.

•

Galvanized.

Y10

Y10/341

• Bevelled.

• Finish

Y10

- Uncoated. •
- External bitumen sheathing.
- External reinforced bitumen sheathing.
- External bitumen enamel wrapping.
- External reinforced bitumen enamel wrapping. ٠
- External coal tar enamel wrapping.
- External plastic cladding.
- Internal bitumen lining.
- Internal -
- Concrete lining. •
- Centrifugally applied cement mortar lining. ٠

Y10.2135# NON-ALLOY STEEL TUBES TO BS EN 10224:

- Material Non alloy steel to
- BS EN 10216-1.
- BS EN 10217-1.
- Standard

•

•

- BS EN 10224, seamless. ٠
- BS EN 10224, welded. •
- Dimensions BS EN 10220. •
 - Ends
 - Plain.
 - Bevelled. •
- Finish •
 - ٠ Uncoated.
 - External Bitumen coating.
 - External Coal tar coating.
 - External Epoxy coating.
 - External Epoxy modified coating.
 - External Polyethylene coating.
 - External Polypropylene coating.
 - External Polyurethane coating. ٠
 - External Polyurethane modified coating.
 - External Hot dip galvanised coating.
 - Internal Cement mortar lining.
 - Internal Epoxy coating. ٠
 - Internal Epoxy modified lining. ٠
 - Internal Thermoplastic lining.
 - Internal Hot dip galvanised lining. ٠

Y10.2140# ALLOY FINE GRAIN SEAMLESS STEEL TUBES TO BS EN 10216-3:

- Material Alloy fine grain steel
 - Grade P275NL1.
 - Grade P275NL2. ٠
 - Grade P355N. •
 - Grade P355NH. •
 - Grade P355NL1
 - Grade P355NL2.
 - Grade P460N.
 - Grade P460NH.
 - Grade P460NL1.
 - Grade P460NL2.

 - Grade P620Q.
 - Grade P620QH
 - Grade P620QL.

- Y10.2100# WROUGHT CARBON AND FERRITIC ALLOY STEEL FITTINGS TO BS 1640-3: Material - Steel to BS 1640-3, table 1. •
- Standard BS 1640-3. •
 - Wrought seamless.
- Fabricated.
- Size range 20mm to 600mm.
- Dimensions BS 1640-3. •
- Ends •
- Plain.
- Bevelled as BS 1640-3. •
- Finish •
 - Unvarnished. •
 - Varnished. ٠

Y10.2110# FORGED CARBON AND ALLOY STEEL TO BS 3799:

- Material BS 3799 Table 3.
 - Carbon and carbon alloy steel.
- Austenitic stainless steel.
- Standard BS 3799. •
- Dimensions
 - Screwed to BS 3799 tables 4 to 12. ٠
 - Socket-welding to BS 3799 tables 13 to 16.
- Ends •
 - Screwed.
 - Socket-welding.
- Finish Forged. •

Y10.2120# WROUGHT AND CAST AUSTENITIC CHROMIUM-NICKEL STEEL FITTINGS TO BS 1640-4:

- Material Steel to BS 1640-4, table 1.
- Standard BS 1640-4. ٠
 - Wrought seamless.
 - Cast seamless.
 - Wrought fabricated. •
 - Cast fabricated.
- Size range 20mm to 600mm. •
- Dimensions BS 1640-4. •
- Ends •
 - Plain. •
 - Bevelled as BS 1640-4.

Y10.2130# CARBON STEEL TO BS 534:

Material - Non alloy and alloy steel to

Finish •

•

•

٠

•

•

٠

٠

Ends

• Plain. **KJ TAIT ENGINEERS**

٠

•

Standard

Unvarnished. Varnished.

• BS EN 10216-1.

BS EN 10216-2.

BS EN 10217-1.

BS EN 10217-2.

BS 534, welded.

BS 534, seamless.

BS EN 10311, joints.

Dimensions - BS EN 10220, random single lengths.

- Grade P690Q.
- Grade P690QH.
- Grade P690QL1. •
- Grade P690QL2.
- Standard BS EN 10216-3.
 - Category of testing
 - Category 1.
 - Category 2.
- Dimensions •
 - BS EN 10220. •
 - BS 1600, table 1. •
 - BS EN 10216-3, table 8.
- Ends •
 - ٠ Plain.
 - Grooved for mechanical joints. ٠
- Finish ٠
 - Uncoated.
 - Standard mill protective coating.
- Option •

Y10.2145# ALLOY FINE GRAIN WELDED STEEL TUBES TO BS EN 10217-3:

- Material Alloy fine grain steel
 - Grade P275NL1.
 - Grade P275NL2. •
 - Grade P355N. •
 - Grade P355NH. ٠
 - Grade P355NL1. ٠
 - Grade P355NL2. ٠
 - Grade P460N. ٠
 - Grade P460NH. ٠
 - Grade P460NL1. •
 - Grade P460NL2. •
- Standard BS EN 10217-3. •
 - Category of testing
 - Category 1.
 - Category 2.
- Dimensions •
 - BS EN 10220. •
 - ٠ BS 1600, table 1.
 - BS EN 10217-3, table 9. ٠
- Ends •
 - Plain. ٠
 - Grooved for mechanical joints.
- Finish •
 - Uncoated.
 - Standard mill protective coating.
- Option •

Y10.2150# SUBMERGED ARC WELDED NON-ALLOY AND ALLOY STEEL TUBES TO BS EN 10217-5:

- Material Non-alloy and alloy steel.
 - Grade P235GH. ٠
 - Grade P265GH. ٠
 - Grade 16Mo3. •
- Standard BS EN 10217-5.
 - Category of testing
 - Category 1.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINES

Category 2.

- Dimensions
 - BS EN 10220. •
 - BS 1600, table 1. •
 - BS EN 10217-5, table 6.
- Ends

Y10

- Plain.
- Grooved for mechanical joints. •
- Finish •
 - Uncoated.
 - Standard mill protective coating •
- Option

•

•

•

•

.

٠

•

Finish

Option

Y10.2155# SUBMERGED ARC WELDED NON-ALLOY STEEL TUBES TO BS EN 10217-6:

- Material Non-alloy and alloy steel.
 - Grade P215NL.
 - Grade P265NL.
- Standard BS EN 10217-6.
 - Category of testing
 - Category 1.
 - Category 2.
 - Dimensions
 - BS EN 10220.

 - BS 1600, table 1.
 - BS EN 10217-6, table 6.
- Ends
 - Plain. ٠
 - Grooved for mechanical joints. •
 - Finish
 - Uncoated. ٠
 - Standard mill protective coating. •
- Option

Y10.2160# NON ALLOY AND ALLOY SEAMLESS STEEL TUBES TO BS EN 10216-4:

- Material Non-alloy and alloy steel.
 - Grade P215NL.
 - Grade P255QL.
 - Grade P265NL. •
 - Grade 26CrMo4-2. ٠
 - Grade 11 MnNi5-3. •
 - Grade 13MnNi6-3.
 - Grade 12Ni14. •

Grade X10Ni9.

• Standard - BS EN 10216-4.

Category of testing

• Category 1.

BS 1600, table 1.

Category 2.

BS EN 10216-4, table 6.

Standard mill protective coating

Grade X12Ni14. •

Dimensions

Ends - Plain.

Uncoated.

KJ TAIT ENGINEERS

• BS EN 10220.

Y10.2170# NON-ALLOY WELDED STEEL TUBES TO BS EN 10217-4:

- Material Non alloy steel.
- Grade P215NL.
- Grade P265NL.
- Standard BS EN 10217-4.
- Category of testing
 - Category 1.
 - Category 2.
- Dimensions.
 - BS EN 10220.
- BS 1600, table 1.
- BS EN 10217-4, table 6.
- Ends Plain.
- Finish
 - Uncoated.
 - Standard mill protective coating.
- Option

Y10.2200# CARBON & STAINLESS STEEL COMPRESSION COUPLINGS TO BS 4368-1:

- Material
 - Non alloy and alloy steel
 - BS EN 10216-1.
 - BS EN 10216-2.
 - BS EN 10217-1.
 - BS EN 10217-2.
 - BS EN 10217-3.
 - BS EN 10217-5.
 - Stainless steel to BS EN 10216-5 and BS EN 10217-7.
- Standard
 - BS 4368-1, type A. ٠
 - BS 4368-1, type B.
 - BS 4368-1, type C.
- Size range 6mm to 50mm.
- Dimensions BS 4368-1, tables 4 to 28.
- Ends Plain. •
- Finish •
 - Manufacturer's standard to BS EN 12329 or BS EN 12330.
 - Manufacturer's standard to BS EN 12476.
 - Coated to BS 3382. ٠

Y10.2215# CARBON AND STAINLESS STEEL COMPRESSION COUPLINGS TO BS EN ISO 8434:

- Material
 - Steel tubes for precision applications to BS EN 10305-1 and BS EN 10305-4.
- Stainless steel to BS EN ISO 1127.
- Standard BS EN ISO 8434-1.
- Dimensions 24° compression fittings BS EN ISO 8434-1.
- Ends Plain. •
- Finish •
 - Manufacturer's standard.

Y10.2215A CARBON STEEL COMPRESSION COUPLINGS TO BS EN ISO 8434: Material - Steel tubes to BS EN 10305-1 and BS EN 10305-4. Standard - BS EN ISO 8434-1. Dimensions, compression fittings BS EN ISO 8434-1 Ends - Plain. Finish - Manufacturer's standard.

Y10

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINES

Y10.2215B STAINLESS STEEL COMPRESSION COUPLINGS TO BS EN ISO 8434: Material - Stainless steel to BS EN ISO 1127. Standard - BS EN ISO 8434-1. Dimensions, compression fittings BS EN ISO 8434-1 Ends - Plain. Finish - Manufacturer's standard.

Y10.2220 STAINLESS STEEL TO BS EN 10312: Material - Stainless steel, grade as per table A.1. Standard - BS EN 10312. Dimensions - BS EN 10312 as per tables 1 and 2. Ends - Plain. Finish - Uncoated.

Y10.2230# AUSTENITIC STAINLESS STEEL TO BS 4825-1:

- Material Austenitic stainless steel.
- Standard
 - Cold finished seamless
 - Grade 304S11.
 - Grade 304S31.
 - Grade 316S11.
 - Grade 316S13.
 - Grade 316S31.
 - Grade 316S33.
 - Welded and bead rolled.
 - Grade 304S22.
 - Grade 304S25.
 - Grade 316S22.
 - Grade 316S26.
- Dimensions
- BS 4825-1, table 2.
- Ends Plain.
- Finish
 - Cold worked and bright annealed.
- Polished.
- Abrasive cleaned. •
- Acid descaled.

Y10.2240# AUSTENITIC STAINLESS STEEL FITTINGS TO BS 4825:

- Material
 - Fittings austenitic steel.
 - Gaskets
 - natural rubber tested to BS 903-A26.
 - synthetic rubber tested to BS 903-A26.
- Standard BS 4825-1.
- Size range
- BS 4825-2, 12mm to 219.1mm.
- BS 4825-3, expanded type 25mm to 76.1mm.
- BS 4825-3, welded type 25mm to 219.1mm.
- BS 4825-4, 12mm to 101.6mm.
- BS 4825-5, expanded type 25mm to 76.1mm.
- BS 4825-5, welded type 25mm to 101.6mm.
- Dimensions
- BS 4825-2 Bends and Tees. •
- BS 4825-3 Clamp type couplings. •
- BS 4825-4 Screwed couplings. •
- BS 4825-5 Recessed ring joint type coupling.
- Ends Plain.

Y10

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINES

 Finish Cold worked and bright annealed. Polished. Abrasive cleaned. Acid descaled. Y10.2250# AUSTENITIC STAINLESS STEEL FOR PRESSURE PURPOSES : Material - Austenitic stainless steel. Standard BS EN 10216-5, seamless. 		Y10.2270A COPPER HALF HARD: Kite marked. Material - Copper. Standard - BS EN 1057, R250, (Class X). Dimensions - BS EN 1057 table 3. Ends - Plain Finish - Uncoated. Y10.2310A CAPILLARY FITTINGS FOR COPPER TUR Material - Copper or dezincifiable resistant copper alloy Standard - BS EN 1254-1
 BS EN 10217-7, welded. CC (Compression). Dimensions BS EN ISO 1127. BS 1600, table 1. 		Size range - 6mm to 67mm. Dimensions - BS EN 1254-1 table 2. Ends - Integral (lead-free) solder ring. Finish - Natural.
 Ends - Plain. Finish Uncoated. Y10.2250A AUSTENITIC STAINLESS STEEL TO BS EN 10216-5: Material - Austenitic stainless steel seamless 		Y10.2320A TYPE A COMPRESSION FITTINGS FOR 0 Kite marked. Material - Dezincifiable resistant copper alloy Standard - BS EN 1254-2, type A, non-manipulative. Size range - 6mm to 54mm. Dimensions - BS EN 1254-2, table 2 and 3
Standard - BS EN 10216-5. Dimensions - BS EN ISO 1127. Ends - Plain. Finish - Uncoated.		Ends - Socket. Finish - Natural. Y10.2330A COPPER TO BS EN 12449: Material - Copper.
Y10.2250B AUSTENITIC STAINLESS STEEL TO BS EN 10217-1: Material - Austenitic stainless steel, welded. Standard - BS EN 10217-7. Dimensions - BS EN ISO 1127. Ends - Plain		Standard - BS EN 12449, seamless, round tubes. Dimensions - BS EN 12449. Ends - Plain or screwed. Finish - Uncoated.
 Y10.2255# STAINLESS STEEL FITTINGS, GROOVED MECHANICAL JOINTS: Material 40 ANSI schedule 10 Type 316TL (DIN 14401). Stainless steel grades 304, 316, 316L, 316T, schedules 5S, 10S, 20S, 40S. 		Material - Copper. Material - Copper. Standard - BS EN 12450, seamless, round copper capi Dimensions - BS EN 12450. Ends - Plain or screwed. Finish - Uncoated.
 Standard - Manufacturer's. Size range - 20mm to 600mm. Dimensions - Manufacturer's standard. Ends - Grooved for mechanical joints. Finish - Natural. 		 Y10.2390# CAST IRON PIPES AND FITTINGS TO BS Material - Cast iron. Standard - BS EN 877. Dimensions - BS EN 877 table 1. Ends - Plain
Y10.2255A STAINLESS STEEL FITTINGS, GROOVED MECHANICAL JOINTS: Material - Stainless steel grades 304, 316, 316L, 316T, schedules 5S, 10S, 20S, 40S. Standard - Manufacturer's. Size range - 20mm to 600mm. Dimonsions - Manufacturer's standard		 Finish - External Red epoxy. Grey epoxy.
Ends - Grooved for mechanical joints. Finish - Natural. Y10.2257 STAINLESS STEEL PUSH-FIT FITTINGS		Material - Cast iron. Standard - BS EN 877. Dimensions - BS EN 877, table 1. Ends - Plain.
Material - Stainless steel Standard - Manufacturer's standard. Size range - 15mm to 54mm. Dimensions - to suit stainless steel pipe to BS EN 10216-5 and BS EN 10217-7. Ends - push-fit with EPDM O ring. Finish - Natural.		Finish - Red epoxy. Y10.2390B GREY CAST IRON PIPES AND FITTINGS Material - Cast iron. Standard - BS EN 877. Dimensions - BS EN 877, table 1. Ends - Plain.
	>/10/047	

KJ TAIT ENGINEERS

BING, GENERAL POTABLE RANGE: y.

COPPER TUBING:

illary tubes.

SEN 877:

TO BS EN 877:

TO BS EN 877:

Y10

Finish - Grey epoxy.

Y10.2430 LAYERED PIPE AND FITTINGS FOR HOT AND COLD WATER: Material - Internal pipe - PE-x; aluminium pipe; and PE80 cover. Standard - Manufacturer's standard. Size range - 16mm to 50mm. Dimension - Manufacturer's standard. Ends - compression. Finish - Black.

Y10.2450# UNPLASTICIZED PVC TO BS 3505:

- Material •
 - Unplasticized PVC, class C.
 - Unplasticized PVC, class D.
 - Unplasticized PVC, class E.
- Standard BS 3505.
- Dimension BS 3505, table 1 lengths 6m, or 9m.
- Ends - Plain
- Finish
 - Blue.
 - Grey. ٠

Y10.2450A UNPLASTICISED PVC PIPES TO BS 3505: Material - Unplasticized PVC. Class C, D or E to suit working pressure. Standard - BS 3505. Dimensions - BS 3505, table 1 - lengths 6m or 9m. Ends - Plain.

Finish - Blue.

Y10.2460# UNPLASTICIZED PVC TO BS 3506:

- Material
 - Unplasticized PVC, class 0.
 - Unplasticized PVC, class B. •
 - Unplasticized PVC, class C. •
 - Unplasticized PVC, class D. •
 - Unplasticized PVC, class E. •
 - Unplasticized PVC, class 6.
 - Unplasticized PVC, class 7.
- Standard BS 3506.
- Dimensions BS 3506, table 1 lengths 3m, 6m or 9m.
- Ends Plain.
- Finish Natural self colour.

Y10.2470 UNPLASTICIZED PVC FITTINGS, SOLVENT WELDING TO BS 4346-1: Material - Unplasticized PVC. Standard - BS 4346-1. Size range - 10mm to 300mm. Dimensions - BS 4346. Ends - Spigot/Socket. Finish - Natural self colour.

Y10.2480A UNPLASTICIZED PVC TO BS 4514: Material - Unplasticized PVC. Standard - BS 4514. Dimensions - BS 4514. Ends - Plain. Finish - Black, grey or white.

Y10.2490A UNPLASTICIZED PVC FITTINGS, SOLVENT WELDING TO BS 4514:

Material - Unplasticized PVC. Standard - BS 4514, table 2. Size range - 82mm,110mm or 160mm. Dimensions - BS 4514 tables 3 and 5. Ends - Spigot/plain. Finish - Black, grey or white.

Y10.2495A PLASTICS PIPING SYSTEMS TO BS EN 1453: Plastics piping system with structured wall pipes for soil and waste discharge (low and high temperature) within the building structure. Material - Unplasticised polyvinyl chloride (PVC-U). Standard - BS EN 1453. Dimensions - Length - manufacturer's standard range. BS EN 1453 tables1, 2 and 3. Ends - Plain: elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.

Finish - Grey, black, or white.

Y10.2496A PLASTICS PIPING SYSTEMS TO BS EN 1329-1 - FITTINGS: Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure. Material - Unplasticised polyvinyl chloride (PVC-U).

Standard - BS EN 1329-1. Size range - 32mm to 315mm. Dimensions - BS EN 1329-1 tables 5 - 14. Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.

Finish - Grey.

Y10.2500# POLYETHYLENE TO BS 6730:

- Material Polyethylene.
- Standard BS 6730.
- Dimensions BS 6730 table 1. Lengths - straight pipe 6 and 12m. Lengths - coils 50m, 100m and 150m.
- Ends
 - Plain. •
 - Sockets.
- Finish Black pigment.

Y10.2510# COMPRESSION FITTINGS FOR POLYETHYLENE PIPES:

- Material Copper and dezincifiable resistant copper alloys.
- Standard BS EN 1254-3 or BS 864-5. •
- Size range
 - 20mm to 63mm.
 - 0.5in. to 1.0in.
- Dimensions BS EN 1254, tables 2 and 3.
- Ends Socket.
- Finish Natural.

Y10.2510A COMPRESSION FITTINGS FOR POLYETHYLENE PIPES: Material - Copper/copper alloy (dezincifiable resistant). Standard - BS EN 1254-3 or BS 864-5. Size range - 20mm to 63mm. Dimensions - To suit pipes to BS EN 12201. Ends - Socket. Finish - Cast.

Y10.2520 POLYETHYLENE TO BGC/PS/PL2 AND BS 3412: Material - Polvethylene. Standard - To BGC/PS/PL2 Part 1, table 2. Dimensions - To BGC/PS/PL2 Part 1, table 2. Lengths - straight pipe 6m or 12m.

KJ TAIT ENGINEERS

Ends - Plain.

Ends - Plain.

Yellow

Ends - Plain.

Finish

•

•

Black

Yellow.

structure.

Finish

Black

Y10

Plastics piping systems for soil and waste discharge (low and high temperature) within the building Lengths - coiled pipe multiples of 50m. structure. Finish - Natural self colour. Material - Polypropylene (PP). Standard - BS EN 1451-1. Y10.2528 POLYETHYLENE PIPES TO BS EN 1555: Size range - 32mm to 315mm. Dimensions - BS EN 1451-1 tables 5 - 8. Material - Polyethylene. Standard - BS EN 1555-1, BS EN 1555-2 and BS EN 1555-5. Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement. Dimensions - BS EN 1555-2, table 1. Finish - Grey, black, or white. Lengths - straight pipe 6m or 12m. Lengths - coiled pipe multiples of 50m. Y10.2580A PVC-U PIPING SYSTEMS - PIPES: Marking - BS EN 1555-2, table 7. Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure. Material - Unplasticised polyvinyl chloride (PVC-U). Standard - PVC-U to BS EN 1329-1. Dimensions - Length - manufacturer's standard range. BS EN 1329-1 tables 1, 2, 3 and 4. Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement. Black with yellow identification stripes. Finish - Grey, black, or white. Y10.2530 POLYETHYLENE FITTINGS, FUSION TO BGC/PS/PL2 PART 2: Y10.2580B ABS PIPING SYSTEMS - PIPES: Material - Polyethylene. Plastics piping systems for soil and waste discharge (low and high temperature) within the building Standard - To BGC/PS/PL2 Part 2. structure. Size range - Socket type up to 125mm. Butt type up to 500mm. Saddle type up to 180mm. Material - Acrylonitrile-butadiene-styrene (ABS). Dimensions - To BGC/PS/PL2 Part 2. Standard - ABS to BS EN 1455-1. Dimensions - Length - manufacturer's standard range. BS EN 1455-1 tables 1, 2, 3 and 4. Finish - Natural self colour. Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement. Finish - Grey, black, or white. Y10.2538 POLYETHYLENE FUSION FITTINGS TO BS EN 1555: Material - Polyethylene. Y10.2585A PVC-U PIPING SYSTEMS TO BS EN 1329-1 - FITTINGS: Standard - BS EN 1555-1, BS EN 1555-3 and BS EN 1555-5. Plastics piping systems for soil and waste discharge (low and high temperature) within the building Dimensions - BS EN 1555-3, Section 6, to suit pipes to BS EN 1555-2. structure. Marking - BS EN 1555-3, table 7. Material - Unplasticised polyvinyl chloride (PVC-U). Ends - Sockets with heating elements for fusion jointing. Standard - PVC-U to BS EN 1329-1. Size range - 32mm to 315mm. Dimensions - BS EN 1329-1 tables 5-14. Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement. Finish - Grey, black, or white. Y10.2540 POLYPROPYLENE TO BS 5254: Material - Polypropylene. Y10.2585B ABS PIPING SYSTEMS TO BS EN 1455-1 - FITTINGS: Standard - BS 5254. Plastics piping systems for soil and waste discharge (low and high temperature) within the building Dimensions - BS 5254, table 1-4m lengths. structure. Ends - Plain/Socket. Material - Acrylonitrile-butadiene-styrene (ABS). Finish - Natural self colour. Standard - ABS to BS EN 1455-1. Size range - 32mm to 315mm. Y10.2545A PLASTICS PIPING SYSTEMS TO BS EN 1451-1 - PIPES: Dimensions - BS EN 1455-1 tables 5-12. Plastics piping systems for soil and waste discharge (low and high temperature) within the building Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement. Finish - Grey, black, or white. Material - Polypropylene (PP). Standard - BS EN 1451-1. Y10.2590# UNPLASTICIZED PVC ANCILLARY FITTINGS TO BS 4660 AND BS EN 13598-1: Dimensions - Length - manufacturer's standard range, BS EN 1451-1 tables 1, 2, 3 and 4. Material Ends - Plain: elastomeric ring seal socket and spigot; or socket and spigot for solvent cement. Unplasticized polyvinyl chloride. Finish - Grey, black, or white. Polvethylene. Y10.2550A POLYPROPYLENE FITTINGS, TO BS 5254: Polypropylene. Material - Polypropylene. • Standard - BS EN 13598-1. Standard - BS 5254. Size range - 110mm and 160mm. • Size range - 32 to 50mm. Dimensions - BS EN 13598-1, section 6. Dimensions - BS 5254, table 1. Marking - BS EN 13598-1, table 6. • Ends - Plain; or ring seal, multi-vane or compression sockets. • Ends Finish - Natural self colour. • Plain. Socket, ring seal. Y10.2555A PLASTICS PIPING SYSTEMS TO BS EN 1451-1 - FITTINGS: Socket, solvent cement.

KJ TAIT ENGINEERS

- Finish
 - Orange.
 - Black
 - Dusty grey.

Y10.2620# UNPLASTICIZED PVC FITTINGS TO BS 4346-2:

- Material Unplasticized polyvinyl chloride.
- Standard BS 4346-2. •
- Size range 14mm to 610mm (outside diameter). •
- Dimensions •
 - To suit pipes to BS 3505.
- To suit pipes to BS 3506.
- Ends
- Finish Natural self colour. •

Y10.2630# ABS TO BS 5391-1:

- ٠ Material - ABS (Acrylonitrile-butadiene-styrene).
- Standard •
 - BS 5391-1, class B. •
 - BS 5391-1, class C. •
 - BS 5391-1, class D. •
 - BS 5391-1, class E. ٠
 - BS 5391-1, class T.
- Dimensions ٠
- BS 5391-1, table 1 lengths 3m, 6m and 9m.
- Ends •
 - Plain. ٠
 - Screwed to BS 21 and BS EN 10226-1, class T only. •
- Finish Natural.

Y10.2640# ABS FITTINGS, SOLVENT WELDING TO BS 5392-1:

- Material ABS (Acrylonitrile-butadiene-styrene). •
- Standard •
 - BS 5392-1, class B.
 - BS 5392-1, class C. •
 - BS 5392-1, class D. ٠
 - BS 5392-1, class E.
- Size range 10mm to 200mm.
- Dimensions BS 5392-1, table 1. •
- Ends Spigot/socket.
- Finish Natural. •

Y10.2653# POLYETHYLENE PIPES TO BS EN 13244:

- Material Polyethylene.
- Standard BS EN 13244. •
- Dimensions •
 - BS EN 13244-2, table 1 ٠
 - Lengths
 - Straight pipe 6m, 9m or 12m.
 - Coils 50m, 100m or 150m.
 - Manufacturer's standard.
- Marking •
 - BS EN 13244-2, table 6
- Ends •
 - Plain.
- Sockets.
- Finish
- Black.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINES

- Y10.2654# POLYETHYLENE FITTINGS TO BS EN 13244:
- Material Polyethylene.
- Standard BS EN 13244-3. •
- Type •

Y10

- Butt fusion.
- Socket fusion.
- Electrofusion. •
- Compression. •
- Flanged. •
- Dimensions
- BS EN 13244-3, section 6 and Annex A.
- Marking

•

- BS EN 13244-3, table 7. ٠
- Ends - Plain.
- Finish
 - Black. •

Y10.2665# POLYETHYLENE TO WIS 4-32-17:

- Material Polvethylene.
- Standard WIS 4-32-17. •
- Dimensions
 - WIS 4-32-17, table 6
 - Lengths
 - Straight pipe 6m, 12m or 18m.
 - Coils 25m, 50m, 100m or 150m.
 - Manufacturer's standard.
 - Ends

•

•

- Plain.
- Sockets. ٠
- Finish •
- Blue. Black. •
- Black with brown stripes. ٠
- Black with green stripes. •

Y10.2665A POLYETHYLENE TO WIS 4-32-17: Material - Polyethylene.

Standard - WIS 4-32-17. Dimensions - WIS 4-32-17 table 6.

Lengths - straight pipe 6m, 12m or 18m; coils, 25m, 50m, 100m or 150m.

Ends - Plain.

Finish - Blue, black, black with brown stripes or black with green stripes.

Y10.2668# POLYETHYLENE PIPES TO BS EN 12201:

• Material - Polyethylene.

BS EN 12201-2, table 1

• BS EN 12201-2, table 6

Standard - BS EN 12201-1, BS EN 12201-2 and BS EN 12201-5. •

• Straight pipe 6m, 9m or 12m.

Coils 50m, 100m or 150m.

Manufacturer's standard.

Dimensions •

Marking

• Plain.

Sockets.

KJ TAIT ENGINEERS

Ends

•

•

Lengths

•

•

- Finish •
 - Blue. Black with blue stripes.

Y10.2668A POLYETHYLENE TO BS EN 12201:

Material - Polyethylene. Standard - BS EN 12201-1, BS EN 12201-2, BS EN 12201-5. Dimensions - BS EN 12201-2, table 1. Marking - BS EN 12201-2, table 6. Lengths - straight pipe 6m, 12m or 18m; coils, 25m, 50m, 100m or 150m. Ends - Plain or sockets. Finish - Blue.

Y10.2668B POLYETHYLENE TO BS EN 12201: Material - Polyethylene. Standard - BS EN 12201-1, BS EN 12201-2 and BS EN 12201-5. Dimensions - BS EN 12201-2, table 1. Marking - BS EN 12201-2, table 6. Lengths - straight pipe 6m, 12m, or 18m; coils, 25m, 50m, 100m or 150m. Ends - Plain or sockets. Finish - Black with blue stripes.

Y10.2669# POLYETHYLENE FITTINGS TO BS EN 12201:

- Material Polyethylene. •
- Standard BS EN 12201-3. •
- Type •
 - Butt fusion. •
 - Socket fusion. ٠
 - Electrofusion. •
 - Compression.
 - Flanged.
 - Dimensions
- BS EN 12201-3, section 6 and Annex A.
- Marking
 - BS EN 12201-3, table 7.
- Ends Plain.
- Finish
- Blue. ٠
- Black. •

Y10.3010# CIRCULAR FLANGES FOR PIPES AND FITTINGS:

- Material
 - BS EN 1092-3, copper alloy.
 - BS EN 1092-1, ferretic steel. ٠
 - BS EN 1092-1, austentic steel. •
 - BS EN 1092-1, nickel steel. •
 - BS EN 1092-2, grey cast iron. ٠
 - BS EN 1092-2, ductile cast iron. •
 - BS EN 1092-2, malleable cast iron. •
 - BS EN 1092-4, aluminium alloy.
- Flange type
 - Plate flange for welding. •
 - Loose plate flange with weld on plate collar or for lapped pipe end.
 - Loose plate flange with weld neck collar. ٠
 - Blank flange. •
 - Weld neck flange. ٠
 - Hubbed slip-on flange for welding.
 - Hubbed threaded flange.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINES

- Hubbed socket weld flange.
- Integral flange.
- Flange facings

Y10

- Flat face type A.
- Spigot type E.
- Raised face type B.
- Recess type F.
- Tongue type C.
- O-ring recess. •
- Groove type D. O-ring groove.
- Ancillaries
 - Weld neck plate on collar.
 - Lapped pipe end.
 - Weld neck collar.
- Bolting
- In accordance with BS EN 1092-1.
- In accordance with BS EN 1092-2.
- In accordance with BS EN 1092-3. ٠
- Bolting made using free cutting steel.
- Threaded flanges
 - BS 21 and BS EN 10226-1 parallel thread.

Y10.3010A CIRCULAR FLANGES FOR PIPES, PN DESIGNATED - WELDED FLANGE: Material - BS EN 1092-1.

Flange type - Weld neck flange or hubbed slip-on flange for welding. Flange facings - Raised face - type B. Bolting - In accordance with BS EN 1092-1.

Y10.3010B CIRCULAR FLANGES FOR PIPES, PN DESIGNATED - THREADED FLANGE: Material to BS EN 1092-1. Facings - Raised face type B. Bolting - in accordance with BS EN 1092-1. Threaded flanges - BS 21 and BS EN 10226-1 parallel thread.

Y10.3020# FLANGE JOINTING RINGS:

- Non-metallic flat gaskets for flanges to, BS EN 1092-1 or BS EN 1092-2: Standard - BS EN 1514-1
 - Gasket type
 - Full face for type A flanges.
 - Full face for type B flanges.
 - Inside bolt circle for type A flanges.
 - Inside bolt circle for type B flanges.
 - Tongue and groove gasket for type C/D flanges.
 - Spigot and recess gasket for type E/F flanges. •
 - Suitable for flanges to BS EN 545.
 - Suitable for flanges to BS EN 598.
 - Suitable for flanges to BS EN 969.
 - Suitable for potable water (material compliant with BS 6920-1).
 - Material
 - Rubber without fabric.
 - Rubber with fabric insertion.
 - Rubber without fabric plus wire reinforcement. •
 - Plastics material.
 - Expanded graphite with insertion.
 - Vegetable fibre.
 - Cork based.

Compressed fibre with suitable binder for operating conditions.
Spiral wound gasket for flanges to BS EN 1092-1, BS EN 1092-2, BS EN 1092-3 or BS EN 1092-• 4

Standard - BS EN 1514-2.

- Gasket type
 - Sealing element with centring ring and inner ring.
- Sealing element with centring ring.
- Non-metallic PTFE envelope gaskets
- Standard BS EN 1514-3.
- Gasket type
 - IBC type for type A flanges.
 - IBC type for type B flanges.
 - Machined fin type.
 - Machined square type.
 - Folded tape type.
 - Machined chamfer type.

Corrugated, flat or grooved metallic and filled metallic gaskets for flanges to BS EN 1092-2 Standard - BS EN 1514-4.

- Gasket type
 - Corrugated metal, with filler or corrugated metal jacketed with filler.
 - Corrugated metal.
 - Flat metal jacketed with filler.
 - Grooved metal with or without a layer of additional gasket material.
 - Solid flat metal.
- Installation features
 - Self centring for type A flanges.
 - Self centring for type B flanges.
 - Incorporating centring ring for type A flanges.
 - Incorporating centring ring for type B flanges.
- Covered serrated metal gaskets, to BS EN 1514-6, for use with flanges complying with BS EN 1092-1.

Y10.3020A JOINTING RINGS - NON-METALLIC FLAT GASKETS: Non-metallic flat gaskets for flanges to BS EN 1092-1, BS EN 1092-2, BS EN 1092-3 or BS EN 1092-

4 Standard - BS EN 1514-1 Gasket type - Full face for type B.

Y10.3020B JOINTING RINGS - METALLIC GASKETS: Corrugated, flat or grooved metallic and filled metallic gaskets for flanges to BS EN 1092-1, BS EN 1092-2, BS EN 1092-3 or BS EN 1092-4. Standard - BS EN 1514-4 Gasket type - Corrugated metal. Gasket design - Self centring for type B.

Y10.3030# SCREWED JOINTS TO BS 21 AND BS EN 10226-1:

- Use hemp and jointing compound to BS 6956-5 or BS EN 751-2.
- Use PTFE tape to BS 7786.
- Use hemp and jointing compound to BS 6956-5 or BS EN 751-2, prior to chemical treatment and use PTFE tape to BS 7786 after chemical treatment.
- Use silicone sealant.

Y10.3030A SCREWED JOINTS TO BS 21 AND BS EN 10226-1: Use PTFE tape to BS 7786 or use hemp and jointing compound to BS 6956-5, or BS EN 751-2.

Y10.3030B SCREWED JOINTS TO BS 21 AND BS EN 10226-1 WITH PTFE TAPE: Use PTFE tape to BS 7786.

Y10.3030C SCREWED JOINTS TO BS 21 AND BS EN 10226-1 WITH CHEMICAL CLEANING:

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINES

Use hemp and jointing compound to BS 6956-5 or BS EN 751-2, prior to chemical treatment and use PTFE tape to BS 7786 after chemical treatment.

Y10.3040# UNION CONNECTIONS:

Spherical seating

Y10

- bronze to bronze, navy pattern.
- bronze to iron, railroad pattern.

Y10.3040A RAILROAD UNION CONNECTIONS: Seating - Spherical seating bronze to iron, railroad pattern.

Y10.3040B NAVY UNION CONNECTIONS: Seating - Spherical seating bronze to bronze, navy pattern.

Y10.3050# WELDED JOINTS:

- Use welding rods as follows
 - Steel
 - Gas welding, BS 1453 type A2 or A3.
 - Electric arc welding BS 2633.
 - Electric arc welding BS 2971.
 - Copper Bronze welding BS 1453.

Y10.3050A WELDED JOINTS, WELDING RODS FOR STEEL PIPES: Gas welding, BS 1453 type A2 or A3; electric arc welding BS 2633; or electric arc welding BS 2971.

Y10.3070A CAPILLARY JOINTS FOR COPPER: Use materials as follows Solder - BS EN ISO 9453. Flux - Copper pipe - BS EN 29454-1.

Y10.3095# JOINTING MATERIALS FOR PLASTICS PIPES TO BS 7291:

- Plastics fittings to BS 7291.
 - Method of jointing to BS 5955-8
 - Mechanical joints.
 - Compression.
 - Pushfit. •
 - Flat faced unions.
 - Flanges.
 - Screwed unions.
 - Solvent cement joints.
 - Thermal fusion joints.
- Compression with fittings to BS EN 1254-3 or BS 864-5.

Y10.3095B JOINTING MATERIALS FOR PLASTICS PIPES TO BS 7291 - PUSHFIT: Plastics fittings to BS 7291.

Method of jointing to BS 5955-8 Mechanical joints - Pushfit.

Y10.3095C JOINTING MATERIALS FOR PLASTICS PIPES TO BS 7291 - SOLVENT CEMENT: Plastics fittings to BS 7291.

Method of jointing to BS 5955-8 - Solvent cement joints.

Y10.3095D JOINTING MATERIALS FOR PLASTICS PIPES TO BS 7291 - THERMAL FUSION: Plastics fittings to BS 7291.

Method of jointing to BS 5955-8 - Thermal fusion joints.

Y10.3095E JOINTING MATERIALS FOR PLASTICS PIPES - COMPRESSION FITTINGS: Compression with fittings to BS EN 1254-3, or to BS 864-5.

Y10.3102 JOINTING EQUIPMENT FOR PUSH-FIT SYSTEM:

Provide manufacturer's recommended tool for releasing push-fit fittings in push-fit jointing systems for copper and plastic pipe.

Y10.3105# COUPLINGS FOR CAST IRON PIPES TO BS EN 877:

- Material
- Stainless steel.
 - Bolts and bolt holder
 - Stainless steel.
 - Zinc coated.
- Austenitic steel with galvanised bolts.
 - Ductile iron.
 - Finish
 - Red.
 - Grev.
 - Black.
- Gaskets
 - EPDM.
 - Nitrile. •

Y10.3105A STAINLESS STEEL COUPLINGS FOR CAST IRON PIPES TO BS EN 877: Material - Stainless steel, with zinc coated bolts and bolt holder. Gasket - EPDM.

Y10.3105B RED DUCTILE IRON COUPLINGS FOR CAST IRON PIPES TO BS EN 877: Material - Ductile iron. Finish - Red. Gasket - EPDM.

Y10.3105C GREY DUCTILE IRON COUPLINGS FOR CAST IRON PIPES TO BS EN 877: Material - Ductile iron. Finish - Grey. Gasket - EPDM.

Y10.3125 JOINTING EQUIPMENT FOR PRESS FITTING SYSTEM: Provide the manufacturer's recommended pressfitting tool for use with press fitting system.

Y10.3130# PRESS FITTING JOINTING SYSTEM ON STAINLESS STEEL PIPE:

- Material •
 - Stainless Steel.
- Standard
 - To manufacturers standard.
 - ٠ To BS EN 10216-5.
 - To BS EN 10217-7. •
 - To BS EN 10088.
- Size range
 - 15mm to 108mm for water.
 - 15mm to 108mm for gas.
- Dimensions to suit stainless steel pipe to BS EN 10216-5 and BS EN 10217-7... •
- Ends •
 - With O ring seal for use with water to manufacturer's standard.
- With O ring seal for use with gas to manufacturer's standard.
- Finish Natural.

Y10.3132# PRESS FITTING JOINTING SYSTEM ON THIN WALL STEEL PIPE:

- Material
 - Thin wall carbon steel pipe.
- Standard

- To DIN EN 10305-3.
- Size range 12mm to 54mm. •
- Size range 12mm to 108mm.
- Dimensions to suit thin wall carbon steel pipe to DIN EN 10305-3.
- Ends
- With O ring seal to manufacturer's standard. •
- Finish
 - Galvanised.
 - Polypropylene coated.

Y10.3135# PRESS FITTING JOINTING SYSTEM ON COPPER PIPE:

- Material •
- Copper pipe.
- Standard •
 - To Manufacturers standard.
 - To BS EN 1057.
 - Grade
 - R250
 - R290
- Size range
 - 12mm to 54mm.
 - 12mm to 108mm.
- Dimensions to suit copper pipe to BS EN 1057. •
- Ends
- With O ring seal to manufacturer's standard. •
- Finish
 - To manufacturers standard

Y10.3140# MECHANICAL JOINTS, GROOVED STEEL PIPES:

- Material
 - Malleable cast iron to BS EN 1562.
 - Ductile cast iron to BS EN 1564.
 - Carbon steel to BS EN 10025-1, BS EN 10025-2. ٠
- Joint
 - Standard, flexible.
 - Standard, rigid.
 - Reducing joint.
 - Flange adaptor PN
- Size range 20mm to 600mm.
- Gaskets
- Grade 'E' EPDM.
- Grade 'T' Nitrile.
- Finish
 - Painted to manufacturer's standard.
 - Galvanized. •

Y10.3140A MECHANICAL JOINTS, GROOVED STEEL PIPES: Material - Malleable cast iron to BS EN 1562; ductile cast iron to BS EN 1564; or carbon steel to BS EN 10025-1, BS EN 10025-2. Joint - Standard, flexible or rigid; or reducing joint. Size range - 20mm to 600mm. Gaskets - Grade 'E' EPDM. Finish - Painted to manufacturer's standard.

Y10.3150# MECHANICAL JOINTS, PLAIN END STEEL PIPES:

- Material
 - Malleable cast iron to BS EN 1562.

Y10

Y10/359

Y10

- Ductile cast iron to BS EN 1564.
- Size range 40mm to 400mm.
- Gaskets
 - Grade 'E' EPDM.
 - Grade 'T' Nitrile.
- Finish
- Manufacturer's standard. ٠
- Galvanized.

Y10.3150A MECHANICAL JOINTS. PLAIN END STEEL PIPES: Material - Malleable cast iron to BS EN 1562; or ductile cast iron to BS EN 1564. Size range - 40mm to 400mm. Gaskets - Grade 'E' EPDM. Finish - Manufacturer's standard.

Y10.3152# MECHANICAL JOINTS, GROOVED STAINLESS STEEL PIPES:

- Material
 - Malleable cast iron to BS EN 1562. ٠
 - Ductile cast iron to BS EN 1564. ٠
 - Carbon steel to BS EN 10025-1. BS EN 10025-2.
 - Stainless steel type 316 (DIN 14401).
 - Stainless steel type 304 (DIN 14301).
- Joint
 - Standard, flexible. ٠
 - Standard rigid. ٠
 - Reducing joint. •
 - Flange adaptor PN
 - Size range 20mm to 600mm.
- Gaskets

٠

- Grade 'E' EPDM. •
- Grade 'T' Nitrile.
- Finish
 - Painted to manufacturer's standard. •
 - Galvanized. •
 - Self colour.

Y10.3152A MECHANICAL JOINTS, GROOVED STAINLESS STEEL PIPES:

Material - Malleable cast iron to BS EN 1562; ductile cast iron to BS EN 1564; carbon steel to BS EN 10025-1, BS EN 10025-2; stainless steel type 316(DIN 14401); or stainless steel type 304 (DIN 14301).

Joint - Standard, flexible or rigid; or reducing joint. Size range - 20mm to 600mm. Gaskets - Grade 'E' EPDM.

Finish - Painted to manufacturer's standard or self colour.

Y10.3170# FLEXIBLE COUPLINGS, SLEEVE TYPE:

Joint •

Bolted, sleeve type, with wedge type elastomeric gaskets.

- Type •
 - End load capable, gripping elements embedded in gaskets (up to 250mm).
 - Non-end load capable.
- Dimensions Manufacturer's standard.
- Material
 - Malleable cast iron to BS EN 1562. •
 - Ductile cast iron to BS EN 1564.
- Carbon steel to BS EN 10025-1, BS EN 10025-2.
- Finish •
 - Manufacturer's standard.

Y10/361

KJ TAIT ENGINEERS

- Galvanized. Nylon coated. ٠
- Gaskets •
 - BS EN 682
 - GA Gaseous fuel (-5°C to 50°C)
 - GAL Gaseous fuel (-15°C to 50°C)
 - GB hydrocarbon fluids (-5°C to 50°C)
 - GBL hydrocarbon fluids (-15°C to 50°C)
 - BS EN 681-1
 - WA cold potable water.
 - WB hot potable water.
 - WD hot non-potable water.

 - copolymer.
 - resistance.
 - BS EN 681-2
 - WT above ground use.

Y10.3170A FLEXIBLE COUPLINGS, SLEEVE TYPE: Joint - Bolted, sleeve type, with wedge type elastomeric gaskets. Type - Non-end load capable.

Dimensions - Manufacturer's standard.

Material - Ductile cast iron to BS EN 1564, or to BS EN 1563. Finish - Manufacturer's standard.

Gaskets - In accordance with BS EN 681-1, BS EN 681-2 or BS EN 682.

Y10.3180# FLEXIBLE FLANGE ADAPTERS. SLEEVE TYPE:

- Joint
- Bolted, sleeve type, with wedge type elastomeric gaskets, flanged on end. Type •
 - End load capable, gripping elements embedded in gaskets (up to 250mm). Non-end load capable.
- Dimensions Manufacturer's standard.
- Material
- Ductile cast iron to BS EN 1564.
- Carbon steel to BS EN 10025. •
- Flange •
 - To connect to BS EN 1092-1, BS EN 1092-2, BS EN 1092-3 or BS EN 1092-4, PN10 flange.
- Finish
 - Manufacturer's standard.
 - Galvanized.
 - Nylon coated.
- Gaskets
- BS EN 682
 - GA Gaseous fuel (-5°C to 50°C)
 - GAL Gaseous fuel (-15°C to 50°C)
 - GB hydrocarbon fluids (-5°C to 50°C)
 - GBL hydrocarbon fluids (-15°C to 50°C)
- BS EN 681-1
 - WA cold potable water.
 - WB hot potable water.

H - Aromatic hydrocarbon fluids and gaseous fuels containing condensates (-5°C to 50°C)

• WC - cold non-potable water supply, drainage, sewerage and rainwater pipes.

WE - hot potable water, seals manufactured from isoprene-isobutylene copolymer. • WF - hot non-potable water, seals manufactured from isoprene-isobutylene

WG - cold non-potable water supply, drainage, sewerage and rainwater pipes with oil

• To connect to BS EN 1092-1, BS EN 1092-2, BS EN 1092-3 or BS EN 1092-4, PN16 flange.

H - Aromatic hydrocarbon fluids and gaseous fuels containing condensates (-5°C to 50°C)

WC - cold non-potable water supply, drainage, sewerage and rainwater pipes.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINES

KJ TAIT ENGINEE	RS			١	(10 / 363	KJ TAIT ENGINEE	RS	
Between Pipeline insulated or uninsulated	and Wall Finish	Clearance (mm) 25]			standard manu maximum aspe square tees at Use bends Use elbow	and square tees.	uired, use eccentric ed two pipe sizes; a g points. Square elk ere practical.
Space pipe runs in relation to one another, other services runs and building structure, allow for specified thickness of thermal insulation and ensure adequate space for access to pipe joints, etc. The following are recommended as minimum clearances in spacing of pipe runs:-			 Y10.4070# PIPE FITTINGS: Use eccentric type reductions and enlargements on h venting, concentric on vertical pipes, with easy transit degree. Do not use bushes, except at radiators and a 					
Y10.4020 SPACING	G:		ta an anna an airte 11-11-11-11-11-11-11-11-11-11-11-11-11-			generally allow the	flexure at changes	in direction. Allow f
Y10.4010 APPEAR Arrange all exposed building structure, s Ensure all vertical p	ANCE: d pipe runs to prese subject to gradients pipes are plumb or f	ent neat appear for draining or follow building I	ance, parallel with oth venting. ine.	ner pipe or service i	runs and	y10.4060 EXPANS	SION AND CONTRA	ACTION:
Use brass pipe clip	S.	' GLIPS, GOPP	ER FIFEWUKK:			Y10.4050 DRAIN F Grade pipework to	REQUIREMENTS: allow system to be	drained. Provide a
Y10.3200A PIPE R Use suitable pipe, h and pipe/insulation	INGS AND CLIPS, nangers, slider and surface temperatur	STEEL PIPEW roller type supp re.	ORK: ports, taking into acco	unt the pipe load, n	naterial	Y10.4040B AUTON Provide a means o Provide an automa drain line or to ano	MATIC AIR VENTS: f venting the pipe sy tic air vent valve wit ther suitable locatio	vstem at all high po h a copper outlet p n.
 Copper pipework Use plastic pipe clips. Use brass pipe clips. Proprietary pipe rings and clips 			Y10.4040A AIR BOTTLES: Provide a means of venting the pipe system at all high poi Provide a vertical extension from the pipe approximately 1 copper extension pipe with a manual vent cock located in					
 Y10.3200# PIPE R Steel and cast Use suitabl material an Use pipe cl 	INGS AND CLIPS: iron pipework e pipe, hangers, sli d pipe/insulation st ips	de and roller ty Irface temperat	pe supports, taking in ure.	to account the pipe	e load,	 A vertical e With a cop An automatic a With a cop suitable loce 	extension from the p per extension pipe v air vent valve. per outlet pipe from cation.	ipe approximately ⁻ with a manual vent the valve to a tund
Y10.3190B WALL, Material - Plastic. Fixing - Clipped wit	FLOOR AND CEIL h plastic lug.	ING PLASTIC I	MASKING PLATES:			Y10.4040# AIR VE Provide a means o Air Vent Assembly • An air bottle	INT REQUIREMEN	ΓS: /stem at all high po
Y10.3190A WALL, Material - Copper a Type - Heavy, split Fixing - Chrome rai	FLOOR AND CEIL lloy, chromium plat on the diameter, clu sed head fixing scr	ING CHROMIU ed. ose fitting to ou ews.	M PLATED MASKING	G PLATES:		Y10.4030 GRADIE Install pipework wit	NTS: h gradients to allow	drainage and/or ai
Flange - 10 connec Finish - Manufactur Gaskets - In accord	er's standard. lance with BS EN 6	81-1, BS EN 68	81-2 or BS EN 682.				One uninsulated Both insulated	75 25
Type - Non-end loa Dimensions - Manu Material - Ductile ca	d capable. facturer's standard ast iron to BS EN 1	564.	ne gaskets, hanged of	n end.		Adjacent pipelines	Both uninsulated	150
Y10.3180A FLEXIB	BLE FLANGE ADAF	PTERS, SLEEV	E TYPE:	n ond		Uninsulated	Adjacent service	50
 BS EN 681 WT - al 	-2 bove ground use.					Insulated Pipeline	Adjacent service runs	25
cor • W(oolymer. G - cold non-potable	e water supply,	drainage, sewerage a	and rainwater pipes	with oil		Soffit Floor Finish	150
• WE • WE • WF) - hot non-potable - hot potable wate - hot non-potable 	water. er, seals manufa water, seals ma	actured from isoprene anufactured from isop	-isobutylene copoly rene-isobutylene	/mer.		Ceiling Finish	50



r release, and to the slopes where indicated.

ints.

100mm long, at the bore of the pipe. cock located in an easily accessible position.

lish in an adjacent drain line or to another

ints. 100mm long, at the bore of the pipe, with a an easily accessible position.

ints. ipe from the valve to a tundish in an adjacent

means of draining the system at all low

ment caused by the thermal changes, for movement at branch connections.

orizontal pipe runs to allow draining and tion and an included angle not exceeding 30 t fittings where required size is not of bushes to allow draining or venting; above this ratio use reducing fittings. Use bows are not acceptable.

Y10.4070A PIPE FITTINGS, BENDS/SWEPT TEES:

Use eccentric type reductions and enlargements on horizontal pipe runs to allow draining and venting, concentric on vertical pipes, with easy transition and an included angle not exceeding 30 degree. Do not use bushes, except at radiators and at fittings where required size is not of standard manufacture. Where required, use eccentric bushes to allow draining or venting; maximum aspect ratio not to exceed two pipe sizes; above this ratio use reducing fittings. Use square tees at venting and draining points. Square elbows are not acceptable. Use bends and swept tees where practical.

Y10.4070B PIPE FITTINGS, ELBOWS/SQUARE TEES:

Use eccentric type reductions and enlargements on horizontal pipe runs to allow draining and venting, concentric on vertical pipes, with easy transition and an included angle not exceeding 30 degree. Do not use bushes, except at radiators and at fittings where required size is not of standard manufacture. Where required, use eccentric bushes to allow draining or venting; maximum aspect ratio not to exceed two pipe sizes; above this ratio use reducing fittings. Use square tees at venting and draining points. Square elbows are not acceptable. Use elbows and square tees.

Y10.4080 FABRICATED JUNCTIONS:

Form by inserting a branch section of a pulled bend into the main pipe. Develop the profiles of both the branch section and the hole in the main pipe, to ensure minimum protrusion into the main pipe. Weld or braze into position.

Y10.4090 FABRICATED FITTINGS - FERROUS:

Supply pipe material and end connections to the specification of the associated straight pipe runs. Pattern - Bends, springs, offsets and branches.

Technique - Pipe bore 50mm or less - machine cold bend.

Pipe bore greater than 50mm - machine hot bend.

Ensure that fabricated branch bends of welding saddles are to the fitting proportions in BS 1965-1.

Y10.4100 FABRICATED FITTINGS - NON-FERROUS:

Provide pipe material and end connections to the specification of the associated straight pipe runs. Pattern - Bends, springs, offsets and branches.

Technique - Machine bend and ensure that machine guides and formers are smooth and clean, free from any scores, or other damage. Deformed bends will not be accepted.

Fabricate branch from a section of pulled bend, profiled to match the contour of the main to avoid overlap and protrusion into the main. Cut and swage the main to form a raised cup to accept the spigot end of the branch. Limit angle of the branch to 60°. Join by bronze welding on site. Apply reinforcement by plates, collars or shoes.

Y10.4110 PIPES THROUGH WALLS AND FLOORS:

Enclose pipes passing through building elements, (walls, floors, partitions, etc.) concentrically within purpose made sleeves. Fit masking plates where visible pipes pass through building elements, including false ceilings of occupied rooms.

Y10.4110# PIPES THROUGH WALLS AND FLOORS - FIRE STOPPING:

- Material
 - Fire Stopping Compound
 - Thickness
 - 75mm
 - 100mm
 - 150mm
 - Intumescent Pillows
 - Dimensions
 - 300x200x30mm
 - 300x150x30mm
 - 300x100x30mm
 - 300x50x30mm •
 - Intumescent Coated Batt
 - Dimensions
 - Intumescent Pipe Wrap

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINES

- Dimensions
 - 50mm
- 100mm •
- Standard
 - To manufacturer's standard
- To BS 476-20
- To BS 476-22
-
- Fire Rating
- 1 hour
- 2 hours
- 3 hours
- 4 hours

Installation

To manufacturer's standard

Y10.4120# PIPE SLEEVES:

- Where pipe insulation is not carried through pipe sleeve, cut sleeves from material same as pipe one or two sizes larger than pipe to allow clearance. Do not use sleeves as pipe supports.
- Where pipe insulation is carried through pipe sleeve, cut sleeves from material same as pipe one or two sizes larger than pipe and insulation to allow clearance. Do not use sleeves as pipe supports.

Install sleeves flush with building finish. In areas where floors are washed down install with a 100mm protrusion above floor finish.

Y10.4120A PIPE SLEEVES:

Where pipe insulation is not carried through pipe sleeve, cut sleeves from material same as pipe one or two sizes larger than pipe to allow clearance. Do not use sleeves as pipe supports. Install sleeves flush with building finish. In areas where floors are washed down install with a 100mm protrusion above floor finish.

Y10.4120B PIPE SLEEVES WITH INSULATION CARRIED THROUGH: Where pipe insulation is carried through pipe sleeve, cut sleeves from material same as pipe one or two sizes larger than pipe and insulation to allow clearance. Do not use sleeves as pipe supports. Install sleeves flush with building finish. In areas where floors are washed down install with a 100mm protrusion above floor finish.

Y10.4125 PIPE SLEEVES THROUGH FIRE BARRIERS: Pack annular space between pipe and sleeve or insulation and sleeve with non-flammable and fire resistant material to form a fire/smoke stop of required rating. Apply 12mm deep cold mastic seal at both ends within sleeve.

Y10.4125# PROPRIETARY PIPE SLEEVES THROUGH FIRE BARRIERS:

- Provide fire stopping for pipes penetrating fire barriers utilising proprietary fire sleeves fully coated internally with intumescent sheet.
 - Pipe construction
 - Carbon Steel
 - Stainless Steel •
 - Copper • Plastic
 - Thermal insulation requirements
 - Non-insulated
 - Thermally Insulated • Length of pipe sleeves

Y10

- 205mm
- Construction of pipe sleeves
- 0.25mm thick stainless steel
- Testing of pipe sleeves
 - Sleeves to be 4 hour fire tested.
 - Provide test data on pipe sleeves
- Fixing details
 - Slot and tab fixing to pipe sleeve

Y10.4130 CONNECTIONS TO EQUIPMENT:

Make final connections to equipment in accordance with manufacturer's instructions and as indicated.

Y10.4140 DISTRIBUTION HEADERS:

Terminate ends with a cap, a blank flange, a grooved blank end or as indicated.

Y10.4150# TEMPORARY PLUGS, CAPS AND FLANGES:

Seal all open ends as installation proceeds by plugs, caps or blank flanges, to prevent ingress of foreign matter.

- Plug material
 - Metal.
 - Plastic. ٠
 - Wooden.
- In the event of such precautions not being taken, strip out pipework adjacent to open ends to demonstrate that fouling of bores has not occurred.

Y10.4150A TEMPORARY PLUGS, CAPS AND FLANGES:

Seal all open ends as installation proceeds by plugs, caps or blank flanges, to prevent ingress of foreign matter.

Use plugs of metal, plastic or wood to suit pipework material.

In the event of such precautions not being taken, strip out pipework adjacent to open ends to demonstrate that fouling of bores has not occurred.

Y10.4160 FLANGED JOINTS GENERAL:

Use number and diameters of bolts to standard. Fit bolts of length to give not less than one thread, or more than 3mm protrusion beyond nut when joint is pulled up. Fit washers under each nut.

Y10.4170 DISSIMILAR METALS:

Take appropriate means to prevent galvanic action where dissimilar metals are connected together.

Y10.4180 PIPE RINGS AND CLIPS:

Select type according to the application and material compatibility, give particular attention where pipes are subject to axial movement due to expansion or contraction.

Y10.4190 ANCHORS:

Location

As drawing numbers

Construct to resist axial stress transmitted by flexure of horizontal and vertical pipe runs or loading on vertical pipes assuming that unbalanced forces exist at all anchor points, even when these are situated in intermediate positions between two expansion loops or bellows. Use similar or compatible materials to the attached pipe.

Provide and fix all associated backing plates, nuts, washers and bolts for attachment to or building into building structure; ensure structure is suitable for transmitted stress. Set out and line up anchors accurately in position. Inspect final grouting into building structure.

Y10.4200 SLIDE GUIDES:

Location

• As drawing numbers

Direct movement of expansion and contraction from pipe anchor points towards loops, bellows or flexible inserts. Ensure that thrust is linear relative to the axis of pipe.

KJ TAIT ENGINEERS

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINES

Apply a friction reducing material between metal faces subjected to movement.

Y10.4205 PIPE SUPPORTS:

Arrange supports and accessories for equipment, appliances or ancillary fitments in pipe runs, so that no undue strain is imposed upon pipes. Ensure that materials used for supports are compatible with pipeline materials.

Y10.4210 SUPPORT SYSTEM - WIRE ROPE:

- 4215# WIRE ROPE SUSPENSION SYSTEM:
 - Type

Y10

- Application
- Manufacturer and reference
- Or approved equivalent
- Standards
- BS EN 12385-1. •
- BS EN 13411-3.
- BS EN 13411-4.
- DIN 3093.
- BSRIA COP 22/2002.
- Dimensions
 - Safe working load (kg)
 - Length
- Components
 - Wire rope
 - Safe working load (kg)
 - Length (mm) •
 - Material
 - Stainless steel grade 316
 - Galvanised
 - Fastener
 - Components
 - Springs stainless steel grade 302
 - Adjustment •
 - Tamperproof
 - Fixing
 - Loop
 - Safe working load (kg)
 - Length (mm)
 - Stud (permanently fixed to wire rope length)
 - Single toggle
 - Double toggle
 - Double karabiner •
 - Hook
 - Accessories
 - Setting keys
 - Span/bearer supports
 - Ceiling clip fixings
 - Threaded adaptors
 - Anchor bolts
 - Anchor for stud fixings
 - Ceiling fixing kit •
 - Corner saddle
 - Fastener décor cover

Provide wire rope support system. Confirm wire rope is suitable for supporting pipelines.

Y10.4215# WIRE ROPE SUSPENSION SYSTEM:

- Type
- Application

1.4

1.8

2.4

2.4

2.7

3.0

3.0

3.0

3.0

3.6

-

-

-

-

-

-

-

-

Polyethylene Pipe

Class D, E, 6, 7

Type 32

horizont

al

0.3

0.4

0.4

3.0

3.0

3.0

3.6

3.6

4.6

4.6

4.6

5.4

5.4

6.0

6.0

10.0

12.0

12.6

13.2

14.4

16.8

UPVC Pipe

horizont

_

15

20

Class O, B, C

Maximum Support Spacing (M)

horizo

ntal

0.6

0.6

0.65

•	Manufacturer and reference	15	
	Or approved equivalent		
•	Standards	20	2.4
	• BS EN 12385-1.		1
	• BS EN 13411-3.	25	2.4
	• BS EN 13411-4.		
	• DIN 3093.	32	2.7
	• BSRIA COP 22/2002.		
•	Dimensions	40	3.0
	Safe working load (kg)		1
	Length	50	3.0
•	Components		
	Wire rope	65	3.7
	Safe working load (kg)		
	Length (mm)	80	3.7
	Material		
	Stainless steel grade 316	100	3.7
	Galvanised		
	Fastener	125	3.7
	Components		
	 Springs - stainless steel grade 302 	150	4.5
	Adjustment		
	Tamperproof	200	5.6
	Fixing		
	• Loop	250	5.0
	Safe working load (kg)		
	Length (mm)	300	6.1
	 Stud (permanently fixed to wire rope length) 	L	1
	Single toggle	350	10.0
	Double toggle		
	Double karabiner	400	10.5
	Hook		
•	Accessories	450	11.0
	Setting keys		
	Span/bearer supports	500	12.0
	Ceiling clip fixings	000	0
	Threaded adaptors	600	14.0
	Anchor bolts	000	
	Anchor for stud fixings		
	Ceiling fixing kit	Pipe	Maxi
	Corner saddle	Bore	Maxi
	Fastener décor cover	(mm)	
Y1().4220 SUPPORT SPACING:	Nomin	UPV
Spa	ace supports as tables.	al	Class
Pip	e Maximum Support Spacing (M)		
Boi	e		horiz
(mr	n)		al
		L	
No	nin Steel Pipe Copper Pipe Iron Pipe	Up to	-
al		10	1
		L	
	horizont vertic horizont vertical horizo vertic	15	-

al

Up to 1.8

al

1.2

1.8

al

2.4

ntal

-

al

-

KJ TAIT ENGINEERS

2.1	-	-
2.4	-	-
20		
3.0	-	
3.0	-	-
3.0	1.8	1.8
3.6	-	-
3.6	2.7	2.7
36	27	27
0.0	<i>L.1</i>	<u> </u>
3.6	-	-
4.2	3.7	3.7
-	3.7	3.7
-	4.5	5.4
-	8.0	10.0
1	0.0	
-	-	-
-	-	-
-	-	-
-	-	-
-	_	-
1		<u> </u>
(M)		
lono Dino	Class F	line
E, 6, 7	Type 50))
horizont al	horizo ntal	horizo ntal
0.45	-	-
0.6	-	
	L	
0.6	-	-

25	-	0.75	0.4	0.6	-	-
		1	r	1	T	
32	-	0.8	0.45	0.7	-	-
	1					
40	-	0.9	0.45	0.7	0.9	1./
50	4 4	1.0	0.55	0.95	10	17
50	1.1	1.2	0.55	0.05	1.2	1.7
65	1.2	1.4	0.55	0.85	-	-
	1				1	1]
80	1.4	1.5	0.6	0.9	1.2	1.7
100	1.5	1.7	0.7	1.1	1.2	1.7
105	1		T	1		1 1
125	1./	1.9	-	-	-	-
150	10	01		10	10	17
150	1.0	2.1	-	1.5	1.2	1.7
175	2.0	2.3	-	-	-	-
				1	1	11
200	2.1	2.5	-	-	-	-
225	2.3	2.7	-	-	-	-
050			1	1		
250	2.4	2.9	-	-	-	-
300	26	21	_	_	_	
300	2.0	0.1	-	-	-	-
350	2.9	3.4	-	-	-	-
		1		1	1	11
400	3.1	3.7	-	-	-	-
			•			
450	3.4	3.7	-	-	-	-
			1	1	1	1 1
Above 450	3.7	3.7	-	-	-	-

Maximum horizontal support spacing for grooved steel pipe 6 metres.

Vertical support spacing

Check total self-weight and pressure loading against manufacturer's recommendations when using mechanical joints or end load capable flexible couplings. Ensure adequate pipe support when using non-end load capable flexible couplings.

Space vertical support intervals for plastics pipe at not greater than twice horizontal intervals tabulated.

Where multiple pipe runs of differing bores are supported from a common point, use support spacing of pipe requiring closest spacing.

Spacings give for PVC-U pipe to BS 3505 are for 20°C. Support continuously for temperatures 60°C and above.

Y10.4230# ISOLATION AND REGULATION:

- Provide valves, cocks and stop taps for isolation and/or regulation where indicated, and on
- mains to isolate major sections of distribution.
- the base of all risers and drops, except where only one item of apparatus only is served, via a • local valve or stop tap.
- points of pipe connection of all items of apparatus and equipment except where the item could conveniently be isolated or regulated by valves provided for other adjacent items.
- draw-off fittings except where ranges of fittings are served by a common float, the isolator then being fitted with the float.

Y10

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINES

Y10.4230A ISOLATION AND REGULATION:

Provide valves, cocks and stop taps for isolation and/or regulation where indicated, and on:mains to isolate major sections of distribution; the base of all risers and drops except in cases where one item of apparatus only is served which has its own local valve or stop tap; points of pipe connection of all items of apparatus and equipment except where the item could

conveniently be isolated or regulated by valves provided for other adjacent items: draw-off fittings except where ranges of fittings are served by a common float, the isolator then being fitted with the float.

Y10.4240 MAINTENANCE AND RENEWAL:

Arrange pipework, valves, drains, air vents, demountable joints, supports, etc., for convenient routine maintenance and renewals. Provide all runs with a regularly spaced pattern of demountable joints in the form of unions, flanges, etc., and also at items of equipment to facilitate disconnection. Locate valves, drains, flanges etc. in groups.

Y10.4250 CLEANING:

Remove cement and clean off all pipework and brackets.

Y10.4260 NON-FERROUS COMPONENTS: Thoroughly clean and degrease.

Y10.5010A WELDING GENERAL, CLASS 1:

Use skilled craftsman in possession of a current Certificate of Competence appropriate to type and class of work, issued by an approved authority. Mark each weld to identify operative. Submit specimen welds, representative of joints and conditions of site welding, for each craftsman, test nondestructively, approximately 10% of butt weld joints and 5% of all other joints. Weld pipeline joints to BS 2633 as appropriate. Carry out non-destructive testing on 10% or as indicated.

Y10.5010B WELDING GENERAL, CLASS 2:

Use skilled craftsman in possession of a current Certificate of Competence appropriate to type and class of work, issued by an approved authority. Mark each weld to identify operative. Submit specimen welds, representative of joints and conditions of site welding, for each craftsman, test nondestructively, approximately 10% of butt weld joints and 5% of all other joints. Weld pipeline joints to BS 2971 and to HVCA Code of Practice TR/5, Welding of Carbon Steel Pipework, as appropriate.

Y10.5020 WELDED JOINTS. STEEL PIPES: Preparation, Making and Sealing.

Arc welding, conforming to BS 2633 or BS 2971 appropriate to system temperature and pressure. Use arc welding process on piping greater than 100mm.

Y10.5030 PAINTING WELDED JOINTS, STEEL PIPES: Unless pipework is being prepared for galvanizing after manufacture, wire brush and paint all welds with red oxide paint when welds are complete.

Y10.5040 FLANGED JOINTS, STEEL PIPES: Welded Flanges

Weld neck and bore of 'slip on' flange.

Butt weld neck of welding neck flange.

Screwed Flanges

Apply jointing materials. Screw on flange and expand tube into flange with roller expander where necessary.

Preparation

holes are correctly aligned.

Making and Sealing

Insert jointing between flange mating faces. Pull up joint equally all round.

- Ensure that flange mating faces are parallel; flange peripheries are flush with each other; and bolt

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINES

Y10.5050 SCREWED JOINTS, STEEL PIPES:

Preparation

Ensure that plain ends are cut square. Reamer out bore at plain ends. Screw plain ends, taper thread.

Making and Sealing

Coat male pipe threads with jointing compound and hemp, or PTFE tape on small sizes. Immediately after applying coating, connect with female end of socket or fitting, and tighten ensuring that coating does not intrude into pipe. Leave joint clean.

Y10.5060 MECHANICAL JOINTS, GROOVED STEEL AND STAINLESS STEEL PIPES: Preparation

Ensure that cut ends are square, free of bumps, dents and score marks and are within manufacturer's tolerances. Form groove in accordance with manufacturer's recommendations. Assemble joint in accordance with manufacturer's instructions.

Making and Sealing

Ensure gasket is suitable for service. Thoroughly lubricate gasket, externally and internally, using manufacturer's recommended lubricant. Stretch gasket over pipe end and bring pipe ends together. Slide gasket into central position over both pipe ends. Position joint half housings over gasket and insert bolts and nuts and electrical continuity clip if required. Tighten bolts to manufacturer's instructions. Check alignment of joint and pipework.

Earth continuity

Use manufacturer's earth continuity clips to ensure compliance with IET regulations.

Y10.5070A ANCHORS, STEEL PIPES, U-BOLTS:

Provide anchors constructed using mild steel over-straps or heavy U-bolts. Secure to channel section, adequately attached to or grouted into building structure; weld longitudinal edges of strap to pipe.

Y10.5070B ANCHORS, STEEL PIPES, SLIP-ON FLANGES:

Provide anchors constructed by passing two slip-on flanges over pipe to anchor point. Bolt together through an interposed mild steel channel section attached to or grouted into building structure, and finally weld flanges to pipe.

Y10.5090 STEEL PIPEWORK PAINTING:

Remove scale, rust or temporary protective coating by chipping, wire brushing or use of approved solvents and paint with one coat of red oxide primer, as work proceeds.

Y10.5100 COMPRESSION JOINTS, STAINLESS STEEL PIPES:

Use BS EN 1254-2 Type 'A' fittings.

Preparation - Ensure that plain ends are cut square. Reamer out bore at plain ends to full bore size. Clean plain ends with fine steel wool.

Making and Sealing - In accordance with fitting manufacturer's instructions.

Y10.6030 COMPRESSION JOINTS, COPPER PIPES, LIGHT GAUGE: Preparation for fittings to BS EN 1254-2.

Type `A' fitting

Ensure that plain ends are cut square. Reamer out bore at plain ends to full bore size. Clean plain ends with fine steel wool or fine sandpaper.

Type `B' fitting

Ensure that plain ends are cut square. Reamer out bore at plain ends to full bore size. Clean plain ends with fine steel wool or fine sandpaper. Then comply with manufacturer's instructions.

Making and Sealing - As manufacturer's instructions.

Y10.6040 CAPILLARY JOINTS, COPPER PIPES, LIGHT GAUGE:

Preparation - Ensure that plain ends are cut square. Reamer out bore at plain ends to full bore size. Clean plain ends with fine steel wool.

Making and sealing - Use specified flux ensuring no excess material used. Make joint in accordance with manufacturer's instructions. Clean off traces of flux when joint is completed.

Y10.6050 BRAZED JOINTS, COPPER/COPPER ALLOY PIPES: Preparation - Prepare for brazing in accordance with BS EN 14324. Use manufactured fittings not subject to dezincification and suitable for application. Making and Sealing - Use flame heat and make in accordance with BS EN 14324. Use silver brazing filler alloy suitable for application.

Y10.6060A ANCHORS, COPPER PIPES, SADDLE CLAMPS: Provide anchors constructed by fitting two flanges to copper female adapters in pipe run at anchor point. Bolt together through an interposed mild steel channel section attached to or grouted into building structure.

Y10.6060B ANCHORS, COPPER PIPES, SADDLE CLAMPS: Anchor pipework using saddle clamps to mild steel channel section attached to or built into building structure.

Y10.6090 PUSH-FITTING SYSTEM:

Carry out the installation of push-fit fitting systems on copper pipe in accordance with manufacturer's recommendations. Ensure all fittings are electrically continuous when the jointing process is complete.

Y10.7010 FLANGED JOINTS. CAST IRON/DUCTILE IRON PIPES: Preparation - Ensure that flange mating faces are parallel, flange peripheries are flush with each other and bolt holes are correctly aligned.

Making and Sealing - Coat both sides of joint ring with jointing compound to BS 6956-5 or BS EN 751-2. Insert joint ring between flange mating faces. Pull up joint with bolts, nuts and washers, ensuring that excess compound does not intrude into the pipe. Leave joint clean.

Y10.7030 FLEXIBLE JOINTS, CAST IRON PIPES: Preparation - Ensure that cut ends are square. Form groove to manufacturer's detail. Assemble joint in accordance with manufacturer's instructions. Making and Sealing - Ensure joint ring is suitable for service. Thoroughly lubricate joint ring. Slip ring over pipe end and bring ends together. Slide ring into central position over both pipe ends. Position metal half housings over joint ring and insert bolts and nuts. Tighten bolts to manufacturer's instructions. Check alignment of joint and pipework.

Y10.8010 SOLVENT WELDED JOINTS, PVC PIPES: Use solvent welded joints generally, ring seal joints at expansion joints and elsewhere as necessary. Preparation - Ensure that plain ends are cut square. Reamer out bore at plain ends. Clean plain ends with solvent cleaner.

Making and Sealing - In accordance with fitting manufacturer's instructions.

Y10.8020 FUSION JOINTS. POLYETHYLENE PIPES: Preparation - Square cut plain ends. Form pipe ends for socket type joints. Making and Sealing - In accordance with fitting manufacturer's instructions.

Y10.8030 MECHANICAL FITTINGS FOR POLYETHYLENE PIPE: Preparation - Ensure that cut ends are square. Check wall thickness/pressure rating of fitting. Making and sealing - Ensure correct gasket type is used for service (e.g. water or gas). Assemble fitting in accordance with manufacturer's instructions.

Y10.8040 ANCHORS - PVC PIPES: Clamp pipework to mild steel channel section attached to or grouted into building structure, using PVC coated over-straps, or clamps and with a polypropylene strip between pipe and mild steel section.

Y10.8050 JOINTING POLYBUTYLENE PIPES AND FITTINGS: Carry out installation of polybutylene pipes and fittings in accordance with manufacturer's instructions.

Y10.9010 FLEXIBLE COUPLINGS AND FLANGE ADAPTERS, SLEEVE TYPE: Preparation - Ensure that cut ends are square and free of bumps, dents and score marks and are within manufacturer's tolerances.

Making and sealing - Ensure gasket is suitable for service. Thoroughly lubricate gasket using manufacturer's recommended lubricant. Assemble coupling in accordance with manufacturer's instructions.

For non-end load capable couplings, ensure that adequate pipe anchorage is provided to prevent pipe disengagement.

Y10.9020A STEAM AND CONDENSE MAINS:

Install steam and condense mains to a minimum fall of 1 in 250. Take steam connections to plant and equipment from the top of the steam main. Connect condense discharge from trap sets, into the top of the condense main.

Do not use trap sets to lift condense on equipment with automatic control valves. On steam mains, provide drain trap sets discharging into the condense mains, at all low points in steam mains. Connect drain traps to a large bore pocket below the steam mains.

Y10.9020B STEAM AND CONDENSE MAINS:

Install steam and condense mains to a minimum fall of 1 in 250. Take steam connections to plant and equipment from the top of the steam main. Connect condense discharge from trap sets, into the top of the condense main. Do not use trap sets to lift condense on equipment with automatic control valves. On steam mains, provide drain trap sets discharging into the condense mains, at all low points in steam mains and immediately before all automatic control valves in the steam mains. Connect drain traps to a large bore pocket below the steam mains.

Y10.9030 PROTECTION OF UNDERGROUND PIPEWORK: Location

• As shown on drawing

Protect where indicated against corrosion by the application of a compatible anti-corrosive, noncracking, non-hardening waterproof sealing tape.

Apply, after cleaning pipework, by wrapping contrawise with two layers spirally around the pipe, ensuring a 50% minimum overlap.

Y10.9040A PROTECTION OF BURIED PIPES, UNMARKED: Provide earth cover as follows

Water pipework

900 mm minimum; 1200 mm maximum where practicable. Fuel oil and gas - 500 mm minimum. Under roadways provide minimum cover of 900 mm.

Y10.9040B PROTECTION OF BURIED PIPES, MARKED: Location Provide earth cover as follows Water pipework 900 mm minimum; 1200 mm maximum where practicable. Fuel oil and gas - 500 mm minimum.

Under roadways provide minimum cover of 900 mm. Provide a marker tape to identify buried pipe services as indicated.

Y10.9060A INSTALLATION OF THERMALLY INSULATED UNDERGROUND PIPELINES TO BS EN 253:

Install preinsulated bonded pipelines to BS EN 253, BS EN 448, BS EN 488 and BS EN 489 in accordance with manufacturer's instructions.

Y10.9060B INSTALLATION OF THERMALLY INSULATED UNDERGROUND PIPELINES TO BS 4508-1:

Install thermally insulated underground pipelines comprising steel casing with air gap in accordance with BS 4508-1.

Y10.9100 CORROSION PROTECTIVE TAPE:

Apply basic cotton carrier tape saturated with petroleum hydrocarbons with inert siliceous fillers. Wind tape spirally contrawise round pipework applied and overlapped to manufacturer's recommendations.

Y10.9110 MECHANICAL PROTECTIVE TAPE: Apply hessian based bituminous tape over the corrosion protective tape. Wind tape spirally contrawise round pipework applied and overlapped to manufacturer's recommendations.

Y10.9120A STEELWORK GALVANIZED AFTER MANUFACTURE: Prepare supports, bearers and other uncovered steelwork as steel pipework. Where not exposed, paint with one coat zinc chromate or red oxide primer. **Y11 PIPELINE ANCILLARIES**

Y11.1000 GENERAL SAFETY AND RELIEF VALVES, SELF OPERATED, APPLICATION: 1010 Safety - To discharge with rapid opening action to prevent pre-determined safe pressure being exceeded. Relief - To discharge with opening action proportional to increase in pressure above set pressure. 1020 EXPOSED VALVES: Fit easy-clean covers over glands and bonnets to small copper alloy valves exposed in areas other than plant rooms. Fit thermoplastic valve wheels. Fit dust caps to lockshield valves. 1030 TESTING: Ensure that valves and cocks are pressure tested at manufacturer's works, in accordance with appropriate British Standards specification. Test valves in accordance with BS EN 12266-1 and BS EN 12266-2. Y11.2010A THREADED ENDS STOP TAPS TO BS 1010-2: Material - Bronze or DZR copper alloy body. Washer material suitable for service fluid and operating temperature. Ends - Threaded to BS 21 and BS EN 10226-1. Pattern - Straight pattern. Y11.2010B CAPILLARY FITTING STOP TAPS TO BS 1010-2: Material - Bronze or DZR copper alloy body. Washer material suitable for service fluid and operating temperature. Ends - Capillary fitting to BS EN 1254-1. Pattern - Straight pattern.

Y11.2015A STOP VALVES TO BS EN 1213 FOR POTABLE WATER SUPPLIES - COMPRESSION ENDS FOR COPPER: Pattern - Straight. Material - copper alloy. Flow rate class - VA (straight and angle pattern stopvalves). End connections - Compression to BS EN 1254-2.

Y11.2015B STOP VALVES TO BS EN 1213 FOR POTABLE WATER SUPPLIES - COMPRESSION ENDS FOR PLASTICS: Pattern - Straight. Material - copper alloy. Flow rate class - VA (straight and angle pattern stopvalves). End connections - Compression to BS EN 1254-3.

Y11.2015C STOP VALVES TO BS EN 1213 FOR POTABLE WATER SUPPLIES - CAPILLARY: Pattern - Straight. Material - copper alloy. Flow rate class VA (straight and angle pattern stopvalves). End connections - Capillary to BS EN 1254-1.

Y11.2015D STOP VALVES TO BS EN 1213 FOR POTABLE WATER SUPPLIES - THREADED: Pattern - Straight. Material - copper allov. Flow rate class - VA (straight and angle pattern stopvalves). End connections - Threaded to BS 21 and BS EN 10226-1.

Y11.2020# STOP VALVES - GATE TYPE TO BS EN 12288:

Series

•

- A.
- B.
- Gate valve type
 - Solid or split wedge.

- Double disk.
- Parallel slide.
- Ends
 - Threaded to BS EN ISO 228-1 or ISO7-1.
 - Flanged to BS EN 1092-3 PN
 - Compression to BS EN 1254-2.
 - Compression to BS EN 1254-3.
 - Capillary to BS EN 1254-1, or BS EN 1254-5.
 - Loose nut/union end.
- Stem
- Inside screw rising stem.
- Inside screw non-rising stem.
- Outside screw rising stem.
- Trim material
- Manufacturer's standard.
- Suitable for potable water supply.
- Operation
 - Handwheel.
 - Lockshield.
- Options
 - Metallic renewable seat/disk rings.
 - Non-metallic renewable seat/disk rings.
 - Body tappings and drain plug.
 - Position indicator.
 - Locking device.

Y11.2020A THREADED ENDS GATE VALVES TO BS EN 12288: Series - B.

Gate valve type - Solid or split wedge. Ends - Threaded to BS EN ISO 228-1 or ISO 7-1. Stem - Inside screw non-rising stem. Trim material - Manufacturer's standard. Operation - Handwheel.

Y11.2020B COMPRESSION ENDS GATE VALVES TO BS EN 12288: Series - B. Gate valve type - Solid or split wedge. Ends - Compression to BS EN 1254-2. Stem - Inside screw non-rising stem. Trim material - Manufacturer's standard.

Operation - Handwheel.

Y11.2020C FLANGED ENDS GATE VALVES TO BS EN 12288: Series - B. Gate valve type - Solid or split wedge. Ends - Flanged to BS EN 1092-3. Stem - Inside screw non-rising stem. Trim material - Manufacturer's standard.

Operation - Handwheel.

Y11.2020D LOOSE NUT/UNION ENDS GATE VALVES TO BS EN 122883 Series B. Gate valve type - Solid or split wedge. Ends - Loose nut/union end.

Stem - Inside screw non-rising stem. Trim material - Manufacturer's standard. Operation - Handwheel.

Y11.2030# STOP VALVES - GATE TYPE TO BS EN 1171:

Y11

- Valve type
 - Solid or split wedge.
 - Double disk.
 - Inside screw stem (non-rising). ٠
 - Outside screw stem (rising).
- Seat ٠
 - Resilient.
 - Metal.
- Stem sealing
 - Stuffing box and gland.
 - Injector packing form.
 - Toroidal sealing rings (O-rings).
- Ends
 - Flanged to BS EN 1092-2. PN
 - Threaded to BS 21 and BS EN 10226-1. ٠
- Grooved.
- Body and bonnet material
 - Grey cast iron.
 - SG cast iron. •
 - Malleable cast iron.
- Trim category
 - Copper alloy faced.
 - Resilient seated.
 - All iron. •
- Stainless steel.
- Operation
- Handwheel.
- Key. •
- Actuator.
- Options •
 - Suitable for use with potable water.
 - Body tappings and plug.
 - Indicator.
 - Back seating surface. ٠
 - Bypass. ٠
 - Locking device. ٠

Y11.2030A FLANGED GATE VALVES TO BS EN 1171: Valve type - Solid or split wedge. Seat - Metal. Ends - Flanged to BS EN 1092-2. Body and bonnet material - Grey cast iron. Trim category - Copper alloy faced. Operation - Handwheel.

Y11.2030B GROOVED END GATE VALVES TO BS EN 1171: Valve type - Solid or split wedge. Seat - Metal. Ends - Grooved. Body and bonnet material - Ductile iron. Trim category - Copper alloy faced. Operation - Handwheel.

Y11.2040A THREADED END GLOBE VALVES TO BS 5154: Series - B. Pattern - Straight. Ends - Threaded to BS 21 and BS EN 10226-1. Stem - Inside screw rising stem.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **PIPELINE ANCILLARIES**

Trim material - Manufacturer's standard. Operation - Handwheel. Options - Non-metallic renewable seat/disk rings.

Y11.2040B FLANGED GLOBE VALVES TO BS 5154: Series - B. Pattern - Straight. Ends - Flanged to BS EN 1092-3. Stem - Inside screw rising stem. Trim material - Manufacturer's standard. Operation - Handwheel. Options - Non-metallic renewable seat/disk rings. Y11.2040C COMPRESSION GLOBE VALVES TO BS 5154: Series - B.

Pattern - Straight. Ends - Compression fitting to BS EN 1254-2. Stem - Inside screw rising stem. Trim material - Manufacturer's standard. Operation - Handwheel. Options - Non-metallic renewable seat/disk rings.

Y11.2040D COMPRESSION GLOBE VALVES TO BS 5154 FOR PLASTIC PIPE: Series - B. Pattern - Straight. Ends - Compression fitting to BS EN 1254-3 or BS 864-5. Stem - Inside screw rising stem. Trim material - Manufacturer's standard.

Operation - Handwheel. Options - Non-metallic renewable seat/disk rings.

Y11.2050A FLANGED GLOBE VALVES TO BS EN 13789: Pattern - Straight. Stem - Rising stem outside screw. Ends - Flanged to BS EN 1092-2. Material - Manufacturer's standard.

Y11.2060A PARALLEL SLIDE VALVES TO BS EN 1171: Ends - Flanged BS EN 1092-2. Stem - Rising stem. Valve faces - Stainless steel disc and seat.

Y11.2070A FLANGED STOP VALVES - GATE TYPE TO BS EN 1984: Pattern - Full bore or reduced bore. Materials - Cast steel body and materials to suit fluid and operating conditions. Ends - Flanged. Operation - Handwheel.

Y11.2070D THREADED STOP VALVES - GATE TYPE TO BS EN 1984: Pattern - Full bore or reduced bore. Materials - Cast steel body and materials to suit fluid and operating conditions. Ends - Threaded to BS 21 and BS EN 10226-1. Operation - Handwheel.

Y11.2080# STOP VALVES - BALL TYPE:

- Material
 - Bronze or DZR copper alloy body.
- Brass body.
 - Stainless steel.
- Ends

Y11

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINE ANCILLARIES

Threaded to BS 21 and BS EN 10226-1. Provide le	ever and gear operated valves with long body ne
Compression to BS EN 1254-2. Seat - Bor	nded.
Compression to BS EN 1254-3, or BS 864-5. Materials	- Cast iron body; stainless steel shaft; aluminiur
Capillary to BS EN 1254-1. Operation	 Lever and graduated notch plate.
Grooved (to suit copper pipe).	
Chrome or nickel plated DZR sphere with full bore flow aperture. Y11.2090	B GEAR OPERATED BUTTERFLY VALVES TO
PTFE seats and stem seals. Anti-blow out stem. Construct	tion - Provide controlled elastomer compression
Operation	or installation between flanged pipework connect
Lever operated. Sect. Dec.	ever and gear operated valves with long body ne
Screw driver operated. Seal - Bol Materials	Cast iron body: staiplass stool shaft; aluminiur
Key operated.	- Cast from body, stainless steer shall, aluminiu
Lockshield.	r - gear operated.
Extended spindle. Y11.2090 JOINTS:	C LEVER OPERATED BUTTERFLY VALVES 1
Y11.2080A THREADED END BALL TYPE VALVES - SCREW DRIVER/KEY OPERATED: Construct	tion - Semi-lugged wafer type design, for installa
Materials - Bronze or DZR copper alloy body.	ends.
Ends - Threaded to BS 21 and BS EN 10226-1.	ever and gear operated valves with long body ne
Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-	nded.
blowout stem. Materials	- Ductile iron body; stainless steel shaft; rubber
Operation - Screw driver operated or key operated. Operation	I - Lever and graduated notch plate.
Y11.2080B COMPRESSION END BALL TYPE VALVES - SCREW DRIVER/KEY OPERATED:	ND GEAR OPERATED BUTTERELY VALVES TO
Materials - Bronze or DZR copper alloy body.	D GEAR OF ERATED BOTTERIET VALVES IN
Ends - Compression fittings to BS EN 1254-2.	tion - Semi-lugged water type design, for installa
Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-	ends.
blowout stem.	ever and gear operated valves with long body ne
Operation - Screw driver operated or key operated. Seat - Bor	nded.
Materials	- Ductile iron body; stainless steel shaft; rubber
Y11.2080C THREADED END BALL TYPE VALVES - LEVER OPERATED: Operation	n - gear operated.
Materials - Bronze or DZR copper alloy body.	
Ends - Inreaded to BS 21 and BS EN 10226-1. Y11.2110	# STOP VALVES - SLUICE TYPE TO BS 5163
Onrome or nickel plated DZR sphere with full bore flow aperture. PIFE seats and stem seals. Anti- Valve	e type
A A A	۱.
• B	8.
• Ends	
• Fl	langed to BS EN 1092-2, PN
Ends - Compression fittings to BS EN 1254-2.	Grooved.
Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-	
Blowout stem.	Resilient seated.
Operation - lever operated. • M	letal seated.
• Stem	seal
Y11.2080E THREADED END BALL TYPE VALVES - LOCKSHIELD: • S	Stuffing box and gland.
Materials - Bronze or DZR copper alloy body.	njector packing foil.
Ends - Threaded to BS 21 and BS EN 10226-1.	oroidal sealing rings (O-rings).
Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti- • Opera	ation
• T	key.
• R	Ring key/bar.
	landwheel.
TIL2000F UDWIPHESSION BALL TYPE VALVES - LUGKSHIELD: • E	lectric actuator.
Mater	rials
Chrome or nickel plated DZR sphere with full hore flow aperture PTEE seats and stem seals Anti-	Ianufacturer's standard.
hlowout stem	VRAS approved.
Operation - lockshield Option	ns
• S	stem cap.
Y11.2090A LEVER OPERATED BUTTERFLY VALVES TO BS EN 593 BETWEEN FLANGES:	

Construction - Provide controlled elastomer compression on flange faces; semi-lugged wafer type design, for installation between flanged pipework connections, body to suit BS EN 1092-2.

KJ TAIT ENGINEERS

KJ TAIT ENGINEERS

Grooved ends.

•

• Flanged to BS EN 1092-2, PN

dy neck for lagging clearance.

inium bronze disc; EPDM seat.

S TO BS EN 593 BETWEEN FLANGES: sion on flange faces; semi-lugged wafer type nections, body to suit BS EN 1092-2. dy neck for lagging clearance.

iinium bronze disc; EPDM seat.

ES TO BS EN 593 BETWEEN MECHANICAL

stallation between mechanical joints, body with

dy neck for lagging clearance.

bber coated ductile iron disc; EPDM seat.

ES TO BS EN 593 BETWEEN MECHANICAL

stallation between mechanical joints, body with

dy neck for lagging clearance.

ober coated ductile iron disc; EPDM seat.

5163-1 AND BS 5163-2:

Y11.2110A STOP VALVES - KEY OPERATED SLUICE TYPE A TO BS 5163-1 AND BS 5163-2:

Valve type - A

Seat - Resilient or metal seated.

Stem seal - Stuffing box and gland; injector packing foil; or toroidal sealing rings (O-rings). Operation - T key.

Materials - Manufacturer's standard and WRAS approved. Options - Stem cap.

Y11.2110B STOP VALVES - KEY OPERATED SLUICE TYPE B TO BS 5163-1 AND BS 5163-2:

• Flanged to BS EN 1092-2, PN

Grooved ends.

Valve type - A

Seat - Resilient or metal seated.

Stem seal - Stuffing box and gland; injector packing foil; or toroidal sealing rings (O-rings). Operation - T key. Materials - Manufacturer's standard and WRAS approved.

Options - Stem cap.

Y11.2120# STOP VALVES TO BS 5433:

- Bronze or DZR copper alloy body threaded to BS 21 and BS EN 10226-1.
- Washer material suitable for service fluid and operating temperature.

Y11.2125# POLYETHYLENE VALVES TO BS EN 13244-5:

- Pattern
 - Straight.
 - Angle. ٠
 - Oblique.
- Material polyethylene.
- Standard BS EN 13244-5.
- Type
 - Butt fusion.
 - Socket fusion. •
 - Electrofusion. •
 - Compression. ٠
 - Flanged.
- Operation
- Handwheel.
- Valve actuator.
- Dimensions
- BS EN 13244-4, section 6.
- Marking
 - BS EN 13244-4, tables 5 and 6.
- Finish •

•

Black.

Y11.2128# POLYETHYLENE VALVES TO BS EN 1555-4:

- Pattern
- Straight.
- Angle.
- Oblique.
- Material polyethylene. ٠
- Standard BS EN 1555-1, BS EN 1555-4 and BS EN 1555-5.
- Ends
- Butt fusion.
- Socket fusion.
- Electrofusion.
- Compression. •
- Flanged.
- Operation

KJ TAIT ENGINEERS

- Hand wheel. Valve actuator.
- Dimensions
- BS EN 1555-4, section 6.
- Marking
 - BS EN 1555-4, table 5.
- Finish
- Black. •
- Yellow.

Y11.2230A THREADED ENDS FLOW MEASUREMENT DEVICES TO BS 7350, COPPER ALLOY: BS 7350, section 3.2 - type 3

A fixed orifice either integral with or as a fixed orifice fitting close coupled to a double regulating globe valve.

Ends - Threaded to BS 21 and BS EN 10226-1. Material - Double regulating globe valve, bronze or DZR copper alloy to BS 5154 series B and close coupled fixed orifice fitting to BS 7350 table 6. Options - Independent means for positive isolation on pressure tapping or adapter.

Y11.2230C FLANGED FLOW MEASUREMENT DEVICE TO BS 7350 CAST IRON. TYPE 3: BS 7350, section 3.2 - type 3 A fixed orifice either integral with or as a fixed orifice fitting close coupled to a double regulating globe

valve. Ends - Flanged to BS EN 1092-2.

Material - Double regulating globe valve to BS EN 13789 and close coupled fixed orifice fitting to BS 7350. table 6.

Options - Independent means for positive isolation on pressure tapping or adapter.

Y11.2230E THREADED ENDS FLOW MEASUREMENT DEVICES TO BS 7350 TYPE 4, COPPER ALLOY:

BS 7350, section 3.2 - type 4, variable orifice valve. Ends - Threaded to BS 21 and BS EN 10226-1. Material - Variable orifice, double regulating globe valve, bronze or DZR copper alloy to BS 5154 series B.

Options - Independent means for positive isolation on pressure tapping or adapter.

Y11.2230G FLOW MEASUREMENT DEVICES TO BS 7350 TYPE 4, CAST IRON: BS 7350, section 3.2 - type 4, variable orifice valve. Ends - Flanged to BS EN 1092-2.

Material - Variable orifice, double regulating globe valve, cast iron to BS EN 13789. Options - Independent means for positive isolation on pressure tapping or adapter.

Y11.2260A RADIATOR VALVES TO BS 2767 (TYPE 4):

- Finish
 - Natural.

Chromium plated.

Material - Bronze or brass copper alloy body. Pattern - Angle or straight to suit application.

Straight - Threaded to BS 21 and BS EN 10226-1 or compression to BS EN 1254-2 to suit pipework as indicated.

Angle - Threaded to BS 21 and BS EN 10226-1 with one end internal and other end external with union nut and tail pipe; or compression joint to BS EN 1254-2 one end and other end externally threaded to BS 21 and BS EN 10226-1 with union nut and tail pipe to suit pipework as indicated. Options - Fit wheel valves on flow connections to radiators, and other heat emitters, without thermostatic radiator valves. Fit lockshield valves on return connections.

Y11.2270C THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.3:

- Pattern
 - Straight

Y11/383

 Angle Material to Annex A. Pattern - Straight or angle pattern to suit application. Dimensions - Table A.3 series S. Thermostatic valve type - Integral sensor unless otherwise indicated.

Y11.2270F TAMPER PROOF THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.2:

- Pattern
 - Straight
 - Angle

Material to Annex A. Pattern - Straight or angle pattern to suit application. Provide tamper proof TRV's. Dimensions - Table A.2 series S. Thermostatic valve type - Integral sensor unless otherwise indicated.

Y11.2280A FLOAT OPERATED VALVES TO BS 1212-1, COPPER FLOAT: Piston type float operated valve to BS 1212-1. Connection - Side or bottom entry to suit application. Float - Copper to BS 1968.

Y11.2315A OPEN/CLOSE CONTROL BALL VALVES: Valve - Open/Close valve. Rotary Actuator - Open/close. Material - Nickel-plated brass; stainless steel ball; PTFE seal; stainless steel spindle; EPDM spindle seal. Connections - Threaded to BS 21 and BS EN 10226-1. Ancillaries - Lever for manual operation.

Y11.2315B TWO WAY CONTROL BALL VALVES:

Valve - Two way control valve. Rotary Actuator - Modulating. Material - Nickel-plated brass; stainless steel ball; PTFE seal; stainless steel spindle; EPDM spindle seal. Connections - Threaded to BS 21 and BS EN 10226-1. Ancillaries - Lever for manual operation.

Y11.2315C THREE WAY CONTROL BALL VALVES: Valve - Three way control valve. Rotary Actuator - Modulating. Material - Nickel-plated brass; stainless steel ball; PTFE seal; stainless steel spindle; EPDM spindle seal. Connections - Threaded to BS 21 and BS EN 10226-1. Ancillaries - Lever for manual operation.

Y11.2320# CHECK VALVES - SWING CHECK TYPE TO BS 5154:

- Series •
- A.
- B.
- Pattern
- Straight.
- In vertical lines with flow upwards.
- Ends
 - Threaded to BS 21 and BS EN 10226-1.
 - Flanged to BS EN 1092-3, PN
 - Compression to BS EN 1254-2.
 - Compression to BS EN 1254-3, or BS 864-5.
 - Capillary to BS EN 1254-1.
- Trim material

Manufacturer's standard.

- Suitable for potable water supply.
- Options
 - Metallic renewable seat/disk rings.
 - Non-metallic renewable seat/disk rings.
 - Body tappings and drain plug.

Y11.2320A THREADED ENDS SWING CHECK VALVES TO BS 5154: Series B; horizontal pattern. Ends - Threaded to BS 21 and BS EN 10226-1. Trim material - Manufacturer's standard.

Y11.2320B FLANGED SWING CHECK VALVES TO BS 5154: Series B; horizontal pattern. Ends - Flanged to BS EN 1092-3. Trim material - Manufacturer's standard.

Y11.2330A FLANGED SWING CHECK VALVES TO BS EN 12334 Check valve type to BS EN 736-1 - Swing. Body type - Flanged. Ends - Flanged to BS EN 1092-2. Body and cover materials - Grey cast iron or SG cast iron. Orientation of pipework - Horizontal or vertical.

Y11.2330B WAFER BODY SWING CHECK VALVES TO BS EN 12334: Check valve type to BS EN 736-1 - Swing. Body type - Wafer. Body and cover materials - Grey cast iron or SG cast iron. Orientation of pipework - Horizontal or vertical.

Y11.2385# DEVICES TO PREVENT CONTAMINATION OF WATER BY BACKFLOW TO BS 6282:

- Standard BS 6282.
 - BS 6282-1 check valves.
 - BS 6282-2 terminal anti-vacuum valves.
 - BS 14451 in-line anti-vacuum valves. • BS 6282-4 combined check and anti-vacuum valves.
- WRAS approval.
 - Ends
 - Compression connections to BS EN 1254-2. Threaded to BS 21 and BS EN 10226-1.

 - Flanged to BS EN 1092-3.

Y11.2385A COMBINED CHECK AND ANTI-VACUUM DEVICE TO PREVENT CONTAMINATION OF WATER BY BACKFLOW TO BS 6282: Standard - BS 6282-4 combined check and anti-vacuum valves. WRAS approval.

Ends - Compression connections to BS EN 1254-2.

Y11.2390# ANTI BACK SYPHONAGE VALVES - COMBINED CHECK AND ANTI- VACUUM TYPE:

- Bronze or DZR copper alloy body assembly.
- WRAS approval.
- Ends
- Compression connections to BS EN 1254-2. • Threaded to BS 21 and BS EN 10226-1.
- Pattern
 - Side inlet, bottom outlet pattern.
 - In-line pattern, horizontal.
 - In-line pattern, vertical.
 - Bottom inlet, side outlet pattern.

- Components ٠
 - Stainless steel domed air inlet.
 - Non-return valve with plastic body, rubber actuator and stainless steel to plastic seal.
 - Integral stop valve facility.

Y11.2390A COMBINED CHECK AND ANTI-VACUUM TYPE ANTI BACK SYPHONAGE VALVES: Bronze or DZR copper alloy body assembly with compression connections to BS EN 1254-2. Pattern - In-line pattern.

Components - Stainless steel domed air inlet. Non-return valve with plastic body, rubber actuator and stainless steel to plastic seal. WRAS approval.

Y11.2395A VERIFIABLE BACKFLOW PREVENTER WITH REDUCED PRESSURE ZONE (RPZ) VALVE - GENERAL REQUIREMENTS:

Provide an application to the local water supplier using the WRAS "RPZ Valve Assembly - Application for Installation" form.

Obtain Water Supplier agreement that a Type BA device is a suitable means of backflow protection in the water supply system under consideration.

Test methods and maintenance regimes shall be in accordance with the Water Suppliers requirements and any failure to comply may result in termination of supply or removal of the device. These maintenance requirements must be detailed within the project Operation & Maintenance documentation.

The fitting must be included in the WRAS "Water Fittings and Materials Directory" and satisfy the requirements of the Regulations.

The installer must obtain formal Water Supplier agreement that a Type BA device is a suitable means of backflow protection in the plumbing system under consideration before installation.

Confirm that any Type BA device installed provides protection against back pressure and back siphonage at the point of use from fluids up to and including Category 4 as defined in the Water Supply (Water Fittings) Regulations 1999.

Comply with the stipulations and requirements set out in WRAS Information and Guidance Note No. 9-03-02.

Y11.2395B VERIFIABLE BACKFLOW PREVENTER WITH REDUCED PRESSURE ZONE (RPZ) VALVE - INSTALLATION:

The Type BA device shall not be installed in a place or position which is:

Liable to flooding

Above electrical equipment

Exposed to freezing - unless measures are taken to prevent the assembly from freezing The assembly shall be:

- Installed horizontally with the relief valve discharging downwards
- Installed with inline strainers fitted downstream of the inlet isolating valve and immediately upstream of the device - to prevent fouling of elements of the assembly
- Installed above ground at a height enabling effective inspection and maintenance
- Installed not less than 300mm above ground or floor level or the base of any cabinet to the ٠ underside of the exit port of the relief valve
- Installed no more than 1500mm above ground or floor level •

Installed with an air break between the relief outlet port and the top of the allied tundish Following installation the assembly shall be flushed and disinfected in accordance with BS 6700. Following flushing and prior to commissioning and site test, the assembly shall be checked by the installer to ensure that the relief valve functions correctly - in accordance with the guidelines in WRAS Information and Guidance Note No. 9-03-02.

Y11.2395C VERIFIABLE BACKFLOW PREVENTER WITH REDUCED PRESSURE ZONE (RPZ) VALVE - ON SITE INSPECTION AND TESTING:

Site testing must only be carried out by an accredited tester approved by the Water Supplier. Testing shall be carried out at intervals not exceeding 12 months.

Test data during the commissioning of the assembly and at subsequent intervals shall be entered on the "RPZ Valve Test Report Form" produced by the WRAS.

The inspections and testing shall be in accordance with WRAS Information and Guidance Note No. 9-03-02.

On completion of site tests, a certificate must be completed by the tester in accordance with WRAS Guidance Note and copies submitted to the water supplier and the person responsible for the device. Copies shall be included in the Operation and Maintenance Manuals, including interval periods for subsequent testing.

Y11.2395D VERIFIABLE BACKFLOW PREVENTER WITH REDUCED PRESSURE ZONE (RPZ) VALVE - RECORD OF INSTALLATION AND TEST DATA: Provide records for each assembly.

In general, the record shall indicate the following:

Precise location of the assembly

Purpose of the assembly

Data pertaining to prescribed tests

Frequency of tests

Defects found and measures taken to remedy these defects Details of the person who carried out the test

The installation, commissioning and subsequent test data shall be forwarded to the Water Supplier and copies retained by the Tester and the Water Supplier's customer for a period of at least five years.

Y11.2400# PRESSURE REDUCING VALVES - INTEGRAL SENSOR TYPE:

- Material
 - Bronze or DZR copper alloy body threaded to BS 21 and BS EN 10226-1.
 - Stainless steel valve and seat and return spring.
 - Phosphor bronze bellows.
- Components
- Control spring and hand wheel.

Y11.2420# PRESSURE CONTROL VALVES - DIRECT ACTING TYPE: Provide valves to maintain a pressure downstream of valve.

- Material
- Cast iron body.
- Cast steel body.
- Malleable iron body. •
- Stainless steel valve and seat and return spring.
- Phosphor bronze bellows.
- Components
 - Control spring and handwheel.
- Connections
 - Threaded to BS 21 and BS EN 10226-1.
 - Flanged to BS EN 1092-1 PN
 - Flanged to BS EN 1092-2 PN
 - Flanged to BS EN 1092-3 PN

Y11.2422# IN LINE DIFFERENTIAL PRESSURE CONTROL VALVES - DIRECT ACTING TYPE: Provide valves to maintain a constant differential pressure upstream of the valve.

Material •

- Cast iron body.
- Cast steel body.
- Malleable iron body.
- Brass body.
- Stainless steel valve and seat and return spring.
- Phosphor bronze bellows.
- Components
- Control spring and actuator.
- Valve body and bellows.
- Connections

Integral sensor with an alpha/numeric pressure set-point indicator and locking facility.

• Integral sensor with an alpha/numeric pressure set-point indicator and locking facility.

Y11

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **PIPELINE ANCILLARIES**

- Threaded to BS 21 and BS EN 10226-1.
- Flanged to BS EN 1092-1 PN
- Flanged to BS EN 1092-2 PN
- Flanged to BS EN 1092-3 PN

Y11.2424# BYPASS DIFFERENTIAL PRESSURE CONTROL VALVES - DIRECT ACTING TYPE: Provide valves to maintain a minimum circuit flow rate as system loads change.

- Material •
 - Cast iron body.
 - Cast steel body. •
 - Malleable iron body. •
 - Brass body.
 - Stainless steel valve and seat and return spring.
 - Phosphor bronze bellows.
- Components
 - Control spring and actuator.
 - Valve body and bellows.
- Connections
 - Threaded to BS 21 and BS EN 10226-1.
 - Flanged to BS EN 1092-1 PN •
 - Flanged to BS EN 1092-2 PN ٠
 - Flanged to BS EN 1092-3 PN •

Y11.2430A SAFETY VALVES TO BS EN ISO 4126-1, COPPER ALLOY, SINGLE SPRING: Material - Bronze or DZR copper alloy body. Ends - Threaded to BS 21 and BS EN 10226-1. Spring type - Single spring loaded, high lift type.

Y11.2430B SAFETY VALVES TO BS EN ISO 4126-1, COPPER ALLOY, DOUBLE SPRING: Material - Bronze or DZR copper alloy body. Ends - Threaded to BS 21 and BS EN 10226-1. Spring type - Double spring loaded, high lift type.

Y11.2440A DRAIN COCKS, THROUGHWAY GLAND COCK: Bronze body threaded male to BS 21 and BS EN 10226-1. Tapered plug with square shank for loose lever; bolted gland; strap and blank cap screwed on hand tight.

Outlet to accept hose union.

Y11.2450 DRAIN COCKS - SCREWDOWN TO BS 2879, TYPE 1: Bronze body threaded male to BS 21 and BS EN 10226-1. Screw down plug with square shank for loose lever. Serrated outlet to accept hosepipe, fixed or union pattern. Lockshield to accept key.

Y11.2460 DRAIN COCKS - BALL TYPE: Bronze or DZR copper alloy body; chrome-plated DZR ball; PTFE seats and stem seals; blow-out proof stem; strap and blank cap screwed on hand tight; serrated outlet to accept hose pipe. Lockshield key operated.

Y11.2470 VENT COCKS - TWO WAY GLAND COCK TYPE: Bronze body threaded to BS 21 and BS EN 10226-1; tapered plug with square shank for loose lever; plug position indicator; bolted gland.

Y11.2480 VENT COCKS - BALL TYPE: Bronze or DZR copper alloy body; chrome-plated DZR ball; PTFE seats and stem seals; blow-out proof stem. Permanently identified ports in T-configuration. Lever operated.

Y11.2490 VENT COCKS - THREE WAY GLAND COCK TYPE: Bronze body threaded to BS 21 and BS EN 10226-1; tapered plug with square shank for loose lever; plug position indicator; port markings to indicate inlet, vent, waste; bolted gland. Port configuration, T port.

Y11.2500A THREE WAY PLUG VALVE VENT COCKS - WRENCH OPERATED: Cast iron body, plug and bottom cover. PTFE thrust washer. Ends - Flanged to BS EN 1092-2. T port configuration. Wrench operation.

Y11.2500B THREE WAY PLUG VALVE VENT COCKS - GEAR OPERATED: Cast iron body, plug and bottom cover. PTFE thrust washer. Ends - Flanged to BS EN 1092-2. T port configuration. Gear operation.

Y11.2510A AUTOMATIC AIR VENTS, FLOAT TYPE: Construction - Bronze or DZR copper alloy body with threaded inlet to BS 21 and BS EN 10226-1. Solid polypropylene float and air release valve. Ensure valve is self closing. Operating Conditions - Maximum temperature 130°C. Maximum pressure 10 bar. Options - Provide connection for piping away released air and integral non-return valve where indicated.

Y11.2610A STEEL EXPANSION LOOPS:

 Galvanized after manufacture. Provide expansion loop in material and finish of associated pipeline. Size to limit stress set up in material of pipe wall to 69 MPa. Forge bend from a single length of pipe or join by welding fittings if expansion loops are too large to manufacture in one piece. Where indicated, galvanize after manufacture.

Y11.2620 EXPANSION LOOPS - COPPER: Provide expansion loop in material and finish of associated pipeline. Size to limit total stress set up in material of pipe wall to less than 51.5 MPa. Forge bend from a single length of pipe.

Y11.2630# EXPANSION COMPENSATORS:

- Type
 - Axial.
 - Articulated. •
 - Angular. ٠
- Ends
- Threaded to BS 21 and BS EN 10226-1.
- Flanged to BS EN 1092-1, PN
- Bevelled for welding.
- Grooved for mechanical joints.
- Bellows
 - Stainless steel, multi-ply or single-ply construction.
 - Fitted with stainless steel inner sleeves.
- Operation •
 - given working conditions.
 - Ensure expansion joints are capable of withstanding a pressure test of 1.5 times the design pressure without deformation.

Y11.2630A THREADED END EXPANSION COMPENSATORS, AXIAL BELLOWS: Ends - Threaded to BS 21 and BS EN 10226-1. Bellows - Stainless steel, multi ply or single-ply construction fitted with stainless steel inner sleeves.

• Supply expansion joints capable of not less than 2000 complete reversals of movement at the

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **PIPELINE ANCILLARIES**

Operation - Supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.

Y11.2630B FLANGED EXPANSION COMPENSATORS, AXIAL BELLOWS: Ends - Flanged to BS EN 1092-1.

Bellows - Stainless steel, multi-ply or single-ply construction fitted with stainless steel inner sleeves. Operation - Supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.

Y11.2630C BEVELLED END EXPANSION COMPENSATORS, AXIAL BELLOWS:

Ends - Bevelled for welding.

Bellows - Stainless steel, multi-ply or single-ply construction fitted with stainless steel inner sleeves. Operation - Supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.

Y11.2630D THREADED ENDS EXPANSION COMPENSATORS, ARTICULATED BELLOWS: Ends - Threaded to BS 21 and BS EN 10226-1.

Bellows - Stainless steel, multi-ply or single-ply construction fitted with stainless steel inner sleeves. Operation - Supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.

Y11.2630E FLANGED EXPANSION COMPENSATORS, ARTICULATED BELLOWS: Ends - Flanged to BS EN 1092-1.

Bellows - Stainless steel, multi-ply or single-ply construction fitted with stainless steel inner sleeves. Operation - Supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.

Y11.2630F BEVELLED ENDS EXPANSION COMPENSATORS, ARTICULATED BELLOWS: Ends - Bevelled for welding.

Bellows - Stainless steel, multi-ply or single-ply construction fitted with stainless steel inner sleeves. Operation - Supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.

Y11.2630G THREADED END EXPANSION COMPENSATORS, ANGULAR BELLOWS: Ends - Threaded to BS 21 and BS EN 10226-1.

Bellows - Stainless steel, multi-ply or single-ply construction fitted with stainless steel inner sleeves. Operation - Supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.

Y11.2630H FLANGED EXPANSION COMPENSATORS, ANGULAR BELLOWS: Ends - Flanged to BS EN 1092-1.

Bellows - Stainless steel, multi-ply or single-ply construction fitted with stainless steel inner sleeves. Operation - Supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.

Y11.2630I BEVELLED END EXPANSION COMPENSATORS, ANGULAR BELLOWS: Ends - Bevelled for welding.

Bellows - Stainless steel, multi-ply or single-ply construction fitted with stainless steel inner sleeves. Operation - Supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.

Y11.2630J GROOVED END EXPANSION COMPENSATORS, AXIAL BELLOWS: Ends - Grooved for mechanical joints.

Bellows - Stainless steel, multi-ply or single-ply construction fitted with stainless steel inner sleeves. Operation - Supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.

Y11.2640A THREADED END HOSE COMPENSATORS: Supply convoluted stainless steel hose with stainless steel braiding. Fully welded construction. Ends - Threaded ends to BS 21 and BS EN 10226-1. Operation - Supply hose compensators capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.

Y11.2640B FLANGED HOSE COMPENSATORS: Supply convoluted stainless steel hose with stainless steel braiding. Fully welded construction. Ends - Flanged to BS EN 1092-1. Operation - Supply hose compensators capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.

Y11.2650A FLANGED EPDM RUBBER FLEXIBLE CONNECTIONS UP TO 10 BAR AND 100 DEGREE C:

Material - EPDM rubber with wire reinforced cuffs. Steel reinforcement within the body.

Marking - Mould date of manufacture on bellows. Show manufacturer and type.

Ends - Flanges to BS EN 1092-1 that can swivel and are removable. Operation - Ensure flexible connections have a design life of 120 months at 100°C. Provide tie bars with rubber top hat washers where working pressure exceeds 4 bar. Supply threaded tie bars with adjustable length. Ensure flexible connections are tied when the plant is on vibration isolation mountinas.

Y11.2650B THREADED END EPDM RUBBER FLEXIBLE CONNECTIONS UP TO 10 BAR AND 100 DEGREE C:

Material - EPDM rubber with wire reinforced cuffs. Steel reinforcement within the body.

Marking - Mould date of manufacture on bellows. Show manufacturer and type.

Ends - Threaded to BS 21 and BS EN 10226-1 with one union end. Operation - Ensure flexible connections have a design life of 120 months at 100°C. Provide tie bars with rubber top hat washers where working pressure exceeds 4 bar. Supply threaded tie bars with adjustable length. Ensure flexible connections are tied when the plant is on vibration isolation mountings.

Y11.2660A TERMINAL UNIT CONNECTIONS FOR HEATING SERVICES - STAINLESS STEEL: Material - Stainless steel convoluted hose with stainless steel overbraiding. Carbon steel, stainless steel or copper tube end connections. Fully welded construction. Operation - Ensure hose length is sufficient to prevent the minimum hose bend radius from being exceeded during installation and commissioning. Working pressure 15 - 20 bar and temperature 95°C.

Y11.2660B TERMINAL UNIT CONNECTIONS WITH QUICK RELEASE COUPLINGS FOR HEATING SERVICES - STAINLESS STEEL:

Material - Stainless steel convoluted hose with stainless steel overbraiding.Carbon steel, stainless steel or copper tube end connections. Fully welded construction. Operation - Ensure hose length is sufficient to prevent the minimum hose bend radius from being exceeded during installation and commissioning. Working pressure 15 - 20 bar and temperature 95°C. Options - Supply quick release couplings with screwed ends.

Materials - Male and female nickel plated brass halves each with shut-off valve with rubber seat. Locking mechanism of stainless steel balls and stainless steel internal valve springs.

Y11.2660C TERMINAL UNIT CONNECTIONS FOR HEATING SERVICES - RUBBER: Material - EPDM inner liner with stainless steel wire braid. Nickel plated brass fittings with stainless steel ferrules.

Operation - Ensure hose length is sufficient to prevent the minimum hose bend radius from being exceeded during installation and commissioning. Working pressure 15 - 20 bar and temperature 95°C.

Y11.2660D TERMINAL UNIT CONNECTIONS FOR CHILLED WATER SERVICES - STAINLESS STEEL:

Material - Stainless steel convoluted hose with stainless steel overbraiding. Carbon steel, stainless steel or copper tube end connections. Fully welded construction. Nitrile rubber Class `O' insulation with vapour seal and end protection caps.

Operation - Ensure hose length is sufficient to prevent the minimum hose bend radius from being exceeded during installation and commissioning. Working pressure 15 - 20 bar and temperature 95°C.

Y11.2660E TERMINAL UNIT CONNECTIONS WITH QUICK RELEASE COUPLINGS FOR CHILLED WATER SERVICES - STAINLESS STEEL:

Material - Stainless steel convoluted hose with stainless steel overbraiding. Carbon steel, stainless steel or copper tube end connections. Fully welded construction. Nitrile rubber Class `O' insulation with vapour seal and end protection caps.

Operation - Ensure hose length is sufficient to prevent the minimum hose bend radius from being exceeded during installation and commissioning. Working pressure 15 - 20 bar and temperature 95°C. Options - Supply quick release couplings with screwed ends.

Material - Male and female nickel plated brass halves each with shut-off valve with rubber seat. Locking mechanism of stainless steel balls and stainless steel internal valve springs.

Y11.2670# TEST PLUGS:

Provide test plugs for measurement of temperature and pressure, complete with captive cap for sealing when not in use. Ensure test plugs are suitable for system operating temperature and pressure.

- Self sealing test points
- Valve controlled test points.

Provide one thermometer and pressure gauge for each range of conditions, for use with test plugs.

Y11.2670A TEST PLUGS, SELF SEALING:

Provide DZR copper alloy self sealing test plugs for measurement of temperature and pressure, complete with captive cap for sealing when not in use. Ensure test plugs are suitable for system operating temperature and pressure.

Provide one thermometer and pressure gauge for each range of conditions, for use with test plugs.

Y11.2670B TEST PLUGS, VALVE CONTROLLED:

Provide DZR copper alloy self valve controlled test plugs for measurement of temperature and pressure, complete with captive cap for sealing when not in use. Ensure test plugs are suitable for system operating temperature and pressure.

Provide one thermometer and pressure gauge for each range of conditions, for use with test plugs.

Y11.2680A THREADED PIPELINE STRAINERS, BRONZE:

Material - Bronze to BS EN 1982. Ends - Threaded to BS 21 and BS EN 10226-1. Pattern - Y pattern body. Screen free area - Not less than 250% of pipe bore. Screen perforations

15 to 50mm nominal size, within range 0.7 - 0.9 mm diameter.

65mm and over nominal size, within range 1.5 - 1.8mm diameter. Internal to external flow through screen. Provide plugged connections for drain, air vent and differential pressure monitoring, threaded to BS 21 and BS EN 10226-1.

Y11.2680D PIPELINE STRAINERS, CAST IRON:

Material - Cast iron.

Ends - Flanged to BS EN 1092-2. Pattern - Y pattern body. Screen free area - Not less than 250% of pipe bore. Screen perforations

15 to 50mm nominal size, within range 0.7 - 0.9 mm diameter. 65mm and over nominal size, within range 1.5 - 1.8mm diameter. Internal to external flow through screen. Provide plugged connections for drain, air vent and differential pressure monitoring, threaded to BS 21 and BS EN 10226-1.

Y11.2690A TUNDISHES, COPPER:

Provide tundishes located adjacent to equipment, as indicated. Use 3mm minimum thickness copper sheet. Form sheet into a tapered reducing cone with a minor diameter to suit drain line.

Major diameter nominally 50 mm larger than minor diameter, tapering at approximately 30 degrees.

Y11.2700# GAUGES:

- Use dial type gauges of robust construction, enclosed in dust tight metal cases. Retain dial glass with bezels screwed to case. Finish with chromium plating.
- Dial cases ٠ In plant rooms - 150mm diameter, heavy pattern, finished in black stove enamel. In other areas - 100mm diameter, finish
- Use white dial scales indelibly and clearly marked with black lettering to indicate measured valves. Select scale ranges which indicate 'Normal' when pointer is vertical or central on scale.
- Mount gauges with dial face in vertical plane and locate as follows
- Flush panel Conceal casing within a steel metal cubicle.
- Direct Support casing by connection to instrument.
- Flanged Surface mount casing to equipment or building element.

Y11.2700A GAUGES, GENERAL:

- 150mm black stove enamel finish
 - 2700B GAUGES, 150MM DIAMETER, FLUSH PANEL: metal cubicle.
 - 2700C GAUGES, 150MM DIAMETER, DIRECT MOUNTING: Dial case - 150mm diameter, heavy pattern finished in black stove enamel, for direct connection to instrument.

 - 2700D GAUGES, 150MM DIAMETER, FLANGED: Dial case - 150mm diameter, heavy pattern finished in black stove enamel, with annular mounting flange. Mount gauges with dial face in vertical plane and surface mount casing to equipment or building element, as required.
- 100mm finish
 - 2700E GAUGES, 100MM DIAMETER, FLUSH MOUNTING: Dial case - 100mm diameter for flush mounting to steel panel. Mount gauges with dial face in vertical plane flush to panel and conceal casing within a steel metal cubicle.
 - 2700F GAUGES, 100MM DIAMETER, DIRECT MOUNTING: Dial case - 100mm diameter for direct connection to instrument.
 - 2700G GAUGES, 100MM DIAMETER, FLANGE MOUNTING: Dial case - 100mm diameter with annular mounting flange. Mount gauges with dial face in vertical plane and surface mount casing to equipment or building element, as required.

Use dial type gauges of robust construction, enclosed in dust tight metal cases. Retain dial glass with bezels screwed to case. Finish with chromium plating.

Y11/393

Dial case - 150mm diameter, heavy pattern, finished in black stove enamel for flush mounting. Mount gauges with dial face in vertical plane flush to panel and conceal casing within a steel

Mount gauges with dial face in vertical plane and support casing by connection to instrument.

Mount gauges with dial face in vertical plane and support casing by connection to instrument.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PIPELINE ANCILLARIES

Use white dial scales indelibly and clearly marked with black lettering to indicate measured values. Select scale ranges which indicate `Normal' when pointer is vertical or central on scale.

Y11.2700E GAUGES, 100MM DIAMETER, FLUSH MOUNTING:

Dial case - 100mm diameter for flush mounting to steel panel.

Mount gauges with dial face in vertical plane flush to panel and conceal casing within a steel metal cubicle.

Y11.2700F GAUGES, 100MM DIAMETER, DIRECT MOUNTING: Dial case - 100mm diameter for direct connection to instrument. Mount gauges with dial face in vertical plane and support casing by connection to instrument.

Y11.2700G GAUGES, 100MM DIAMETER, FLANGE MOUNTING:

Dial case - 100mm diameter with annular mounting flange.

Mount gauges with dial face in vertical plane and surface mount casing to equipment or building element, as required.

Y11.2710# TEMPERATURE GAUGES:

- Use temperature gauges with pocket and provided with gland attachment on thermometer stem.
- Type •
 - Mercury in steel, mounted direct in pocket.
 - Vapour pressure to BS EN 13190, mounted direct in pocket with horizontal or vertical stem as • appropriate.
 - Vapour pressure to BS EN 13190, for remote mounting with capillary tube of sufficient length to allow slack run to immersion bulb. Protect capillary along full length by a flexible sheath jointed to dial case and bulb.
- Use separable type pockets, threaded 15/19mm BSP and manufactured from •
 - stainless steel.
- Screw pockets into tapped bosses or stools set in pipelines or vessels. Fill pockets with oil to BS 7207 to ensure contact with thermometer bulb.
- Provide gauges with dial graduation in degrees celsius marked on a logarithmic scale. Ensure pointer movement is clockwise for increase in temperature.
- Provide sensing elements for air and gas systems, where indicated, and fix to provide airtight joints. Provide with metal shielding around sensing element to prevent effects of local radiation from equipment.

Y11.2710A TEMPERATURE GAUGES, GENERAL:

- 2710B TEMPERATURE GAUGES, MERCURY IN STEEL: Provide mercury in steel temperature gauge, mounted direct in pocket.
- Vapour pressure to BS EN 13190
 - 2710C TEMPERATURE GAUGES, VAPOUR PRESSURE TO BS 5235 FOR DIRECT MOUNTING:

Vapour pressure type to BS EN 13190, mounted direct in pocket, with horizontal or vertical stem as appropriate.

2710D TEMPERATURE GAUGES, VAPOUR PRESSURE TO BS 5235 FOR REMOTE MOUNTING:

Vapour pressure type to BS EN 13190, for remote mounting with capillary tube of sufficient length to allow slack run to immersion bulb. Protect capillary along full length by a flexible sheath jointed to dial case and bulb.

- 2710# TEMPERATURE GAUGES:
 - Use temperature gauges with pocket and provided with gland attachment on thermometer stem.
 - Type
 - Mercury in steel, mounted direct in pocket.
 - Vapour pressure to BS EN 13190, mounted direct in pocket with horizontal or vertical stem as appropriate.
 - Vapour pressure to BS EN 13190, for remote mounting with capillary tube of sufficient length to allow slack run to immersion bulb. Protect capillary along full length by a flexible sheath jointed to dial case and bulb.

- Use separable type pockets, threaded 15/19mm BSP and manufactured from stainless steel.
- Screw pockets into tapped bosses or stools set in pipelines or vessels. Fill pockets with oil to BS 7207 to ensure contact with thermometer bulb.
- Provide gauges with dial graduation in degrees celsius marked on a logarithmic scale. Ensure pointer movement is clockwise for increase in temperature.
- Provide sensing elements for air and gas systems, where indicated, and fix to provide airtight joints. Provide with metal shielding around sensing element to prevent effects of local radiation from equipment.

Mercury in steel type, mounted direct in pocket. Use temperature gauges with pocket and provided with gland attachment on thermometer stem. Use separable type pockets, threaded 15/19mm BSP and manufactured from stainless steel. Screw pockets into tapped bosses or stools set in pipelines or vessels. Fill pockets with oil to BS 7207 to ensure contact with thermometer bulb.

Provide gauges with dial graduation in degrees celsius marked on alogarithmic scale. Ensure pointer movement is clockwise for increase in temperature. Provide sensing elements for air and gas systems, where indicated, and fix to provide airtight joints. Provide with metal shielding around sensing element to prevent effects of local radiation from equipment.

Y11.2710B TEMPERATURE GAUGES, MERCURY IN STEEL: Provide mercury in steel temperature gauge, mounted direct in pocket.

Y11.2710C TEMPERATURE GAUGES, VAPOUR PRESSURE TO BS 5235 FOR DIRECT MOUNTING:

Vapour pressure type to BS EN 13190, mounted direct in pocket, with horizontal or vertical stem as appropriate.

Y11.2710D TEMPERATURE GAUGES, VAPOUR PRESSURE TO BS 5235 FOR REMOTE MOUNTING:

Vapour pressure type to BS EN 13190, for remote mounting with capillary tube of sufficient length to allow slack run to immersion bulb. Protect capillary along full length by a flexible sheath jointed to dial case and bulb.

Y11.2720 PRESSURE AND ALTITUDE GAUGES: Use vapour pressure type gauges to BS EN 837-1. Connect to pipeline systems via matched gauge cocks and cock connectors.

Ensure dial graduation is from zero to between 1.5 and 3.0 times normal working pressure. Graduate in bar (gauge) on gauges reading head or working pressure, or in Pascals where pressure differences across plant items are to be established. Where fitted on boilers and pressure vessels, clearly mark with operating and maximum permissible working heads in accordance BS 759. Elsewhere provide gauges with normal working pressure. Ensure dial movement is clockwise for an increasing in head. Fit syphons on steam systems.

Provide flexible piping where gauge is subject to noticeable vibration. Fit gauge cocks preceding all connections to altitude and pressure gauges. Copper alloy, tapered ground plug, with ebonite lever. Unless flanged joints are required, screw inlet ends female and fit outlet ends with union connections allowing removal of gauges.

Y11.2730 VACUUM GAUGES: Use vacuum gauges complying with BS EN 837-1. Calibrate in mm of mercury.

Y11.2750A GAUGE MOUNTING BOARDS, HARDWOOD: Manufacture from 12mm thick, polished hardwood. Mount on walls or purpose made steel frames at a height approximately 1.3m above floor level.

Y11.3010A LOOSE ITEMS, KEYS FOR SPINDLE SHANK VALVES: • Number

Provide tee handled short shank keys suitable for each size of valve spindle shank.

Y11.3010B LOOSE ITEMS, FOR DRAIN COCKS:

KJ TAIT ENGINEERS

Fit pipework connections, where indicated, to provide bleed connection from air bottles terminating with air cock or needle valve in a convenient position.

Y11.4080D DISCHARGE CONNECTIONS, AUTOMATIC AIR VENTS: Fit pipework connections, where indicated, to provide discharge pipe to automatic air vents terminating over a suitable gully or drain line in a visible location.

Y11.4090 EXPANSION DEVICES: Where expansion and contraction cannot be accommodated by selected route, provide pipework loops, as indicated. Limit total stress set up in material of pipe wall, taking into account components due to internal pressure, tension and bending to less than 69 MPa for steel pipelines and less than 51.5 MPa for copper pipe lines.

Where location does not permit sufficient flexibility, provide proprietary devices, as indicated.

Y11.4100 EXPANSION COMPENSATORS INSTALLATION: Provide anchors and guides to contain all movement and resist maximum loads imposed. Install expansion compensators strictly in accordance with manufacturer's instructions.

Y11.4110 FLEXIBLE CONNECTIONS INSTALLATION: Fit rubber bellows as close to source of vibration as practicable. Ensure the pipe at other end of bellows is a fixed point. Install flexible connections strictly in accordance with manufacturer's instructions.

Ensure flexible connections are tied when the plant is on vibration isolation mountings.

Y11.4120 TERMINAL UNIT CONNECTIONS INSTALLATION: Install hose connections strictly in accordance with manufacturer's instructions.

Number

Provide lever pattern keys suitable for each drain cock and loose hose unions for drain cocks.

Y11.4010 INSTALLATION:

Install pipeline ancillaries in accordance with manufacturer's recommendations and BS 6683.

Y11.4020 LOCATION:

Positions

Install valves, cocks, traps, strainers, test plugs, tundishes and other ancillary equipment in positions indicated.

Y11.4025 LOCATION OF THERMOSTATIC RADIATOR VALVES:

Install thermostatic radiator valves in an area which reflects the space temperature. Ensure that they are not behind curtains or enclosed in heating or radiator panels.

Y11.4030 POSITIONING OF COMPONENTS:

Locate flow and pressure measurement valves to ensure manufacturer's recommended straight length of pipe upstream and downstream of valve is provided.

Y11.4040 POSITIONING OF DOUBLE REGULATING VARIABLE ORIFICE VALVE: Install double regulating variable orifice valve to ensure equivalent of 10 diameters of straight pipe upstream and 5 diameters downstream of double regulating valve.

Y11.4045 INSTALLATION OF CONTROL BALL VALVES:

Install control ball valves in accordance with manufacturer's recommendations.

Y11.4050# POSITIONING OF CONTROL COMPONENTS:

- Install pipeline control components in accordance with manufacturer's instructions and in positions indicated.
- Insulation Where control components are incorporated in insulated pipelines provide details of ٠ insulation method proposed for approval.
- Supports Arrange supports for control components to ensure no strain is imposed on components.
- Access Arrange control components to ensure adequate access for operation and maintenance.

Y11.4050A POSITIONING OF CONTROL COMPONENTS:

Install pipeline control components in accordance with manufacturer's instructions and in positions indicated.

Insulation - Where control components are incorporated in insulated pipelines provide details of insulation method proposed, for approval.

Supports - Arrange supports for control components to ensure no strain is imposed on components. Access - Arrange control components to ensure adequate access for operation and maintenance.

Y11.4060 VENT COCKS:

Provide outlets of vent cocks with discharge pipes.

Y11.4070 VALVE STUFFING BOXES:

Adjust glands of all stuffing boxes at normal plant operating temperature and pressure in accordance with manufacturer's instructions. Ensure that valve action is not impaired by over tightening.

Y11.4080A DISCHARGE CONNECTIONS, SAFETY VALVES:

Fit pipework connections, where indicated, to provide discharge connection to Safety and Relief valves terminating at a safe discharge point.

Y11.4080B DISCHARGE CONNECTIONS, VENT COCKS:

Fit pipework connections, where indicated, to provide discharge connection to vent cocks terminating 150mm above floor level.

Y11.4080C DISCHARGE CONNECTIONS, AIR BOTTLES:

Seal Housing - Cast iron to BS EN 1561

water jackets, cooling lines, etc.

Casing - Cast iron to BS EN 1561.

Impeller - Manufacturer's standard.

Seal Housing - Cast iron to BS EN 1561

Shaft - Manufacturer's standard.

Glands and seals - Mechanical.

to be mounted in pipework.

water jackets, cooling lines, etc.

Indicate direction of rotation on pump casing.

Casing - Cast iron to BS EN 1561.

Impeller - Manufacturer's standard.

Shaft - Stainless steel to BS EN 10088.

Seal Housing - Cast iron to BS EN 1561.

Indicate direction of rotation on pump casing.

Bearings - Sealed-for-life. Glands and seals - Mechanical.

prevent clogging.

Configuration

Casing

Impeller

Shaft

Material

Bearings - Sleeve.

Configuration

Casing

Impeller

Shaft

Material

Bearings

Configuration

Y20 PUMPS

Y20.1000 GENERAL PUMPS: 1010 Provide pumps manufactured and tested in accordance with appropriate British Standard, in particular BS EN 809, BS EN 60335-2-41 and BS EN 60335-2-51 where applicable. 1020 PUMP SELECTION: Select pump at or near most efficient part of performance curve for duty required. 1030 SAFETY GUARDS: Fit safety guards around revolving parts on close coupled and belt drive pumps. 1040 PUMP TESTING: Ensure pumps comply with BS EN ISO 5198 and BS EN ISO 9906 as appropriate. Y20.2010A CENTRIFUGAL PUMP - HORIZONTALLY MOUNTED BELT DRIVEN: Configuration Casing and motor side by side mounted on bedplate (beltdrive). Casing Provide casing with drain connection fitted with plug. Provide threaded connections in accordance with BS 21 and BS EN 10226-1 for drains, vents, water jackets, cooling lines, etc.. Provide pump with split casing to allow access to the impeller for service and maintenance. Impeller Ensure impellers are accurately machined and finished smooth, free from blowholes and other defects and designed to be in dynamic balance at all speeds. Provide open or semi-open type impellers for removal of sludge or other foreign material to prevent clogging. Fix impellers to shafts to ensure that they remain firm if direction of rotation is reversed. Indicate direction of rotation on pump casing. Shaft Ensure shaft is of adequate diameter to withstand all imposed loading and has a critical speed when assembled with its impeller at least 10% above normal operating speed. Material Casing - Cast iron to BS EN 1561. Impeller - Manufacturer's standard Shaft - Stainless steel to BS EN 10088. Seal Housing - Cast iron to BS EN 1561. Bearings - Sealed-for-life. Glands and seals - Mechanical. Y20.2010B CENTRIFUGAL PUMP - VERTICALLY MOUNTED BELT DRIVEN: Configuration Motor mounted vertically above casing on a common bedplate (belt drive). Casing Provide casing with drain connection fitted with plug. Provide threaded connections in accordance with BS 21 and BS EN 10226-1 for drains, vents, water jackets, cooling lines, etc. Provide pump with split casing to allow access to the impeller for service and maintenance. Impeller Ensure impellers are accurately machined and finished smooth, free from blowholes and other defects and designed to be in dynamic balance at all speeds. Provide open or semi-open type impellers for removal of sludge or other foreign material to prevent clogging. Fix impellers to shafts to ensure that they remain firm if direction of rotation is reversed. Indicate direction of rotation on pump casing. Shaft Ensure shaft is of adequate diameter to withstand all imposed loading and has a critical speed when assembled with its impeller at least 10% above normal operating speed. Material Casing - Cast iron to BS EN 1561. Impeller - Manufacturer's standard Shaft - Stainless steel to BS EN 10088.

KJ TAIT ENGINEERS

Glands and seals - Mechanical.

prevent clogging.

Y20.2010C CENTRIFUGAL PUMP - CLOSE COUPLED:

Pump casing and motor mounted on a bedplate in line (close coupled).

Provide casing with drain connection fitted with plug. Provide threaded connections in accordance with BS 21 and BS EN 10226-1 for drains, vents,

Provide pump with split casing to allow access to the impeller for service and maintenance.

Ensure impellers are accurately machined and finished smooth, free from blowholes and other defects and designed to be in dynamic balance at all speeds. Provide open or semi-open type impellers for removal of sludge or other foreign material to

Fix impellers to shafts to ensure that they remain firm if direction of rotation is reversed.

Ensure shaft is of adequate diameter to withstand all imposed loading and has a critical speed when assembled with its impeller at least 10% above normal operating speed.

Y20.2010D CENTRIFUGAL PUMP - DIRECT DRIVE IN-LINE:

Direct driven unit with pump body incorporating inlet and outlet connections in line, to allow pump

Provide casing with drain connection fitted with plug. Provide threaded connections in accordance with BS 21 and BS EN 10226-1 for drains, vents,

Provide pump with split casing to allow access to the impeller for service and maintenance.

Ensure impellers are accurately machined and finished smooth, free from blowholes and other defects and designed to be in dynamic balance at all speeds. Provide open or semi-open type impellers for removal of sludge or other foreign material to

Fix impellers to shafts to ensure that they remain firm if direction of rotation is reversed.

Ensure shaft is of adequate diameter to withstand all imposed loading and has a critical speed when assembled with its impeller at least 10% above normal operating speed.

Sealed-for-life or pre-packed type requiring no maintenance (in-line pumps).

Y20.2010E CENTRIFUGAL PUMP - DIRECT DRIVE, IMMERSED ROTOR:

Y20

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE PUMPS

Sealed unit with immersed rotor with pump body incorporating inlet and outlet connections in line, to allow pump to be mounted in pipework.

Casing

Provide casing with drain connection fitted with plug.

Provide threaded connections in accordance with BS 21 and BS EN 10226-1 for drains, vents, water jackets, cooling lines, etc.

Provide pump with split casing to allow access to the impeller for service and maintenance. Impeller

Ensure impellers are accurately machined and finished smooth, free from blowholes and other defects and designed to be in dynamic balance at all speeds.

Provide open or semi-open type impellers for removal of sludge or other foreign material to prevent clogging.

Fix impellers to shafts to ensure that they remain firm if direction of rotation is reversed.

Indicate direction of rotation on pump casing.

Shaft

Ensure shaft is of adequate diameter to withstand all imposed loading and has a critical speed when assembled with its impeller at least 10% above normal operating speed.

Material

Casing - Cast iron to BS EN 1561, or cast gunmetal to BS EN 1982. Impeller - Manufacturer's standard. Shaft - Stainless steel to BS EN 10088. Seal Housing - Manufacturer's standard.

Bearings

Sealed-for-life or pre-packed type requiring no maintenance (in-line pumps). Glands and seals - Manufacturer's standard.

Y20.2015 VARIABLE FLOW CONTROL:

Supply centrifugal pump with variable speed drive for variable flow control. Variable speed drive to meet the safety requirements of BS EN 61800-5-1.

Y20.3010 DRIVE BELTS: Provide belt driven pumps with two or more belts.

Y20.3020# MATCHING FLANGES:

- Provide flanged pumps with matching flanges
- Flanges to BS EN 1092-1 PN
- Flanges to BS EN 1092-2 PN •
- Flanges to BS EN 1092-3 PN ٠
- Flanges to BS EN 1092-4 PN

Y20.3020A STEEL MATCHING FLANGES: Provide flanged pumps with matching flanges to BS EN 1092-1 PN

Y20.3020B CAST IRON MATCHING FLANGES: Provide flanged pumps with matching flanges to BS EN 1092-2 PN

Y20.3020C ALUMINIUM ALLOY MATCHING FLANGES: Provide flanged pumps with matching flanges to BS EN 1092-4 PN

Y20.4010 GENERAL: Comply with manufacturer's recommendations for installation of pumps. For in-line pumps ensure that motor is positioned in accordance with manufacturer's requirements.

Y20.4020 PIPELINE CONNECTIONS:

Support pumps independently from connecting pipework to ensure no load is transmitted from pipework to pump casing on pump suction and discharge.

Y20.4030 MOUNTINGS: Mount motors and pumps for belt drive pumps resiliently.

KJ TAIT ENGINEERS

Y20.4040 ALIGNMENT: Align pump to prevent undue restraint and thrust on interconnecting pipework. Align drives to prevent undue wear and restraint on pump shaft. For belt drives, align pulleys and tension belts to prevent undue wear and out of balance forces.

Y20.4050 ACCESS: Locate pump within the system with adequate space around it for service and maintenance.

Y22 HEAT EXCHANGERS

Y22.1000 GENERAL 1010 HEAT EXCHANGER DESIGN: Supply heat exchangers designed in accordance with British Standards.

Y22.4010 GENERAL: Store, handle and erect all equipr

Store, handle and erect all equipment in accordance with manufacturer's recommendations and relevant British Standards. Make due allowance for valves, fittings, access etc., to accommodate insulation where specified. Support equipment such that all component parts, connections or insulation have clearance from supports.

Y22.4020 FLANGE DRILLINGS: Ensure flange drillings are uniform to facilitate interchange of tube assemblies.

Y22.4030 PROTECTION AND CLEANING: Provide protection from damage and ingress of foreign matter to heat exchangers and condense coolers during storage, installation and testing.

Y22.4040 INSPECTION: Install heat exchangers and condense coolers such that internal and external surfaces can be readily inspected and cleaned.

Y22.4050 RUST PROTECTION: Ensure heat exchanger and condense cooler shells are completely free of rust and corrosion and coated with factory applied primer.

Y21 WATER TANKS/CISTERNS

Y21.1000 GENERAL 1010 TANK DESIGN: Design and fabricate tanks/cisterns in accordance with British Standards. 1020 DOMESTIC STORAGE WATER CISTERNS: Ensure storage cisterns for domestic water purposes comply with the Water Supply (Water Fittings) Regulations 1999 and amendment.

Y21.2020A SECTIONAL A1 GLASS FIBRE REINFORCED SECTIONAL TANK TO BS EN 13280: Class A1 - for potable water incorporating screened air inlet, vent pipe entry device for the cover, screened warning and overflow pipes and particle ingress limitation between a one-piece cistern or sectional tank,

cover and fittings. Sectional tanks - External flanges.

Y21.2020B SECTIONAL A2 GLASS FIBRE REINFORCED SECTIONAL TANK TO BS EN 13280: Class A2 - for potable water. Sectional tanks - External flanges.

Y21.4010 GENERAL:

Store, handle and erect all in accordance with manufacturer's recommendations and relevant British Standards.

Make due allowance for valves, fittings, access, etc., to accommodate insulation and weathering where indicated.

Y21.4020 PROTECTION AND CLEANING:

Ensure adequate protection from damage and ingress of foreign matter to tanks and cisterns during storage, erection and commissioning. Thoroughly clean out all tanks and cisterns prior to site testing and commissioning.

Y21.4030 INSPECTION AND ACCESS: Install tanks and cisterns to allow internal and external surfaces to be easily inspected and cleaned.

Y21.4060 INSTALL GLASS REINFORCED PLASTICS CISTERNS: Install glass reinforced plastics cisterns in accordance with BS EN 13280:

Y24.1000 GENERAL

STANDARDS: 1010 Comply with BS 7671 (IEE Wiring Regulations), BS 6351-1 and BS 6351-2, for the design and specification of electric trace heating.

Y24.2010# ELECTRIC TRACE HEATING:

Supply electric trace heating complete with fixing tape, shrink sleeves, crimps, junction boxes and controls.

- Tape
 - Constant power heating cable.
 - Self regulating heating tape.
- Insulation
 - Modified polyolefin electrical insulation. ٠
 - ٠ PVC.
 - Silicone rubber.
- FEP.
- Jacket
- Tinned copper braid.
- Modified polyolefin jacket. •
- PVC. ٠
- Silicone rubber. •
- FEP.
- Electrical protection
- Protect circuits with MCB's.
- Provide RCD protection. •
- Isolators.

Y24.2010A ELECTRIC TRACE HEATING, CONSTANT POWER, RCD PROTECTION: Supply electric trace heating complete with fixing tape, shrink sleeves, crimps, junction boxes and controls. Tape - Constant power heating cable. Insulation - Silicone rubber. Jacket - Silicone rubber with tinned copper overbraid.

Electrical protection - Provide MCB and RCD protection.

Y24.2010B ELECTRIC TRACE HEATING, CONSTANT POWER, MCB PROTECTION: Supply electric trace heating complete with fixing tape, shrink sleeves, crimps, junction boxes and controls. Tape - Constant power heating cable. Insulation - Silicone rubber.

Jacket - Silicone rubber with tinned copper overbraid. Electrical protection - Protect circuits with MCB's.

Y24.2010C ELECTRIC TRACE HEATING, SELF REGULATING TAPE, RCD PROTECTION: Supply electric trace heating complete with fixing tape, shrink sleeves, crimps, junction boxes and controls. Tape - Self regulating heating tape. Insulation Thermoplastic elastomer or modified polyolefin. Jacket - Tinned copper braid. Electrical protection - Provide MCB and RCD protection.

Y24.2010D ELECTRIC TRACE HEATING, SELF REGULATING TAPE, MCB PROTECTION: Supply electric trace heating complete with fixing tape, shrink sleeves, crimps, junction boxes and controls. Tape - Self regulating heating tape. Insulation

Y24 / 405

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE TRACE HEATING

Thermoplastic elastomer or modified polyolefin. Jacket - Tinned copper braid. Electrical protection - Protect circuits with MCB's.

Y24.3010 INSTALLATION OF ELECTRIC TRACE HEATING: Install electric surface heating in accordance with BS 6351-3 and manufacturer's instructions. Ensure pipe is cleaned of all abrasive material prior to application.

Y24.3020A INSTALLATION OF PIPED TRACE HEATING, CONTINUOUS WELDING: Secure trace heating pipelines in close contact with pipework to be heated. Attach by continuous welding along length of pipework.

Locate trace heating pipelines along underside of pipework to be heated. Single pipeline on centreline.

Two pipelines at 30° to centreline.

Three pipelines on centreline and at 45° to centreline. Isolating valves

Install isolating valves on each section of trace heating pipelines.

Y24.3040 THERMAL INSULATION:

Enclose pipework to be heated and trace heating elements in common thermal insulation. Use oversized insulation.

Y25 CLEANING AND CHEMICAL TREATMENT

Y25.1000 GENERAL

CONDITIONS FOR CLEANING AND CHEMICAL TREATMENT: 1010

Ensure treatment complies with statutory authority and health and safety regulations. Notify manufacturer's and suppliers of equipment of proposed system cleaning and chemical treatment processes. Establish if any manufacturer or supplier of equipment requires any particular cleaning and chemical treatment process due to size of waterways or materials used. All chemicals used are to be compatible with the metallurgy of the systems. METHOD STATEMENT: 1015

Provide a method statement covering the sequence of events, chemicals to be used etc. Statement to be provided at least two months prior to the start of any flushing and/or chemical cleaning works.

Y25.2010 CLEANING AND CHEMICAL TREATMENT SPECIALIST:

Use a specialist for analysis and for design, supply, installation and operation of any system cleaning and chemical treatment process.

Y25.2020A MAINS WATER ANALYSIS:

Obtain an analysis of mains water taken from site supply point. Check with local water authority to ensure analysis results are typical for site area and report variances for instruction; or submit a sample of water to water treatment specialist as appropriate.

Carry out tests to establish total viable counts and Pseudomonas and sulphate reducing bacteria.

Y25.2030A PRELIMINARY CHECKS:

- Prior to carrying out cleaning or chemical treatment process, ensure that
- All foreign matter is removed.
- ٠ Certified pressure tests have been carried out in the parts of the system to be cleaned. Carry out further pressure tests on the isolated sections of the system independently.
- All water used for pressure testing is inhibited. Leave remaining pipework sections full after ٠ testing.
- Where there is a risk of freezing inhibited mono-ethyleneglycol is used.
- Circulation has been demonstrated and approval obtained on all parts of the system. Manipulate and leave fully open all valves other than those used to isolate sections. Carry out balancing and certification after the flushing, cleaning and passivation operations.
- No damage can occur to any item of plant or equipment due to cleaning and chemical ٠ processes.
- Chemicals used are compatible with system materials.
- All items of plant and equipment subject to damage or blockage due to cleaning and chemical treatment processes are isolated or removed.
- Permanent or temporary by-passes are provided as indicated on drawings. ٠
- Dirt pockets are installed at low points to facilitate solids removal. Supply dirt pockets with drain valves sized to pipework size.
- All drains provided have been tested and approved and that any pumping equipment associated with the drainage system is fully commissioned.
- Dead legs, that are more than 3 pipe diameters in length are looped to allow effective cleaning.
- Strainer baskets and filter media, incorporated within systems, are removed; and where necessary spool or stool pieces are installed.
- Temporary strainers and filters are installed as required for removal of solids during cleaning and chemical treatment processes.
- Strainers are clean prior to the start of the cleaning process, throughout the cleaning and on • completion.
- Suitable supply and drainage points are provided with 50mm minimum connections, properly sited and installed, either valved or plugged.
- All automatic/manual air vents are fully commissioned.
- All requirements of COSHH regulations are complied with during the chemical cleaning and chemical treatment of the system.
- Where required by local water authority, provide effluent tanks for storage of all waste products of cleaning and chemical treatment processes.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE CLEANING AND CHEMICAL TREATMENT

- Following local water authority approval, either neutralize and dispose to drain of all waste products; or ensure authorised disposal at registered sites. Comply with Waste Management Duty of Care: A Code of Practice and The Hazardous Waste (England & Wales) Regulations 2005 where appropriate.

Y25.2040A PROCEDURAL PRECAUTIONS FOR CLEANING AND CHEMICAL TREATMENT:

- Carry out tests to ensure that cleaning and chemical treatment processes are operating as required.
- Carry out tests to ensure that cleaning and chemical treatment processes are operating as required, and detailed in the Method Statement.
- Submit all test and sample results for certification and approval.

Y25.2040B PROCEDURAL PRECAUTIONS FOR CLEANING AND CHEMICAL TREATMENT INCLUDING TAKING SAMPLES:

- Take samples during and following chemical treatment and/or cleaning.
- Submit samples to an independent analyst. •
- Use sterile containers to take samples. •
- Carry out tests to ensure that cleaning and chemical treatment processes are operating as required.
- Submit all test and sample results for certification and approval.
- Ensure all samples are witnessed.

Y25.2060A CHEMICAL INJECTION AND DOSING METHODS FOR CLOSED SYSTEMS: Method of introducing chemicals

Dosing pots; manually initiated timer controlled dosing; or proportional dosing as appropriate.

Y25.2060B CHEMICAL CLEANING AND DOSING METHODS FOR OPEN RECIRCULATING SYSTEMS:

- Method of introducing chemicals
- Chemical dosing for scale and corrosion inhibitors Continuous; timer controller; or proportional dosing as appropriate. Bleed-off control.
- Biocide dosing automatic dosing control.

Y25.2060C PACKAGED CHEMICAL INJECTION AND DOSING PLANT: Provide packaged monitoring and treatment plants.

Y25.2060D DOSING - CLOSED SYSTEMS: Chemical feed

Provide feeder (dosing pots) with a tundish for filling; separate air vent with discharge tube; drain and isolating valves.

Install in each water system a means of taking a sample as follows:-Chilled water systems - provide a gate valve and discharge. Heating systems - provide a sample cooler with a copper coil and cooling jacket with cooling water valve and drained to waste.

Y25.2060E DOSING - OPEN SYSTEMS:

Chemical dosing

- Provide an interface between water treatment plant and system pumps to allow the initiation of water circulation in addition to the requirements of the building services. Where control by-passes are used, set valves to allow reduced circulation but not complete isolation of the equipment.
- Provide control of chemical inhibitors by linking the dosing pump control unit to operate on a signal from a water meter.
- Provide skid mounted packaged equipment to feed chemical inhibitors including pre-wired controls and dosing pump, high density polyethylene tank, chemical diaphragm pump complete with all necessary valves and tubing.
- Provide control of total dissolved solids by linking a solenoid purge valve to operate by a signal automatically received from a conductivity sensor.
 - Biocide dosing

Y25

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE CLEANING AND CHEMICAL TREATMENT

Provide skid mounted packaged equipment to feed two types of biocides on an automatically alternating basis including pre-wired timer controls and twin biocide diaphragm pumps complete with all necessary valves and tubing. Draw biocide chemical direct from the chemical supply drums located on the skid.

Control

Provide low level alarms for all dosing units.

Provide BMS connections to monitor dosing and show run and alarm conditions. Injection manifold

Provide an injection manifold for use with the above water treatment equipment.

Connect the manifold across flow and return pipework and mount above the dosing plant modules, unless otherwise indicated.

Y25.2065 CHEMICALS - DOSING:

Provide biocides effective against Legionella Pnueumophilia, algae, fungi, moulds and slime forming bacteria including pseudomonas and sulphate reducing bacteria.

Supply biocides as recommended by water treatment specialist.

Incorporate a bio dispersant in the programme to break up and disperse any slime masses, where required.

The water treatment specialist shall select the appropriate corrosion inhibitors, to minimise corrosion. and biocides to prevent any proliferation to mild steel, copper and copper alloys.

Provide a specific inhibitor to protect aluminium when it is present in the system.

The cleaning agent is to be specified by the water treatment specialist.

Y25.2070A MONITORING:

Remote location

Provide monitoring system to enable on-line analyses, system alarms and chemical stock levels to be monitored by water treatment specialist.

Where indicated, provide facility for system to be monitored by water treatment specialist at remote location.

Y25.2070B SAMPLING:

Provide testing equipment to carry out tests for all inhibitors used in treatment programme indicated.

Y25.2070C SAMPLING KITS:

Provide the following test kits as appropriate.

Boiler water test kit for steam boilers: conductivity test kit; pH test kit; inhibitor test kit; hardness test kit where a softener is installed: chloride level test kit.

Install a corrosion test rig to enable corrosion rates to be monitored using corrosion coupons. Bacteriological monitoring with use of dipslides.

Log sheets for recording of test results, bacteriological analysis and any actions required or taken.

Y25.2080A CHEMICAL PROVISION, STANDARD ARRANGEMENT:

Provide consumables for a period of 12 months.

Where indicated, provide for supply of chemicals from containers refilled by drumless delivery system. Include for supply of chemicals for all systems using the basis of:

Open circuit systems operating at 100 % load for 2080 hours per annum.

Closed circuit systems make-up 1% system volume/month.

Y25.2090 AVOIDANCE OF STAGNANT WATER IN PRESSURISATION UNIT EXPANSION VESSELS:

Install pressurisation units with re-circulating circuits, to avoid stationary pockets of water and minimise bacterial growth.

Y25.3010A FLUSHING:

System filling

- Temporary connection from mains in compliance with the Water Supply (Water Fittings) Regulations 1999, and the Water Supply (Water Fittings) (Amendment) Regulations 1999.
- Temporary connection from fire hydrant pipework.
- By installation of temporary tank and pump arrangement.

Carry out flushing of water systems in accordance with BSRIA Application Guide 1/01 Pre-commission cleaning of pipework systems. Section 2 Installation considerations 2.1 Management 2.2 Pipework installation 2.3 Preparation for flushing and cleaning 2.4 Procedure for filling, pressure testing and static flushing. Section 3 System dynamic flushing. C1 Flushing objectives

C2 Dynamic flushing procedure.

Inspection and witnessing, as section 1.4.

Y25.3010B FLUSHING:

All water used for pressure testing, flushing and system filling is of good quality. Leave remaining pipework sections full and treated after pressure testing. Install all necessary pipework ancillaries to enable a specialist to carry out flushing, inspection and witnessing of water systems in accordance with BSRIA Application Guide AG 1/01. Pre-commission cleaning of pipework systems.

Temporary connection from the mains must be in compliance with the Water Supply (Water Fittings) Regulations 1999 and amendment, or by installation of a temporary tank and pump arrangement. Domestic water systems are to be flushed and disinfected in accordance with the requirements of BS 6700, and to the satisfaction of the local water supply authority. Flush systems using mains water until the water is clear.

Y25.3020A TESTING AND PURGING GAS PIPEWORK - INDUSTRIAL AND COMMERCIAL INSTALLATIONS:

Comply with IGE/UP/1 Strength and tightness testing and direct purging of industrial and commercial gas installations.

Y25.3020B TESTING AND PURGING GAS PIPEWORK - SMALL LOW PRESSURE INDUSTRIAL AND COMMERCIAL INSTALLATIONS:

Comply with IGE/UP/1A Strength and tightness testing and direct purging of small low pressure industrial and commercial natural gas installations.

Y25.3020C TESTING GAS PIPEWORK TO BS EN 12327:

- Purge each system using either Nitrogen or CO₂.
 - This operation is to prove the continuity of the pipework, remove any cutting fluid and ensure that the nozzles are clear.
 - Flimsy paper bags are to be attached to all nozzles during the purge and removed upon completion of the purge.

Carry out pressure testing in accordance with BS EN 12327.

Y25.3030A CHEMICAL CLEANING AND SOLIDS REMOVAL - INHIBITED ACID: Carry out chemical cleaning procedure in accordance with BSRIA Application Guide 1/01 Precommission cleaning of pipework systems.

- 4.1 Introduction.
- 4.2 Cleaning options.
 - 4.2.1 Degreasing.
 - 4.2.2 Biocide wash.
 - 4.2.3 Removal of surface oxides Inhibited acid cleaning.
 - 4.2.4 Effluent disposal/final flushing.
 - 4.2.5 Neutralisation.
 - 4.2.6 Passivation
 - 4.2.7 Corrosion inhibitor/biocide dosing.
 - 4.2.8 Treatment up to system handover.
- 4.3 On-going water treatment.

Inspection and witnessing, as section 1.4.

Y25.3030B CHEMICAL CLEANING AND SOLIDS REMOVAL - FORMULATED PRODUCTS:

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE CLEANING AND CHEMICAL TREATMENT

Carry out chemical cleaning procedure in accordance with BSRIA Application Guide 1/01 Precommission cleaning of pipework systems.

- 4.1 Introduction.
- 4.2 Cleaning options.
 - 4.2.1 Degreasing.
 - 4.2.2 Biocide wash.
 - 4.2.3 Removal of surface oxides Inhibited acid cleaning.
 - 4.2.4 Effluent disposal/final flushing.
 - 4.2.5 Neutralisation.
 - 4.2.6 Passivation
 - 4.2.7 Corrosion inhibitor/biocide dosing.
 - 4.2.8 Treatment up to system handover.
- 4.3 On-going water treatment.

Inspection and witnessing, as section 1.4.

Y25.3035# CLEANING AND CHEMICAL TREATMENT REGIME:

The specialist shall submit a method statement prior to commencing work which fully prescribes the proposed regime and sequence for the flushing, cleaning and chemical treatment of all closed and condenser water systems. The following shall be considered in preparation of the method statement:

- Delay filling the pipework for the first time for as long as possible. •
- If any pipework is to be wet for more than 2 weeks prior to cleaning, treat the fill water with biocide • and bio-dispersant.
- Take samples for microbiological analysis 1 week prior to commencing the water treatment.
- If sample results are poor, undertake a biocide wash on all previously wetted areas after the initial flush. Biocide treated water should be drawn into any previously wetted terminal unit coils slowly (which have been isolated for the clean) to avoid the introduction of debris, after which the coils should be isolated again.
- During the initial flush flows should be maximised, recorded and witnessed. Batch work on terminal unit by passes should be carefully undertaken in accordance with BSRIA Application Guide AG 1/01, and the correct number of terminal unit by-passes opened at any one time in order to maximise flow along the horizontal runs.
- Chemical clean.
- Second dynamic flush using the same methodology as the initial flush.
- Dose with biocide and inhibitor.
- Circulate systems fully.
- Back flush all terminal units.
- Top up inhibitor as necessary and add another dose of biocide (use a biocide with longevity and broad spectrum base).

Y25.3040 STERILIZATION - GENERAL:

After flushing process, carry out sterilization in accordance with BS 6700. Prior to sterilization ensure each system is flushed, cleaned and drained. Provide temporary connections to system terminal points suitable for introduction of sterilization chemicals and fluids and 22mm minimum valved drain connection on incoming main immediately downstream of mains isolating valve. Fill system with clean, fresh water.

Y25.3050 STERILIZATION - MAINS WATER SYSTEM:

• System standing time

Carry out the following operations in accordance with BS 6700.

Flush system and introduce sterilisation chemical.

Take samples from all sentinel points to ensure correct chlorine concentration.

Leave system to stand for period of time indicated.

Repeatedly flush system with clean water until all traces of chlorine have been removed - leave system filled.

Submit samples to registered laboratory for microbiological analysis and report. Certificate of conformity

Immediately prior to handover, retake samples and submit for analysis and report. Where necessary repeat sterilisation of potable water system immediately prior to handover. Y25.3060 STERILIZATION - WATER STORAGE SYSTEMS: Carry out the following operations in accordance with BS 6700 and HSE L8 Legionnaires' disease control of legionella bacteria in water systems ACOP and guidance. Carry out operations on all water storage tanks and cisterns, cold and hot.

Carry out procedures as for mains water systems.

Y25.3075# WATER TREATMENT:

- Туре
- Water Softener
- Application
- Manufacturer and reference • Or approved equivalent
- Standards
- BS EN 14743
- BS EN 15161
- Water Filter
 - Application
 - Manufacturer and reference
 - Or approved equivalent

Y25.3080 SERVICE VISITS:

Provide monthly service visits for one full year by a fully qualified chemist, to carry out the following:-Review water analysis records, correspondence and reports since previous visit. Test water samples on site for hardness; all inhibitors; dissolved solids; pH; total alkalinity. Check performance of feeding equipment, softeners, and testing equipment on site. Submit a written report.

Carry out micro-biological analysis using dipslides. Special requirements as indicated.

Y25.3090 DOCUMENTATION:

- Provide number of copies as indicated of hard cover binders containing details of Programme outlines.
- Purpose of chemical treatment.
- Chemicals used and quantity.
- On site testing procedures.
- Control limits of tests.
- Equipment data and drawings.
- Product notes and material safety data sheets for all chemicals used.
- Provide a complete training programme for site operatives covering
- Methods of basic water testing. Explanation of results obtained.
- Actions to be taken on test results.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **AIR DUCTLINES AND ANCILLARIES**

Y30.2040A ZINC-COATED DUCTWORK MATERIAL: DW 144 Part 2 - Standards, paragraph 7, zinc-coated steel.

Y30.2040B MILD STEEL DUCTWORK MATERIAL: DW 144 Part 2 - Standards, paragraph 7, mild steel.

Y30.2040C STAINLESS STEEL DUCTWORK MATERIAL: DW 144 Part 2 - Standards, paragraph 7, stainless steel.

Y30.2050A PROTECTIVE FINISHES - GALVANIZING: DW 144 Part 7 - General, Section 27, galvanizing after manufacture.

Y30.2060# CONSTRUCTION:

- Rectangular ductwork DW 144 Part 3.
- Circular ductwork DW 144 Part 4.
 - Spirally wound.
- Straight seamed. •
- Flat oval ductwork DW 144 Part 5.
 - Spirally wound.
 - Straight seamed.

Y30.2060A RECTANGULAR CONSTRUCTION: Rectangular ductwork - DW 144 Part 3.

Y30.2060B CIRCULAR CONSTRUCTION: Circular ductwork - DW 144 Part 4, spirally wound or straight seamed.

Y30.2060C FLAT OVAL CONSTRUCTION: Flat oval ductwork - DW 144 Part 5, spirally wound or straight seamed.

Y30.2130A PREINSULATED EXTERNAL THERMAL/ACOUSTIC DUCTWORK: Supply preinsulated ductwork where indicated.

Y30.2130B PRE-INSULATED ALUMINIUM DUCTWORK: External aluminium - Thickness 8mm.

Finish - Embossed, protected with polyester lacquer Internal aluminium - Thickness 8mm.

Finish - Embossed, protected with polyester lacquer Insulation - 20mm polyurethane.

Y30.2140A HANGERS AND SUPPORTS: Provide hangers and supports throughout in accordance with DW 144 Part Six Section 19; DW 154 Part 5; or DW 191 Section 7 as appropriate. Comply with BS EN 12236.

Y30.2150A SUPPORT OF AIR TERMINAL UNITS: Support air terminal units and their plenums by the ceiling grids, as DW 144 Part One, paragraph 4.8.

Y30.3010 CONSTRUCTION AND FINISHES: Ensure that materials of accessories are compatible with ductwork and that finishes of accessories comply with any special requirements for ductwork. Ensure casing losses of components are compatible with ductwork in which they are incorporated.

Y30.3020A METAL DUCTWORK INSPECTION/SERVICING ACCESS OPENINGS: Provide access/inspection openings in accordance with DW 144 Part Seven Section 20 and Appendix M Table 25 Level 1.

Y30.3020D DUCTWORK INSPECTION/SERVICING ACCESS OPENINGS: Provide access/inspection openings in accordance with HVCA TR/19, Section 3.

KJ TAIT ENGINEERS

Y30.1000 GENERAL DUCTWORK INSTALLATION STANDARDS: 1010 Carry out construction and installation of ductwork in accordance with DW 144, DW 154, DW 171, DW 191 and BS 5588 as appropriate. 1020 DUCTWORK DIMENSIONS: Sizes of ductwork are internal dimensions. Where applicable make allowance for any internal lining.

Y30.1030 ELECTRICAL BONDING TERMINAL:

Y30 AIR DUCTLINES AND ANCILLARIES

 Required Ensure an electrical bonding terminal suitable for connection of 6mm² maximum conductor is provided where required by BS 7671 Requirements for Electrical Installations (the IEE Wiring Regulations, 16th Edition).

Y30.2010A DESIGN INFORMATION - CLASS A POSITIVE: Supply ductwork in accordance with classification in DW 144 Table 1 and DW 154 Table 1. Ductwork Classification and Air Leakage limits Low pressure - Class A - Positive.

Y30.2010B DESIGN INFORMATION - CLASS A NEGATIVE: Supply ductwork in accordance with classification in DW 144 Table 1 and DW 154 Table 1. Ductwork Classification and Air Leakage limits Low pressure - Class A - Negative.

Y30.2010C DESIGN INFORMATION - CLASS B POSITIVE: Supply ductwork in accordance with classification in DW 144 Table 1 and DW 154 Table 1. Ductwork Classification and Air Leakage limits Medium pressure - Class B - Positive.

Y30.2010D DESIGN INFORMATION - CLASS B NEGATIVE: Supply ductwork in accordance with classification in DW 144 Table 1 and DW 154 Table 1. Ductwork Classification and Air Leakage limits Medium pressure - Class B - Negative.

Y30.2030B MEDIUM PRESSURE DUCTWORK AIR LEAKAGE TESTING:

Test medium pressure ductwork in accordance with DW 144, A5.

Test indicated sections of duct system for air leakage. Test at the pressure recommended in DW 144 Table 17 for the classification of the selected ductwork. Carry out the tests as the work proceeds and prior to application of thermal insulation.

If the test fails, pressure test two further sections as indicated. If the further tests fail, apply remedial action to the complete ductwork system.

Provide documented evidence of the calculations used to arrive at the allowable loss for the section to be tested and ensure the client or his agent witnesses and signs the results of the tests. Testing plant items, DW 144, Part 8, A.8.

Y30.2035 STRENGTH AND LEAKAGE TESTING OF CIRCULAR SHEET METAL DUCTWORK: Carry out ductwork strength and air leakage testing on circular sheet metal ductwork in accordance with BS EN 12237.

Test procedure shall be as detailed in BS EN 12237, Section 7. Produce a test report as detailed in BS EN 12237, Section 8.

Y30.2040# DUCTWORK MATERIAL:

DW 144 Part 2 - Standards, paragraph 7.

- Zinc-coated steel.
- Mild steel.
- Stainless steel.
- Aluminium.
- Pre-coated steel.

Provide test holes in ductwork system, as shown on drawings, to allow complete testing and balancing of system in accordance with CIBSE Commissioning Code A. Site drill test holes in accordance with DW 144 paragraph 20.6.

Y30.3040 HOLES FOR CONTROLS/INSTRUMENTS - METAL DUCTWORK: Provide holes in ductwork, in accordance with DW 144 Part Seven, paragraph 20.7, to accommodate thermostats, humidistats and other control sensors in positions and sizes indicated on drawings.

Y30.3042 INSTALLATION OF INSTRUMENTS AND CONTROLS:

Instruments and controls should be installed to manufacturers or specialist supplier's requirements. The installation must be checked by the manufacturer or specialist supplier, and rectified as necessary.

Y30.3050A CLEANING ACCESS - LEVEL 2:

Provide access for cleaning in accordance with DW 144 Part Seven, paragraph 20.8 and Appendix M Table 25 Level 2.

Y30.3050B CLEANING ACCESS - LEVEL 3:

Provide access for cleaning in accordance with DW 144 Part Seven, paragraph 20.8 and Appendix M Table 25 Level 3.

Y30.3050C CLEANING ACCESS - HVCA TR/19: Provide access/inspection openings in accordance with HVCA TR/19, Section 3.

Y30.3060B STEEL MULTI-BLADE BALANCING DAMPERS - METAL DUCTS:

Provide single or double skin steel multi-blade balancing dampers in accordance with DW 144 Part Seven Section 21. Parallel or opposed blade, manual operation. Locations and size as shown on drawings.

Y30.3070D STAINLESS STEEL CURTAIN FIRE DAMPERS - BLADES OUT OF AIR STREAM: Supply and install stainless steel folding curtain fire dampers, with blades out of the air stream, in accordance with DW 144 Part Seven Section 22, size and location as shown on the drawings.

Y30.3070J FIRE DAMPERS ACCESSORIES:

 No. of spare fusible links Provide accessories compatible with fire dampers. Electrical cut-out switches and external visual indication of fire damper blade position.

Supply spare fusible links for fire dampers to fuse at 72°C as specified in DW 144.

Y30.3090B STEEL MULTI-BLADE COMBINATION SMOKE AND FIRE DAMPERS: Supply and install multi-blade combination smoke and fire dampers in accordance with DW 144 Part Seven Section 24, size and location as shown on the drawings.

Y30.3100C PVC/POLYESTER LAMINATE FLEXIBLE DUCTS:

Supply and fasten PVC/polyester laminate flexible duct connections as DW 144 Part Seven Section 25. Use flexible duct connections in applications listed in DW 144 paragraph 25.1. Comply with BS EN 13180. Maximum length 600mm.

Y30.3110A FLEXIBLE JOINT CONNECTIONS:

Supply and install flexible joint connections as detailed in DW 144 Section 26 or DW 154 Section 18, as appropriate.

Use flexible joints, as shown on drawings; on fan inlet/outlets; and on building expansion joints. Comply with BS 476-6, BS 476-7, BS 476-20, BS 476-21, BS 476-22, BS 476-23 and BS 476-24.

Y30.3120A BIRD WIRE GUARDS:

Fit bird screens of 13mm square mesh wire on all intake and extract louvres to atmosphere. Wire gauge to be not less than 1mm. Finish - Plastic coated wire.

Y30

Y30.3140A STAINLESS STEEL PRESSURE CONTROL FLAPS: Supply pressure control flaps with flap and adjustable balance weight assembly manufactured from stainless steel. Construct wall mounting casings from stainless steel. Set the balance weight assembly on flap to control at pressure indicated.

Y30.3150# PRESSURE RELIEF DAMPERS:

- Wall mounted dampers with subframe.
- Wall mounted dampers.
- Door mounted dampers with subframe.
- Door mounted dampers.
- Material
- Supply frames made from
- galvanized sheet steel.
- extruded aluminium section. Supply blades made from
- aluminium.
- PVC.

Y30.3150A WALL MOUNTED PRESSURE RELIEF DAMPERS: Supply wall mounted dampers with subframe. Material -

Supply frames made from galvanized sheet steel or extruded aluminium section. Supply blades made from aluminium or PVC.

Y30.3170 NON RETURN DAMPER:

Supply non return dampers manufactured with galvanized sheet steel frame and aluminium blades. Ensure non return dampers in smoke handling systems have the required stability and integrity rating to match the system requirements.

Y30.4010 GENERAL WORKMANSHIP:

Install ductwork in accordance with DW 144, DW 154 and DW 191 as appropriate. Ensure that there are no sharp edges or corners on cut edges on ductwork, flanges and supports. Install pre-insulated ductwork in accordance with manufacturer's instructions.

Y30.4020 DUCTWORK SUPPORTS:

Support ductwork in accordance with DW 144 Part Six Section 19; DW 154 Part 5; or DW 191 Section 7 as appropriate. Install supports to ensure insulation can be applied unless otherwise indicated.

Y30.4025 COMPONENT SUPPORT ON PRE-INSULATED ALUMINIUM DUCTWORK: Support ducts with dimensions less than 1m at intervals of no more than 4m. Support ducts with dimensions over 1m at intervals of no more than 2m. Provide independent support for all accessories.

Y30.4030A DUCT SUPPORT FOR VAPOUR SEAL CONTINUITY: Where a vapour seal is required, use method of support detailed on drawing as indicated.

Y30.4040 EXTERNAL DUCTWORK SUPPORT:

As shown on drawings nos.

KJ TAIT ENGINEERS

Support ductwork external to building as indicated.

Y30.4060 DRAINAGE OF DUCTWORK: Arrange ductwork to drain any entrained moisture and ensure the lapping of joints minimises moisture leakage.

Y30.4070A CONNECTIONS TO BUILDERS WORK - METAL DUCTWORK: Comply with DW 144 Part Seven Section 28.

Y30.4070B CONNECTIONS TO BUILDERS WORK - PLASTIC DUCTWORK: Comply with DW 154 Part 6 Section 20.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **AIR DUCTLINES AND ANCILLARIES**

Y30.4090A INTERNAL CLEANLINESS - LEVEL 1: Provide Level 1 of protection, delivery and installation (PDI) as defined in HVCA TR/19, Section 2.

Y30.4090B INTERNAL CLEANLINESS - LEVEL 2:

Provide Level 2 of protection, delivery and installation as defined in HVCA TR/19, Section 2.

Y30.4090C INTERNAL CLEANLINESS -- INTERMEDIATE ADVANCED: Provide the advanced intermediate level of cleanliness and protection as defined in HVCA TM2.

Y30.4090D DRY METHOD OF CLEANING: Method of cleaning in accordance with HVCA TR/19, Table 6.

Y30.4090E WET METHOD OF CLEANING:

Method of cleaning in accordance with HVCA TR/19, Table 7.

The system should be thoroughly dried prior to commissioning/de-commissioning to prevent moisture assisting in the growth of micro-organisms.

A risk assessment must be carried out before any cleaning chemicals or biocides are considered. The details of any such chemicals or biocides must be recorded and any adverse effects of the applied chemicals assessed and determined, with appropriate safe procedures set out in a formal method statement.

Steam cleaning and high pressure waterwash are not recommended for ductwork that is situated above ceilings or in sensitive areas unless carried out in a controlled manner to contain leakage. Procedures to take account of operative safety must be adopted, and should be set out in written form. Careful consideration should be given to the use of chemicals and/or water for surfaces that are porous e.g. internally-lined ductwork, attenuators, fibre board ductwork, attenuators, fibre board ductwork etc., to prevent permanent damage.

Before applying wet cleaning methods care should be taken that condensed vapours and cleaning fluids can be removed from the ductwork system.

Y30.4110A DUCTWORK SLEEVES:

Where indicated, enclose ducts passing through building elements, (walls, floors, partitions, etc.) within purpose made sleeves. Cut sleeves of the same material as the duct and pack with mineral fibre or similar non-flammable and fire resistant material to form a fire/smoke stop of adequate rating and to prevent air movement and noise transmission between duct and sleeve. Where finished insulation is carried through duct sleeves. Pack space between insulation finish and sleeve with non-flammable and fire resistant material to form fire stop.

Y30.4110B DUCTWORK SLEEVES WITH FLANGES:

Where indicated, enclose ducts passing through building elements, (walls, floors, partitions, etc.) within purpose made sleeves. Cut sleeves of the same material as the duct and pack with mineral fibre or similar non-flammable and fire resistant material to form a fire/smoke stop of adequate rating and to prevent air movement and noise transmission between duct and sleeve. Provide flanges on either side of wall where ductwork is exposed in rooms. Where finished insulation is carried through duct sleeves. Pack space between insulation finish and sleeve with non-flammable and fire resistant material to form fire stop.

Y30.4130 INSTALLATION OF CONTROL EQUIPMENT:

Fit sensors, damper motors and other control equipment as indicated.

All control equipment should be installed to manufacturers or specialist supplier's requirements. The installation must be checked by the manufacturer or specialist supplier, and rectified as necessary.

Y30.4140 INSTRUMENT CONNECTIONS:

Positions

Provide instrument connections where indicated.

All instrument connections should be installed to manufacturers or specialist supplier's requirements. The installation must be checked by the manufacturer or specialist supplier, and rectified as necessary.

Y30.4150 FIRE PRECAUTIONS:

 As shown on drawing nos. Install fire dampers as indicated.

Y30.4160 DAMPER ACCESS:

Ensure access is provided to damper mechanisms on fire dampers; smoke dampers; combined smoke and fire dampers; and volume control dampers through access doors, false ceilings etc.. Demonstrate that damper blades close completely. Demonstrate that fire links can be replaced. Where more than one fire damper is installed in a frame ensure access is provided to all fire dampers.

Y30.4170 POSITIONING:

Position components as indicated and in accordance with manufacturer's instructions as shown on the following drawings.

- Contract drawings
- Manufacturer's drawings
- Specialist supplier's drawings •
- Specialist contractor's drawings

Y41 FANS

Y41.1000 GENERAL

Y41.2010A NORMAL OPERATING CONDITIONS WITH CIBSE NOISE REQUIREMENTS Sound Power Level

Select fan, motor, drive and speed control system not to exceed typical fan noise level spectra as given in CIBSE Guide. Provide sound power data in accordance with BS EN ISO 5136, BS ISO 13347-1, BS ISO 13347-2, BS ISO 13347-3, BS ISO 13347-4.

Air Densitv

Relate fan performance to air density 1.20kg/m³. **Temperature Range**

Minimum to maximum operating temperatures -5°C to 30°C.

Y41.2020A CONSTRUCTION AND HANDLING: Casings

Construct rigid casing free from drumming under operating conditions. Supply in sections as required for access or handling. Flange dimensions in accordance with BS 848-4. Safety standards - to BS EN 60335-2-80. Rotating assemblies Balance in accordance with BS ISO 1940-1; BS ISO 11342; or BS 7854-1; as appropriate.

Shafts and hubs

Machine impeller bosses and shafts to BS 4500 and key in accordance with BS 4235-1. Hold impeller to shaft with set screw or taper lock fitting. Shaft bearings - Sealed for life.

Drives and guards

Provide guards over shaft, couplings and rope in accordance with BS EN ISO 12100 and Factory Inspectorate requirements.

Material - galvanized or sheet steel.

Lifting

Provide lifting eyebolts or similar facilities on fans or sections heavier than 20kg.

Y41.2030 TESTING:

Provide results of aerodynamic performance tests in accordance with BS 848-1; noise tests in accordance with BS EN ISO 5136, BS ISO 13347-1, BS ISO 13347-2, BS ISO 13347-3, BS ISO 13347-4; and fan vibration measurements in accordance with BS ISO 14695 and balancing and vibration measurements in accordance with BS 848-7 and BS ISO 14695.

Y41.3110 AIR FLOW SENSORS:

Fit air flow sensors or pressure switches on twin fan units to sense fan failure and provide automatic changeover to standby fan.

Y41.3115 FLOW MEASUREMENT: Provide flow measurement facility.

Y41.3120A ACCESS: Provide access via hinged casing or removable panel as indicated.

Y41.3130 MOUNTING: Provide base frames/mounting brackets when this is integral part of fan set.

Y41.3140 SPEED CONTROLLER: Provide speed controller to match fans.

Y41.4010 LOCATION: Install fans in positions indicated, in accordance with manufacturer's instructions and recommendations in the HEVAC Fan Application Guide.

Y41.4020 ATTITUDE: Mount impeller shaft horizontally unless otherwise indicated.

KJ TAIT ENGINEERS

Y40 AIR HANDLING UNITS

Y40.1000 GENERAL

Y40.3050A DRAINAGE FROM AIR HANDLING UNIT COMPONENTS: Provide drainage pipework from cooling coils, humidifiers and components where water may collect. Comply with recommendations in CIBSE Technical Memorandum TM13 in connection with Legionnaires' disease. Material - Glass drainage system.

Y40.3060A CONTROL DAMPERS:

Provide manufacturer's standard control dampers in accordance with DW 144 Part 7 Section 21. Provide motorized control dampers complete with extended spindle; motor; motor linkage; and motor support.

Y40.4010A COMPONENT ASSEMBLY:

Assemble air handling units using gaskets to prevent air leakage from casing.

Y40.4020 ACCESS: Ensure air handling units are positioned to allow adequate space for maintenance and access.

Y40.4030 HUMIDIFIER INSTALLATION: Comply with manufacturer's installation instructions.

Y40.4040 DUCT CONNECTIONS:

Ensure air is straightened as it leaves unit discharge. Ensure ductwork connection is long enough to ensure the aerodynamic performance of the fan is not affected.

Y40.4050 SERVICES CONNECTIONS:

Ensure panels are sealed around electrical cable and pipework service entry points to prevent air leakage, using suitable and approved methods to suit individual services applications. Provide flexible cables between fan motor and local isolator.

Y40.4060 ISOLATION OF UNITS:

Provide means of isolating air handling units electrically to allow maintenance and repairs to be carried out.

Provide means of isolating pipework to air handling units to allow maintenance and repairs to be carried out.

Provide means of isolating steam to humidifier when access door is opened.

Y40.4070 DRAINAGE OF FREE WATER:

Make provision for free water to be caught, collected and drained away. Provide U-traps on all drains suitable for the negative/positive pressure created by the fan.

Y40,4080A SUPPORT AIR HANDLING UNIT: On builders work base.

Y43 HEATING/COOLING COILS

Y43.1000 GENERAL

Y43.2020A REFRIGERANT COOLING COILS, COPPER WITH ALUMINIUM FINS: Material

Tubes - Solid drawn seamless, refrigeration quality, copper tubes for circuit tubes and distribution pipes. Include copper alloy liquid distributors to equalize refrigerant flow through circuits. Fins - Aluminium.

Headers - Copper, refrigeration quality.

Casing

Enclose body of coil, headers and bends within casing. Drain pan

Provide drainage facility to avoid standing water. **Coil Testing**

Pressure test coils and provide signed test certificate declaring test results. Clean coils internally after testing, dehydrate, charge with inert gas and seal. Packaging

Fit protection for fins prior to despatch.

Y43.2040A ELECTRIC AIR DUCT HEATING COILS: Contactors

Provide suitably rated contactors on each step or stage of heater. Casing

Material and finish as manufacturer's standard. Heating Elements

Supply heating elements mounted on removable terminal plate. Terminal Box

Construct terminal box of welded steel. Ensure box is treated to provide protection in accordance with BS EN 60529 IP as indicated.

Safety Cut-out

Provide manual reset safety cut-out switch, wired in series or via contactor with heating elements. Controls

Provide fan interlock to prevent heating running without fan running; and run-on timer to allow airflow to cool heater before switching off fan. Air flow switch

Provide air flow detector switch wired in series with other safety devices.

Y43.3010 DRIP TRAYS:

Provide removable drip trays.

Incorporate drip tray into base of casing to collect condensate. Fit at a small gradient towards drain socket provided in bottom of tray. Extend tray under external headers/return bends where these are not insulated/vapour sealed. Extend tray, or provide additional tray, where eliminator plates are fitted.

Provide removable drip trays.

Where coils are over 1200mm high provide additional drip trays at 1200mm centre intervals maximum over height of coils, piped in copper or plastic to discharge into base tray. Paint internal surfaces with two coats of epoxy resin or alternative water proofing compound.

Y43.3020A GLASS DRAIN TRAPS UNDER SUCTION: Provide drain trap at least twice working air pressure in depth. Provide an air break between trap

outlet and drainage system. Ensure traps under suction have outlet lower than inlet by depth equivalent to at least one and a half times working pressure. Material - Glass.

Y43.3030 ELIMINATOR PLATES:

Install bank of eliminator plates downstream of coils to prevent carry over of condensate at design air face velocity. Fit plates to allow independent removal from coil casing. Ensure material of eliminators is compatible with casing.

KJ TAIT ENGINEERS

Y41.4030 ALIGNMENT: Ensure fan is installed aligned to allow optimum air flow path.

Y41.4040 TESTING:

Ensure fan is isolated from installation during air leakage testing of ductwork.

Y41.4050 DRAIN CONNECTION:

Fit trap to drain connection at lowest point of scroll on centrifugal fans where indicated.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **HEATING/COOLING COILS**

Y43

C0605LMB Revised-Stage E Mech Spec

Y45 SILENCERS/ACOUSTIC TREATMENT

To match air handling unit and specified method of assembly. •

With external flanges drilled for bolting to counterflanges on adjacent plant or ductwork. •

- With internal flanges drilled for bolting to counterflanges on adjacent plant or ductwork.
- With spigot duct connections. •

Y43.3050# DUCT CONNECTIONS:

Y43.3050A AHU DUCT CONNECTIONS: To match air handling unit and specified method of assembly.

Y43.3050B EXTERNAL FLANGE DUCT CONNECTIONS: With external flanges drilled for bolting to counterflanges on adjacent plant or ductwork.

Y43.3050C INTERNAL FLANGE DUCT CONNECTIONS With internal flanges drilled for bolting to counterflanges on adjacent plant or ductwork.

Y43.3050D SPIGOT DUCT CONNECTIONS: With spigot duct connections.

Y43.3060 MATCHING FLANGES - DUCTWORK: Provide matching flanges for ductwork connections, to suit coil.

Y43.3070 MATCHING FLANGES - PIPEWORK: Provide matching flanges for pipework connections, to suit coil.

Y43.3100 ACCESS DOORS: Provide hinged airtight and watertight access door to allow adequate access for maintenance purposes.

Y43.3110 ACCESS WALKWAY: Provide walkway for maintenance access. Y45.3010 GENERAL: Install acoustic treatment equipment in positions indicated, in accordance with manufacturer's instructions.

Y45.3020 ACOUSTIC ENCLOSURES: Ensure that erection is carried out by enclosure manufacturer.

Y45.3030 ACCESS TO ACOUSTIC ENCLOSURES: Provide door type openings in enclosures as required for access to items enclosed. Provide openings for inlet and discharge ductwork and for connections as indicated. Provide angle flange connections for mating to ductwork and equipment.

Y45.3040 SUPPORTS: Supply steel section supporting frames or brackets where silencers are fixed to the walls of air chambers.

Y45.3050 ACOUSTIC LININGS: Where personnel access is provided, protect acoustic linings to prevent damage.

Y45.3060 SOUND PRESSURE LEVEL READINGS: Measure sound pressure levels at the positions indicated using equipment in accordance with BS EN 61672-1 and BS EN 61672-2.

Y45.3070 MEASURE SOUND INSULATION OF BUILDING ELEMENTS IN ACCORDANCE Measure sound insulation of building elements in accordance with BS EN ISO 140-4, BS EN ISO 140-7 and BS EN ISO 140-14 as appropriate.

Y46 GRILLES/DIFFUSERS/LOUVRES

Y46.4010 GRILLE/DIFFUSER LOCATION:

Fit at terminal air supply, extract and transfer points indicated, in accordance with the HEVAC Air Diffusion Guide.

Y46.4020 LOUVRE LOCATION:

Fit at system main air intake and discharge points, as indicated.

Y46.4030 ACCESSORIES:

Fit accessories to each grille and diffuser in accordance with manufacturer's instructions and as indicated.

Y46.4040 CONNECTION TO DUCTWORK:

When connecting directly to duct spigot, secure grille mounting frame or flange with screws, or bolts and nuts, to returned flange, with filled in corners, at end of duct spigot.

Y46.4050A INSTALLATION IN BUILDERS WORK:

Ensure outer edge of grille mounting frame or flange extends on all sides beyond the joint between any builders work frame and surrounding building construction.

Ensure grilles are sealed to building fabric - including ceilings, to prevent air leakage from pressurised rooms to voids above.

Fix louvres to building fabric using method indicated on drawings.

Y46.4060A TRANSFER GRILLES:

Where transfer points are located in partitions or walls, prevent through vision by fitting a fixed blade grille on both faces of partition or wall. Connect cavity wall or partition transfer grille assemblies with ducting sleeve or collar extending between grilles.

Y46.4060B TRANSFER GRILLES WITH FIRE DAMPER:

Location

Where transfer points are located in partitions or walls, prevent through vision by fitting a fixed blade grille on both faces of partition or wall. Connect cavity wall or partition transfer grille assemblies with ducting sleeve or collar extending between grilles.

Incorporate fire damper in fire compartment wall transfer grille assembly.

Y46.4070 FIXING: Provide details of fixing method for approval.

Y50 THERMAL INSULATION

Y50.1000 GENERAL TEMPERATURE RANGE: 1010 Surface temperature within range -40°C to 230°C. 1020 STANDARDS: Comply in general with BS 5422, BS 5970 and BS EN ISO 12241. Use the description of terms as BS 3533. 1030 MATERIALS: Employ materials that comply with BS 476-4, non-combustibility test, or obtain a Class 'O' fire rating to Building Regulations when tested to BS 476-6 and BS 476-7. Ensure metals and materials that cause galvanic corrosion are not installed in contact. Do not use galvanized or zinc coated steel jacketing and accessories on austenitic stainless steel and austenitic nickel steel/alloy equipment and piping. 1032 PRE-INSULATED EQUIPMENT: Where fire and surface spread of flame certificates relate to factory made products, ensure that certificates are still valid where products are incorporated in pre-insulated equipment. 1034 PROTECTION APPLIED IN SITU: Where fire and surface spread of flame certificates relate to factory made products, ensure that the certificate remains valid when the finish is site applied. Y50.1035A CLASS A1 EUROPEAN CLASSIFICATION FOR REACTION TO FIRE PERFORMANCE: Supply insulating materials that comply with Euroclass A1. Y50.1035B CLASS A2 EUROPEAN CLASSIFICATION FOR REACTION TO FIRE PERFORMANCE: Supply insulating materials that comply with Euroclass A2.

Y50.1035C CLASS B EUROPEAN CLASSIFICATION FOR REACTION TO FIRE PERFORMANCE: Supply insulating materials that comply with Euroclass B.

Y50.1035D CLASS C EUROPEAN CLASSIFICATION FOR REACTION TO FIRE PERFORMANCE: Supply insulating materials that comply with Euroclass C.

Y50.1050# SPREAD OF FLAME:

 When completed, ensure surface-finish complies with BS 476-7 Class 1 spread of flame.

Y50.1050A SPREAD OF FLAME: When completed, ensure surface-finish complies with BS 476-7 Class 1 spread of flame.

Y50.1055# SMOKE EMISSION CHARACTERISTICS: Supply materials classified as less than 5% smoke obscuration rating when tested in accordance with BS EN ISO 5659-2.

Y50.1055A SMOKE EMISSION CHARACTERISTICS: Supply materials classified as less than 5% smoke obscuration rating when tested in accordance with BS EN ISO 5659-2.

Y50.1080 ELECTRICAL BONDING TERMINAL: Ensure an electrical bonding terminal suitable for connection of 6mm² maximum conductor is provided where indicated.

Y50.1090 INSPECTION AND TESTING: Arrange performance test of thermal conductivity on materials selected, carried out at manufacturer's works or at an approved laboratory and in accordance with appropriate British Standard.

Y50.2010 THERMAL CONDUCTIVITY: Ensure values are in accordance with BS 874 and BS 2972.

Y50.2015# THERMAL PERFORMANCE LIFE EXPECTANCY:

KJ TAIT ENGINEERS

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE THERMAL INSULATION

- Ensure the insulation will maintain its thermal performance for a minimum of the plant design life. •
- Provide manufacturer's details which define the life expectancy of the insulation material.

Y50.2015A THERMAL PERFORMANCE LIFE EXPECTANCY FOR PLANT DESIGN LIFE: Ensure the insulation will maintain it's thermal performance for a minimum of the plant design life.

Y50.2015B THERMAL PERFORMANCE LIFE EXPECTANCY DETAILS: Provide manufacturer's details which define the life expectancy of the insulation material.

Y50.2020 RESTRICTIONS ON USE OF MATERIALS:

Protect insulated stainless steel surfaces from the risk of stress corrosion in accordance with the recommendations in BS 5970.

Y50.2030A FOIL FACED MINERAL FIBRE PIPE INSULATION: Standard - BS 3958-4. Nominal density - 80 kg/m³ to 120 kg/m³. Thickness - 20mm to 100mm. Thermal conductivity Not exceeding 0.038 W/mK at a mean temperature of 50°C. Finish - Reinforced aluminium foil with at least 25mm overlap.

Y50.2030B CANVAS COVERED MINERAL FIBRE PIPE INSULATION: Standard - BS 3958-4. Nominal density - 80 kg/m³ to 120 kg/m³. Thickness - 20mm to 100mm. Thermal conductivity - not exceeding 0.038 W/mK at a mean temperature of 50°C. Finish - Canvas covered with at least 25mm overlaps.

Y50.2040# MINERAL FIBRE RIGID DUCT INSULATION:

- Standard BS 3958-5.
- Nominal density 45 48 kg/m³.
- Thickness 25mm to 100mm.
- Thermal conductivity
- Not exceeding 0.04 W/mK at a mean temperature of 50°C. Finish
- Unfaced.
- Reinforced aluminium foil.

Y50.2040A FOIL FACED MINERAL FIBRE RIGID DUCT INSULATION: Standard - BS 3958-5. Nominal density - 45 - 48 kg/m³. Thickness - 25mm to 100mm. Thermal conductivity - Not exceeding 0.04 W/mK at a mean temperature of 50°C. Finish - Reinforced aluminium foil.

Y50.2050# MINERAL FIBRE FLEXIBLE DUCT INSULATION:

- Nominal density 28 kg/m³ to 45 kg/m³.
- Thickness 25mm to 60mm.
- Thermal conductivity Not exceeding 0.04 W/mK at a mean temperature of 50°C.
- Finish
 - Reinforced aluminium foil.

Y50.2050A FOIL FACED MINERAL FIBRE FLEXIBLE DUCT INSULATION: Nominal density - 28 kg/m³ to 45 kg/m³. Thickness - 25mm to 60mm. Thermal conductivity - Not exceeding 0.04 W/mK at a mean temperature of 50°C. Finish - Reinforced aluminium foil.

Y50.2060# MINERAL FIBRE LAMELLA DUCT INSULATION:

KJ TAIT ENGINEERS

- Nominal density 24-45 kg/m³. •
- Thickness - 25mm to 80mm.
- Thermal conductivity Not exceeding 0.051 W/mK at a mean temperature of 50°C.
- Finish
- Reinforced aluminium foil.
- Plain Kraft paper.

Y50.2060A FOIL FACED MINERAL FIBRE LAMELLA DUCT INSULATION: Nominal density - 24-45 kg/m³. Thickness - 25mm to 80mm. Thermal conductivity - Not exceeding 0.051 W/mK at a mean temperature of 50°C. Finish - Reinforced aluminium foil.

Y50.2060B KRAFT PAPER FACED MINERAL FIBRE LAMELLA DUCT INSULATION: Nominal density - 24-45 kg/m³. Thickness - 25mm to 80mm. Thermal conductivity - Not exceeding 0.051 W/mK at a mean temperature of 50°C. Finish - Plain Kraft paper.

Y50.2070# METAL MESH FACED MINERAL FIBRE MATTRESSES:

- Standard BS 3958-3.
- Nominal density 90 128 kg/m³.
- Thickness 25mm to 100mm. •
- Thermal conductivity
- Not exceeding 0.038 W/mK at a mean temperature of 50°C. Mesh
- Galvanized.
- Stainless steel.
- Faced
- One side.
- Both sides.

Y50.2070A GALVANIZED METAL MESH ON MINERAL FIBRE MATTRESSES - ONE FACE: Standard - BS 3958-3. Nominal density - 90 - 128 kg/m³. Thickness - 25mm to 100mm. Thermal conductivity - Not exceeding 0.038 W/mK at a mean temperature of 50°C. Mesh - Galvanized. Faced, one side.

Y50.2070B GALVANIZED METAL MESH ON MINERAL FIBRE MATTRESSES - BOTH FACES: Standard - BS 3958-3. Nominal density - 90 - 128 kg/m³. Thickness - 25mm to 100mm. Thermal conductivity - Not exceeding 0.038 W/mK at a mean temperature of 50°C. Mesh - Galvanized. Faced, both sides.

Y50.2070C STAINLESS STEEL MESH ON MINERAL FIBRE MATTRESSES - ONE FACE: Standard - BS 3958-3. Nominal density - 90 - 128 kg/m³. Thickness - 25mm to 100mm. Thermal conductivity - Not exceeding 0.038 W/mK at a mean temperature of 50°C. Mesh - Stainless steel, Faced, one side,

Y50.2070D STAINLESS STEEL MESH ON MINERAL FIBRE MATTRESSES - BOTH FACES: Standard - BS 3958-3. Nominal density - 90 - 128 kg/m³. Thickness - 25mm to 100mm. Thermal conductivity - Not exceeding 0.038 W/mK at a mean temperature of 50°C.
C0605LMB Revised Stage E Mechanical Specification Including Agreed VE THERMAL INSULATION

Mesh - Stainless steel. Faced, both sides.

Y50.2080# DUCTWORK FIRE PROTECTION INSULATION:

- Material Mineral fibre
- Slab for flat ducts.
 - 45° mitred joints.
 - 90° butted joints.
- Section for circular duct. 17 to 610 mm diameter.
- PSM for circular duct greater than 406mm diameter.
- Nominal density 165 kg/m³.
- Thermal conductivity
- Not exceeding 0.035 W/mK at a mean temperature of 10°C.
- Facing
 - Reinforced aluminium foil.
 - Glass mesh scrim.

Y50.2080A FLAT DUCTWORK FIRE PROTECTION INSULATION - MITRED JOINTS: Material - Mineral fibre, slab for flat ducts, with 45° mitred joints. Nominal density - 165 kg/m³.

Thermal conductivity - Not exceeding 0.035 W/mK at a mean temperature of 10°C. Facing - Reinforced aluminium foil.

Y50.2080B FLAT DUCTWORK FIRE PROTECTION INSULATION - BUTTED JOINTS: Material - Mineral fibre, slab for flat ducts, with 90° butted joints. Nominal density - 165 kg/m³. Thermal conductivity - Not exceeding 0.035 W/mK at a mean temperature of 10°C. Facing - Reinforced aluminium foil.

Y50.2080C CIRCULAR DUCTWORK FIRE PROTECTION INSULATION - SECTION: Material - Mineral fibre

Section for circular duct, 17 to 610 mm diameter.

Nominal density - 165 kg/m³.

Thermal conductivity - Not exceeding 0.035 W/mK at a mean temperature of 10°C. Facing - Reinforced aluminium foil.

Y50.2080D CIRCULAR DUCTWORK FIRE PROTECTION INSULATION - PSM: Material - Mineral fibre

PSM for circular duct greater than 406mm diameter.

Nominal density - 165 kg/m³.

Thermal conductivity - Not exceeding 0.035 W/mK at a mean temperature of 10°C. Facing - Reinforced aluminium foil.

Y50.2110# CLOSED CELL RIGID PHENOLIC FOAM (PF) PREFORMED SECTIONS - CFC AND HCFC FREE:

- Standard BS EN 13166.
- Nominal density 35 40 kg/m³.
- Temperature range: -180 to +120°C.
- Thickness 15mm to 50mm.
- Thermal conductivity
- Not exceeding 0.021 W/mK at a mean temperature of 10°C. Finish
 - Reinforced aluminium foil.
- Unfaced.

Y50.2110A FOIL FACED CLOSED CELL RIGID PHENOLIC FOAM (PF) PREFORMED SECTIONS -CFC AND HCFC FREE: Standard - BS EN 13166. Nominal density - 35 - 40 kg/m³. Temperature range: -180 to +120°C.

Thickness - 15mm to 50mm. Thermal conductivity - Not exceeding 0.021 W/mK at a mean temperature of 10°C. Finish - Reinforced aluminium foil.

Y50.2110B CLOSED CELL RIGID PHENOLIC FOAM (PF) PREFORMED SECTIONS - CFC AND HCFC FREE: Standard - BS EN 13166. Nominal density - 35 - 40 kg/m³. Temperature range: -180 to +120°C. Thickness - 15mm to 50mm. Thermal conductivity - Not exceeding 0.021 W/mK at a mean temperature of 10°C.

Y50.2120# CLOSED CELL RIGID LAMINATED PHENOLIC FOAM (PF). DUCT INSULATION SLAB -CFC AND HCFC FREE:

- Standard BS EN 13166.
- Nominal density 40 kg/m³. •
- Thickness 20mm to 50mm. •
- Thermal conductivity Not exceeding 0.021 W/mK at a mean temperature of 10°C. Finish
 - Reinforced aluminium foil.
 - Unfaced.

Y50.2120A FOIL FACED CLOSED CELL RIGID LAMINATED PHENOLIC FOAM (PF), DUCT **INSULATION SLAB - CFC AND HCFC FREE:** Standard - BS EN 13166. Nominal density - 40 kg/m³. Thickness - 20mm to 50mm. Thermal conductivity - Not exceeding 0.021 W/mK at a mean temperature of 10°C. Finish - Reinforced aluminium foil.

Y50.2120B CLOSED CELL RIGID LAMINATED PHENOLIC FOAM (PF), DUCT INSULATION SLAB -CFC AND HCFC FREE: Standard - BS EN 13166. Nominal density - 40 kg/m³. Thickness - 20mm to 50mm. Thermal conductivity - Not exceeding 0.021 W/mK at a mean temperature of 10°C.

Y50.2130A HIGH DENSITY PHENOLIC PIPE AND DUCT SUPPORT FOAM: Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.

Standard - BS EN 13166. Nominal density - 60 kg/m³ to 120 kg/m³. Temperature range: -180 to +120°C. Thermal conductivity - Not exceeding 0.040 W/mK at a mean temperature of 50°C. CFC and HCFC free.

Y50.2140# CLOSED CELL NITRILE RUBBER ELASTOMERIC SHEET AND PREFORMED FLEXIBLE SECTIONS:

- Nominal density 90 100 kg/m³.
- Temperature range -40 to +105°C.
- Thickness
 - Sections
 - 13mm to 25mm for pipe sizes 15mm to 100mm.
 - 6mm, 9mm and 32mm available for some sizes.
 - Sheets 6mm to 25mm.
- Thermal conductivity Not exceeding 0.04 W/mK at a mean temperature of 20°C.

Y50.2140A CLOSED CELL NITRILE RUBBER ELASTOMERIC SHEET AND PREFORMED FLEXIBLE SECTIONS: Nominal density - 90 - 100 kg/m³.

KJ TAIT ENGINEERS

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE THERMAL INSULATION

- Mild steel sheet continuously hot dipped with aluminium-zinc coating to BS EN 10326 and BS EN • 10327, applied directly to insulating material.
 - 185gm coating.
 - 150gm coating.
 - Thickness
 - 0.4mm.
 - 0.5mm.
 - Finish
 - Flat sheet.
 - Ribbed sheet.
 - Stucco.
 - Ribbed stucco.
- Aluminium sheeting Apply flat (embossed) or profiled aluminium cladding directly to insulating material, thickness
 - 0.56mm on pipework.
 - 0.71mm on ductwork.
- Galvanized sheet steel
 - Enclose insulation with sheeting around insulation and finish.
 - Thickness
 - 1.6mm.
- Canvas with co-polymer solution
 - 4.5oz covering for ductwork with two coats of water based co-polymer solution.
 - With aluminium bands. • Canvas sections for pipework with two coats of water based co-polymer solution.
 - With aluminium bands.
- Rigid PVC
 - Thickness
 - 0.35mm.
 - 0.50mm.
 - 0.75mm.
- Laminated foil/film

Y50.2200A POLYISOBUTYLENE PROTECTION: Minimum thickness 0.8mm.

Y50.2200B ROOFING FELT PROTECTION: Secure in position with galvanized wire netting, of 1mm x 25mm mesh. Finish with two coats of black bituminous paint.

Y50.2200C FLAT ALUMINIUM-ZINC COATED STEEL PROTECTION: Mild steel sheet continuously hot dipped with 185gm aluminium-zinc coating to BS EN 10326 and BS EN 10327, applied directly to insulating material. 0.4mm thick flat sheet.

Y50.2200D RIBBED ALUMINIUM-ZINC COATED STEEL PROTECTION: Mild steel sheet continuously hot dipped with 185gm aluminium-zinc coating to BS EN 10326 and BS EN 10327, applied directly to insulating material. 0.4mm thick ribbed sheet.

Y50.2200E ALUMINIUM SHEETING PROTECTION: Apply flat (embossed) or profiled aluminium cladding directly to insulating material. 0.56mm thick on pipework; 0.71mm thick on ductwork.

Y50.2200F GALVANIZED SHEET STEEL PROTECTION: Enclose insulation with 1.6mm thick sheeting around insulation and finish.

Y50.2200G CANVAS PROTECTION: 4.5oz covering for ductwork with two coats of water based co-polymer solution. Canvas sections for pipework with two coats of water based co-polymer solution.

Temperature range: -40 to +105°C. Thickness Sections - 13mm to 25mm for pipe sizes 15mm to 100mm. Sheets - 6mm to 25mm. Thermal conductivity - Not exceeding 0.04 W/mK at a mean temperature of 20°C.

Y50.2150 CALCIUM SILICATE PREFORMED SECTION AND SLAB: Standard - BS 3958-2. Nominal density - 220 kg/m³. Temperature range - Up to 800°C. Thermal conductivity - Not exceeding 0.05 W/mK at a mean temperature of 100°C.

Y50.2170# VAPOUR BARRIER PERMEANCE:

- Do not exceed the following permeance values for vapour barriers.
- Permeance values Cold water pipework - 0.05g/sMN. Chilled water pipework - 0.015g/sMN. Refrigeration pipework - 0.010g/sMN.

Y50.2170A VAPOUR BARRIER PERMEANCE:

Do not exceed the following permeance values for vapour barriers. Permeance values

Cold water pipework - 0.05g/sMN. Chilled water pipework - 0.015g/sMN. Refrigeration pipework - 0.010g/sMN.

Y50.2180# VAPOUR BARRIER COATINGS:

- Coatings
 - Cut-back bitumens.
 - Vinvl emulsions.
 - Solvent-based polymers. ٠
 - Bitumen emulsions (with or without elastomer latex).
 - Water based co-polymers.
- Reinforcement

Use cotton canvas or open mesh glass cloth to reinforce coatings.

Y50.2180A BITUMEN VAPOUR BARRIER COATINGS: Cut-back bitumens with cotton canvas or open mesh glass cloth to reinforce coatings.

Y50.2180B VINYL VAPOUR BARRIER COATINGS: Vinyl emulsions with cotton canvas or open mesh glass cloth to reinforce coatings.

Y50.2180C SOLVENT POLYMER VAPOUR BARRIER COATINGS: Solvent-based polymers with cotton canvas or open mesh glass cloth to reinforce coatings.

Y50.2180D BITUMEN EMULSION VAPOUR BARRIER COATINGS: Bitumen emulsions (with or without elastomer latex) with cotton canvas or open mesh glass cloth to reinforce coatings.

Y50.2190 ADHESIVES:

Comply with the recommendations of clause 8.2 of BS 5970, section 2 for insulation bonding adhesives, lagging adhesives; and facing and film attachment adhesives.

Y50.2200# PROTECTION:

- Polyisobutylene
- Minimum thickness 0.8mm.
- Roofing felt

Secure in position with galvanized wire netting, of 1mm x 25mm mesh. Finish with two coats of black bituminous paint.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE THERMAL INSULATION

Y50.2200H CANVAS PROTECTION WITH ALUMINIUM BANDS:

4.5oz covering for ductwork with two coats of water based co-polymer solution, with aluminium bands. Canvas sections for pipework with two coats of water based co-polymer solution, with aluminium bands.

Y50.2200I RIGID PVC PROTECTION: 0.35mm thick.

Y50.2200J LAMINATED FOIL/FILM PROTECTION: Enclose insulation with laminated foil/film around insulation and finish.

Y50.2210# REINFORCEMENT:

- Aluminium bands at 300mm centres.
- Aluminium bands at 450mm centres.
- 50mm x 19g galvanised wire netting to BS EN 10223.
- 50mm x 22g galvanised wire netting to BS EN 10223.

Y50.2210A ALUMINIUM BANDS REINFORCEMENT: Aluminium bands at 300mm centres.

Y50.2210B ALUMINIUM BANDS REINFORCEMENT: Aluminium bands at 450mm centres.

Y50.2210C WIRE NETTING REINFORCEMENT: 50mm x 19g galvanised wire netting.

Y50.2210D WIRE NETTING REINFORCEMENT: 50mm x 22g galvanised wire netting.

Y50.2220# VALVE AND FLANGE INSULATION:

- Install insulation on flanges and valves, where indicated.
- Use a protected metal split casing fabricated from 0.91mm aluminium sheet fitted with spring clip fasteners, filled with insulating material with same thermal performance as insulation on adjoining pipe.
- Use a protected metal split casing fabricated from 0.7mm aluminium-zinc coated steel sheet fitted ٠ with spring clip fasteners, filled with insulating material with same thermal performance as insulation on adjoining pipe.
- Cold applications
 - Enclose cold piping valve bodies and flanges with insulating material to maintain vapour barrier.

Y50.2220A VALVE AND FLANGE INSULATION - ALUMINIUM CASING:

Install insulation on flanges and valves.

Use a protected metal split casing fabricated from 0.91mm aluminium sheet fitted with spring clip fasteners, filled with insulating material with same thermal performance as insulation on adjoining pipe.

Y50.2220B VALVE AND FLANGE INSULATION - ALUMINIUM-ZINC COATED STEEL CASING: Install insulation on flanges and valves.

Use a protected metal split casing fabricated from 0.7mm aluminium-zinc coated steel sheet fitted with spring clip fasteners, filled with insulating material with same thermal performance as insulation on adjoining pipe.

Y50.2220C CLOSED CELL VALVE AND FLANGE INSULATION - COLD APPLICATIONS:

Install insulation on flanges and valves.

Enclose cold piping valve bodies and flanges with closed cell insulating material to maintain vapour barrier.

Y50.2220D VALVE AND FLANGE INSULATION - COLD APPLICATIONS:

Install insulation on flanges and valves. Enclose cold piping valve bodies and flanges with insulating material to maintain vapour barrier.

Y50.2230# PROTECTION FOR HEAT EXCHANGERS AND OTHER VESSELS:

- Material
- 0.9mm aluminium ribbed or embossed sheeting.
- 0.7mm aluminium-zinc coated steel embossed or ribbed sheeting.
- Finish with lapped, riveted and sealed joints, laps to shed water. Seal all joints at manholes and stools. Fit cut outs with purpose made over-plates or collars.
- Chests and access covers
 - Enclose chests and access covers in removable covers lined with high density flexible material. Remove manufacturer's name plate and refix on cladding.

Y50.2230A ALUMINIUM PROTECTION FOR HEAT EXCHANGERS AND OTHER VESSELS: Finish with 0.9mm thick aluminium ribbed or embossed sheeting, with lapped, riveted and sealed joints, laps to shed water. Seal all joints at manholes and stools. Fit cut-outs with purpose made overplates or collars.

Y50.2230B ALUMINIUM PROTECTION FOR HEAT EXCHANGERS AND OTHER VESSELS - WITH CHEST AND ACCESS COVERS:

Finish with 0.9mm thick aluminium ribbed or embossed sheeting, with lapped, riveted and sealed joints, laps to shed water. Seal all joints at manholes and stools. Fit cut outs with purpose made overplates or collars.

Enclose chests and access covers in removable covers lined with high density flexible material. Remove manufacturer's name plate and refix on cladding.

Y50.2230C ALUMINIUM-ZINC COATED STEEL PROTECTION FOR HEAT EXCHANGERS AND OTHER VESSELS:

Finish with 0.7mm thick aluminium-zinc coated steel embossed or ribbed sheeting, with lapped, riveted and sealed joints, laps to shed water. Seal all joints at manholes and stools. Fit cut outs with purpose made over-plates or collars.

Y50.2230D ALUMINIUM-ZINC COATED STEEL PROTECTION FOR HEAT EXCHANGERS AND OTHER VESSELS - WITH CHEST AND ACCESS COVERS: Finish with 0.7mm thick aluminium-zinc coated steel embossed or ribbed sheeting, with lapped, riveted and sealed joints, laps to shed water. Seal all joints at manholes and stools. Fit cut outs with purpose made over-plates or collars.

Enclose chests and access covers in removable covers lined with high density flexible material. Remove manufacturer's name plate and refix on cladding.

Y50.2240# INSULATION FOR BOILER FLUES:

- Use preformed sections secured by metal bands direct to flue. Use multi-layers and stagger joints for thicknesses in excess of 65mm.
 - Material
 - Calcium silicate. ٠
 - Bonded mineral fibre. •
- Finish
- Material
 - 0.9mm aluminium ribbed or embossed sheeting.
 - Secured with
 - aluminium bands.
 - stainless steel bands.

Y50.2240A MINERAL FIBRE INSULATION FOR BOILER FLUES WITH ALUMINIUM CASING: Use bonded mineral fibre preformed sections secured with aluminium bands direct to flue. Use multilayers and stagger joints for thicknesses in excess of 65mm. Finish with 0.9mm thick aluminium ribbed or embossed sheeting.

0.7mm aluminium-zinc coated steel embossed or ribbed sheeting.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE THERMAL INSULATION

Y50.2240B MINERAL FIBRE INSULATION FOR BOILER FLUES WITH ALUMINIUM-ZINC COATED STEEL CASING:

Use bonded mineral fibre preformed sections secured with aluminium bands direct to flue. Use multilayers and stagger joints for thicknesses in excess of 65mm. Finish with 0.7mm thick aluminium-zinc coated steel embossed or ribbed sheeting.

Y50.2260 PRE-INSULATED STORAGE VESSELS:

Ensure insulation standards on pre-insulated storage vessels meet the general specification requirements of the works.

Y50.2280 PUMPS AND OTHER IRREGULAR SHAPES:

Where access is required to pumps and other irregular shapes submit proposals for materials and methods of applying a demountable finish, for approval.

Y50.2285 CALCULATION OF INSULATION THICKNESS:

Provide insulation of thickness conforming with the values given in the tables below. These figures are derived from the tables given in BS 5422 and the calculation methods given in BS EN ISO 12241.

Y50.2290 NON-DOMESTIC HOT WATER SERVICE AREAS - MINERAL WOOL: Environmental insulation thickness for non-domestic hot water service areas to control heat loss.

Outside diameter of steel	Thickness of mineral
pipe (mm)	
17	30
21	30
27	30
34	35
42	35
48	35
60	40
76	40
89	40
114	45
140	45
168	45
219	50
273	50
Above 273 & flat surfaces	50

 Use this table for insulation thickness of copper pipework of the nearest equivalent outside diameter.

Use this table for insulation thickness of plastic pipework of the nearest equivalent outside ٠ diameter.

Y50.2300 NON-DOMESTIC HOT WATER SERVICE AREAS - PHENOLIC FOAM: Environmental insulation thickness for non-domestic hot water service areas to control heat loss, aged K-value.

Outside diameter of steel	Thickness of phenolic
pipe (mm)	foam (mm)
17	15
21	15
07	10
27	15
34	20
42	20
10	20
40	20
60	25
76	25
80	25
09	25
114	25
	1
140	30
168	30
100	50
219	30
273	35
Above 273 & flat surfaces	35

- Use this table for insulation thickness of copper pipework of the nearest equivalent outside diameter.
- Use this table for insulation thickness of plastic pipework of the nearest equivalent outside • diameter.

Y50.2310 NON-DOMESTIC HEATING INSTALLATIONS - MINERAL WOOL: Environmental insulation thickness for non-domestic heating installations to control heat loss.

Outside diameter of steel pipe (mm)	Temperature of contents ^o C		
	75	100	150
	Thicknes: insulation	s of minera ı (mm)	al wool
17	30	35	60
21	30	40	60

KJ TAIT ENGINEERS



				_
27	35	40	60	
34	35	45	70	
42	35	45	70	
48	40	50	70	
	1	r	1	
60	40	50	70	
	1	1	,	
76	40	50	80	
89	40	60	80	
114	45	60	80	
140	45	<u></u>		
140	45	60	80	
100	45	<u></u>		
108	45	60	90	
210	50	60	00	
213	50	00	30	
272	50	60	00	
213	50	00	30	
Flat surfaces	50	70	90	
i lai sullaces	50	10	50	

Use this table for insulation thickness of copper pipework of the nearest equivalent outside • diameter.

Y50.2320 NON-DOMESTIC HEATING INSTALLATIONS - PHENOLIC FOAM: Environmental insulation thickness for non-domestic heating installations to control heat loss, aged Kvalue.

Outside diameter of steel pipe (mm)	Temperature of contents ⁰ C	
	75	100
	Thickness of phenolic f	oam insulation (mm)
17	15	20
21	15	20
27	20	20
34	20	25
	1	
42	20	25
48	20	25
	1	
60	25	30
	I	
76	25	30
	1	1
89	25	30

KJ TAIT ENGINEERS

114	25	35
140	30	35
168	30	35
219	30	40
273	30	40
Flat surfaces	35	45

• Use this table for insulation thickness of copper pipework of the nearest equivalent outside diameter.

Y50.2330 DOMESTIC CENTRAL HEATING AND HOT WATER SYSTEMS - MINERAL WOOL: Environmental insulation thickness for domestic central heating installations and hot water systems in potentially unheated areas to control heat loss.

Outside diameter of copper pipe (mm)	Thickness of mineral wool insulation for water at 60 °C for hot water with ambient still air temperature of -1 °C (mm)	Thic woo wate cent amb tem (mm
10	23	24
12	24	25
15	26	29
22	40	40
28	40	45
35	40	45
42	45	45
54	45	45
Cylinders	50	60

Y50.2340 STEAM AND CONDENSATE SYSTEMS

Outside diameter of steel pipe (mm)	Temperature of content	s°C
	Condensate	Ste
	Thickness of mineral wo	ool in
17	35	60

KJ TAIT ENGINEERS

Y50

THERMAL INSULATION

kness of mineral
insulation for
er at 75 °C for
ral heating with
iont still air
$c_{11} c_{11} $
Serature of -1 C
)
MINERAL WOOL:

eam

nsulation (mm)

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE THERMAL INSULATION

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE	
THERMAL INSULATION	

21	40	60	
27	40	60	
24	15	70	
04	45	10	
42	45	70	
		E	
48	50	70	
60	50	70	
00	50	70	
76	50	80	
89	60	80	
11/	60	80	
114	00	00	
140	60	80	
168	60	90	
210	60	00	
213	00	30	
273	60	90	
Flat surfaces	70	90	

Use this table for insulation thickness of copper pipework of the nearest equivalent outside • diameter.

Y50.2350 CHILLED AND COLD WATER SUPPLIES TO PREVENT CONDENSATION - MINERAL WOOL, HIGH EMISSIVITY:

Minimum insulation thickness for chilled and cold water supplies to prevent condensation on a high emissivity outer surface (0,9) with an ambient temperature of 25°C and a relative humidity of 80%.

Outside diameter of steel pipe (mm)	Temperature of contents ⁰ C		
	10	5	0
	Thickness of m	ineral wool insulation	on (mm)
17	20	20	20
21	20	20	20
27	20	20	20
	1		
33	20	20	20
-	T	ſ	
42	20	20	20
	T	1	
48	20	20	20
	T	1	
60	20	20	20

76	25	25	25
89	25	25	25
	•		
102	25	25	25
	1	T	
114	25	25	25
140	25	25	25
100			
168	25	25	25
010	05	05	05
219	20	25	20
245	25	25	25
243	25	25	25
273	25	25	25
270	20	20	20
324	25	25	25
356	30	30	30
406	35	35	35
456	35	35	35
508	35	35	35
	1	1	
610	35	35	35
			
Flat surfaces	40	25	30

- Use this table for insulation thickness of copper pipework of the nearest equivalent outside • diameter.
- Use this table for insulation thickness of plastic pipework of the nearest equivalent outside ٠ diameter.

Y50.2360 CHILLED AND COLD WATER SUPPLIES TO PREVENT CONDENSATION - PHENOLIC FOAM, HIGH EMISSIVITY:

Minimum insulation thickness for chilled and cold water supplies to prevent condensation on a high emissivity outer surface (0.6) with an ambient temperature of 25°C and a relative humidity of 80%.

Outside diameter of steel pipe (mm)	Temperature of contents ⁰ C		
r			<u> </u>
	10	5	0
	Thickness of pl	nenolic foam insula	tion (mm)
17	15	15	15
		·	
21	15	15	15
		·	<u>.</u>
27	15	15	15
	•	•	
33	15	15	15
	•	1	

KJ TAIT ENGINEERS

KJ TAIT ENGINEERS

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE THERMAL INSULATION

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE	
THERMAL INSULATION	

42	15	15	15	
	I			
48	15	15	15	
60	15	15	15	
60	15	15	15	
76	15	15	15	
89	15	15	15	
	I		1	
102	15	15	20	
114	20	20	20	
114	20	20	20	
140	20	20	20	
168	20	20	20	
	I		1	
219	25	25	25	
245	25	25	25	
243	23	25	25	
273	25	25	25	
324	25	25	25	
0.50				
356	25	25	25	
406	25	25	25	
400	25	25	25	
456	25	25	25	
508	25	25	25	
		05	05	
610	25	25	25	
Flat surfaces	25	25	25	
	20	20	20	

- Use this table for insulation thickness of copper pipework of the nearest equivalent outside diameter.
- Use this table for insulation thickness of plastic pipework of the nearest equivalent outside • diameter.

Y50.2370 CHILLED AND COLD WATER SUPPLIES TO PREVENT CONDENSATION - MINERAL WOOL, LOW EMISSIVITY:

Minimum insulation thickness for chilled and cold water supplies to prevent condensation on a low emissivity outer surface (0.05) with an ambient temperature of 25°C and a relative humidity of 80%.

Outside diameter	Temperature of	f contents ^⁰ C	
of steel pipe (mm)			
	10	5	0
	Thickness of m	ineral wool insulati	on (mm)
17	20	25	30

21	20	25	30	
27	20	30	35	
33	20	30	35	
42	25	30	40	
48	25	35	40	
60	25	35	45	
76	30	35	45	
		40		
89	30	40	50	
102	30	40	50	
114	30	40	50	
140	30	45	60	
169	25	45	60	
100	35	40	60	
219	35	50	60	
245	35	50	70	
273	40	50	70	
324	40	60	70	
021				
356	40	60	70	
406	40	60	80	
456	45	60	80	
508	45	60	80	
		70		
610	45	/0	80	
Flat surfaces	50	70	80	

- Use this table for insulation thickness of copper pipework of the nearest equivalent outside diameter.
- Use this table for insulation thickness of plastic pipework of the nearest equivalent outside • diameter.

Y50.2380 CHILLED AND COLD WATER SUPPLIES TO PREVENT CONDENSATION - PHENOLIC FOAM, LOW EMISSIVITY: Minimum insulation thickness for chilled and cold water supplies to prevent condensation on a low emissivity outer surface (0.05) with an ambient temperature of 25°C and a relative humidity of 80%.

Outside diameter	Temperature of contents ⁰ C
of steel pipe (mm)	

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE THERMAL INSULATION

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE	
THERMAL INSULATION	

	10	5	0
	Thicknes	s of phenolic foan	n insulation (mm)
17	15	20	20
21	15	20	20
27	15	20	25
33	15	20	25
42	15	20	25
48	15	25	30
60	20	25	25
76	20	25	30
89	20	25	35
102	20	25	35
114	20	30	35
140	20	30	40
168	25	30	40
219	25	35	40
245	25	35	40
273	25	35	45
324	25	35	45
356	25	35	50
406	25	35	50
456	25	35	50
508	30	40	50
610	30	40	55
Flat surfaces	30	40	55

• Use this table for insulation thickness of copper pipework of the nearest equivalent outside diameter.

Use this table for insulation thickness of plastic pipework of the nearest equivalent outside • diameter.

Y50.2390 CHILLED WATER SERVICES - MINERAL WOOL:

Environmental insulation thickness for chilled water supplies to control heat gain.

Outside diameter of steel pipe (mm)	Temperature of conten	its ⁰C
	5	0
	Thickness of mineral w	/ool in
17	25	30
21	25	30
27	30	35
34	30	35
42	30	40
48	35	40
60	35	45
76	40	45
89	40	50
114	45	60
168	60	70
219	60	70
273	60	80
508	70	80
Flat surfaces	75	100

- Use this table for insulation thickness of copper pipework of the nearest equivalent outside diameter.
- Use this table for insulation thickness of plastic pipework of the nearest equivalent outside diameter.

Y50.2400 CHILLED WATER SERVICES - PHENOLIC FOAM: Environmental insulation thickness for chilled water supplies to control heat gain.

Outside diameter of steel pipe (mm)	Temperature of contents ⁰ C	
	5	0
	Thickness of phenolic for	bam
17	15	15
21	15	15
	-	

isulation (mm)
0



C0605LMB Revised Stage E Mechanical Specification Including Agreed VE THERMAL INSULATION

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE	
THERMAL INSULATION	

27	15	15	
34	15	20	
	I		
42	20	20	
40			
48	20	20	
60	20	25	
00	20	20	
76	25	25	
89	25	30	
114	25	35	
140	30	35	
110			
168	30	40	
219	35	40	
273	35	45	
	40	50	
Fiai surfaces	40	50	

Use this table for insulation thickness of copper pipework of the nearest equivalent outside • diameter.

Use this table for insulation thickness of plastic pipework of the nearest equivalent outside • diameter.

Y50.2410 CHILLED AND MAINS COLD WATER SUPPLIES - CLOSED CELL NITRILE RUBBER:

Outside diameter of steel pipe (mm)	Thickness of closed cell nitrile rubber (mm)
15	19
20	19
25	25
32	25
40	25
50	25
54	32
60	32

Y50.2420 PROTECTION AGAINST FREEZING - MINERAL WOOL:

Outside diameter of	Indoor condition where	Outdoor condition
pipe (mm)	freezing might occur	where freezing might

KJ TAIT ENGINEERS

KJ TAIT ENGINEERS

		000
	ſ	
	Thickness of mi	neral wool ins
Copper pipe		
••••		
15	-	-
22	20	50
		I
28	20	25
35	20	20
42	20	20
54	20	20
76	25	25
70	25	20
108	25	25
Steel nine		
21	40	-
27	20	15
21	20	45
34	20	25
42	20	20
48	20	20
22		
UG	20	20
76	25	25
	I	
89	25	25

Indoor condition is for ambient air temperature of -6°C, permitted ice formation of 50%.

• • Outdoor condition is for ambient air temperature of -10°C, permitted ice formation of 50%.

Y50.2430 PROTECTION AGAINST FREEZING - PHENOLIC FOAM: Within the scope of BS 5422 Table 23.

Outside diameter of steel pipe (mm)	Indoor condition where freezing might occur	Outc whe
		occu
	Thickness of closed cell	pheno
15	30	70
20	20	50
25	20	20

ır	
ulation (mm)	1
ulation (mm)	



C0605LMB Revised Stage E Mechanical Specification Including Agreed VE

Y50

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE THERMAL INSULATION

Environmental thickness of mineral wool insulation (mm)	4 0	50	60
Environmental thickness of phenolic foam	2	25	40
insulation (mm)	0		

Y50.2460 CONDENSATION CONTROL ON CHILLED AIR DUCTWORK - MINERAL WOOL: Minimum insulation thickness for condensation control on ductwork carrying chilled air in ambient conditions: indoor still air temperature 25°C, relative humidity 80%, dew point temperature 21.3°C.

Minimum air temperature inside duct ⁰ C	Thermal conductivity of 0.035 W/mK at a mean temperature of 10 ^o C Surface coefficients		
	Low (0.05)	Medium (0.44)	High (0.90)
	Thickness of mineral wool insulation (mm)		
15	25	25	25
10	50	25	25
5	65	40	25
0	90	50	30

Y50.2470 CONDENSATION CONTROL ON CHILLED AIR DUCTWORK - PHENOLIC FOAM: Minimum insulation thickness for condensation control on ductwork carrying chilled air in ambient conditions: indoor still air temperature 25°C, relative humidity 80%, dew point temperature 21.3°C.

Minimum air temperature inside duct ⁰ C	Thermal conductivity of 0.021 W temperature of 10 °C Surface co		
	Low (0.05)	Medium (0.44)	
	Thickness of phenolic foam insu		
15	25	25	
10	30	25	
5	40	25	
0	50	25	

Y50.2475 CONDENSATION CONTROL ON CHILLED AIR DUCTWORK - CLOSED CELL PVC NITRILE FOAM:

Minimum insulation thickness for condensation control on ductwork carrying chilled air in ambient conditions: indoor still air temperature 25°C, relative humidity 80%, dew point temperature 21.3°C.

KJ TAIT ENGINEERS

	THERMAL INSULATION			
32	20	20		
40	20	20		
	I			
50	20	20		
65	20	20		
80	20	20		
Elat surfaces	25	25		

- Indoor condition is for ambient air temperature of -6°C, permitted ice formation of 50%.
- Outdoor condition is for ambient air temperature of -10°C, permitted ice formation of 50%.
- Use this table for insulation thickness of copper pipework of the nearest equivalent outside diameter.

Y50.2440 PROTECTION AGAINST FREEZING - CLOSED CELL NITRILE RUBBER:

Outside diameter of	Indoor condition where	Outdoor condition
steel pipe (mm)	freezing might occur	where freezing might
		occur
	Thickness of closed cell	nitrile rubber (mm)
		·
15	57	-
20	25	51
25	13	32
32	13	19
40	13	13
50	13	13
65	13	13
80	13	13
Flat surfaces	13	13

Indoor condition is for ambient air temperature of -6°C, permitted ice formation of 50%. •

Outdoor condition is for ambient air temperature of -10°C, permitted ice formation of 50%. •

Use this table for insulation thickness of copper pipework of the nearest equivalent outside • diameter.

Y50.2450 ENVIRONMENTAL THICKNESS ON WARM AIR DUCTWORK:

Temperature difference between air inside ductwork and ambient still air (K)	1 0	25	50
Heat loss (W/m ²)	7.	15.	26.
	2	3	0



36 W/mK at a mean ce coefficients

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE THERMAL INSULATION

Where insulation abuts duct support inserts that have integral vapour barriers seal using class 'O' foil tape to continue vapour barrier.

Y50.3070 INSTALLATION OF FOIL FACED FLEXIBLE DUCTWORK INSULATION: Secure the insulation with adhesive in accordance with manufacturer's recommendations. Use insulation hangers spaced at maximum 300mm centres on the underside of rectangular and flat oval ducts.

Seal joints and pin penetrations using 100mm wide class 'O' aluminium foil tape. Where cut outs for test holes, etc occur tape over insulation membrane and return to the duct surface. Where insulation abuts duct support inserts that have integral vapour barriers seal using class 'O' foil tape to continue vapour barrier.

Y50.3080 INSTALLATION OF FOIL FACED LAMELLA ON DUCTWORK: Secure the insulation with adhesive in accordance with manufacturer's recommendations. Use insulation hangers spaced at maximum 300mm centres on the underside of rectangular and flat oval ducts.

Seal joints and pin penetrations using 100mm wide class 'O' aluminium foil tape. Where cut outs for test holes, etc occur tape over insulation membrane and return to the duct surface. Where insulation abuts duct support inserts that have integral vapour barriers seal using class 'O' foil tape to continue vapour barrier.

Y50.3090 INSTALLATION OF INSULATION ON TANKS: Fit insulation so that two opposite pieces overlap the sides. Bond insulation to the tank with adhesive, applied in accordance with the manufacturer's recommendations. Closely butt together all slabs and seal joints with a matching self-adhesive tape 100mm wide.

Y50.3100 INSTALLATION OF MINERAL WOOL INSULATION ON VESSELS: Cut Lamella to length to wrap around duct with an additional 75mm to form an overlap. Remove insulation from facing of overlap together with dust, and seal overlap with adhesive in accordance with manufacturer's instructions. Butt joints closely together and seal with matching self-adhesive tape at least 100mm wide.

Y50.3110 INSTALLATION OF PHENOLIC FOAM INSULATION ON VESSELS: Use pre-formed segments or pre-slotted foil faced insulation to fit the diameter of the vessel, laid with staggered joints. Vapour seal the joint faces. Use jointing compound to fill and seal joints around protrusions.

Do not use wire to secure insulation.

Secure insulation segments up to 3500mm outside insulation diameter with filament tape 38mm wide at 300mm centres.

Secure insulation segments over 3500mm outside insulation diameter with aluminium banding.

Y50.3120 INSTALLATION OF POLYISOBUTYLENE (PIB) PROTECTION: Wrap pipework and fittings, ductwork or tanks and vessels with PIB sheeting lapped at every joint by at least 50mm. Solvent weld joints and support with banding in accordance with manufacturer's Arrange joints to shed water and prevent the ingress of water.

Y50.3130# INSTALLATION OF SHEET METAL FINISH ON PIPEWORK:

- Secure insulation with metal bands at each end of section and at maximum centres of 450mm. of at least 40mm. Secure the outer part of overlap with
 - self tapping screws or rivets at centres of not more than 150mm. Not on pipes with vapour barrier.
 - self tapping screws or rivets at centres of not more than 100mm. Not on pipes with vapour barrier.
 - metal bands of same material.
- Ensure circumferential overlaps are at least 50mm, secured with self tapping screws or rivets. • Make provision to accommodate expansion and contraction at intervals. Ensure all joints are lapped to shed liquids and seal all joints exposed to weather or spillage. Cover all bends and fittings with matching sheet metal, tailored to fit and sealed as appropriate. Fit pre-insulated, purpose-designed boxes to valves, flanges, etc.

KJ TAIT ENGINEERS

	Т	HERMAL INSULATION
	(0.7)	(0.9)
	Thickness of P	VC Nitrile foam insulation (mm
15	10	8
10	16	12
5	19	16

Y50.3010 GENERAL:

Carry out thermal insulation work using one of the scheduled firms employing skilled craftsmen conversant with class of work.

Do not apply thermal insulation until installation has been fully tested and all joints proved sound. Ensure all materials are kept dry.

25

Ensure all pipework surfaces are dry before the installation of thermal insulation.

Insulate each unit separately. Do not enclose adjacent units together.

Ensure there is clearance between insulated pipes.

25

Application

Apply insulants, facings, coatings and protection strictly in accordance with manufacturer's instructions.

Finish

0

Neatly finish joints, corners, edges and overlaps and, where possible, arrange overlaps to fall on blind side. Ensure overlaps are neat and even and parallel to circumferential and longitudinal ioints.

Y50.3020 INSTALLATION OF FOIL FACED MINERAL WOOL INSULATION ON PIPEWORK: Ensure joints are close butted together. Secure overlaps with adhesive or matching class 'O' tape, a minimum of 50mm wide, on both longitudinal and circumferential butt joints. Insulate fittings to same standard as adjacent pipework and use mitred segments where necessary, taped as above. Where a vapour seal or fibre containment is required tape exposed insulation membrane and return to pipe surface.

Where insulation abuts pipe support inserts that have integral vapour barriers seal using class 'O' foil tape to continue vapour barrier or containment.

Y50.3030 INSTALLATION OF FOIL FACED PHENOLIC FOAM INSULATION ON PIPEWORK: Ensure joints are close butted together. Secure overlaps with adhesive or matching class 'O' tape, a minimum of 50mm wide, on both longitudinal and circumferential butt joints. Insulate fittings to same standard as adjacent pipework and use mitred segments where necessary, taped as above.

Y50.3040 INSTALLATION OF INSULATION WITH CANVAS FINISH ON PIPEWORK: Ensure joints are close butted together and secure overlaps with adhesive and smooth out. Insulate fittings to same standard as adjacent pipework and use mitred segments where necessary, secure with adhesive using a minimum of 50mm wide canvas to cut mitred joints. Apply two coats of class 'O' polymer solution.

Y50.3050 INSTALLATION OF CLOSED CELL NITRILE RUBBER INSULATION ON PIPEWORK: Install closed cell nitrile rubber in accordance with manufacturer's recommendations. Check installation procedure when closed cell nitrile rubber is to be installed on stainless steel pipework.

Y50.3060 INSTALLATION OF FOIL FACED SEMI-RIGID SLAB INSULATION ON DUCTWORK: Secure the insulation with adhesive in accordance with manufacturer's recommendations. Use insulation hangers spaced at maximum 300mm centres on the underside of ducts. Cut slabs so that the top and bottom pieces overlap the sides. Seal joints and pin penetrations using 100mm wide class 'O' aluminium foil tape.

Where cut outs for test holes, etc occur tape over insulation membrane and return to the duct surface.

KJ TAIT ENGINEERS

Form sheet metal to fit tightly over the outer circumference of insulation with a longitudinal overlap

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE THERMAL INSULATION

Install laminated foil/film protection, in accordance with manufacturer's instructions. Ensure all surfaces are dry and clean, free from dust, oil and grease/silicone. Arrange joints to give a water shed with the lap facing down.

Y50.3200 INSTALLATION OF DUCTWORK FIRE PROTECTION INSULATION: Install fire protection insulation on ductwork, in accordance with manufacturer's instructions.

Y50.3210 FLANGES AND VALVES:

Cut back to allow removal of bolts and nuts, finish with neat bevel or use end caps. Where boxes are used fit over insulation on adjacent piping. Ensure operation of valve remains unimpaired with box in place.

Y50.3220 LINERS:

Where load bearing insulation is required use segmental liners suitable for temperature. Fit insulant up to liner and carry facing across the pipe ring.

Y50.3230# INSTALLATION WHERE INSULATION IS CARRIED THROUGH PIPELINE SUPPORT:

- For load bearing insulation, carry through insulation and finish.
- For non-load bearing insulation on hot pipework
 - close butt to a section of load bearing finished material 100mm long.
 - up to 120°C, close butt to a high density phenolic pipe support.
- For non-load bearing insulation on cold pipework, close butt to high density phenolic foam pipe supports. Ensure the vapour barrier is maintained.

Y50.3230A INSTALLATION WHERE INSULATION IS CARRIED THROUGH PIPELINE SUPPORT: For load bearing insulation, carry through insulation and finish. For non-load bearing insulation on hot pipework close butt to a section of load bearing finished material 100mm long.

For non-load bearing insulation on cold pipework, close butt to high density phenolic foam pipe supports. Ensure the vapour barrier is maintained.

Y50.3230B INSTALLATION WHERE CLOSED CELL INSULATION IS CARRIED THROUGH **PIPELINE SUPPORT:**

For load bearing insulation, carry through insulation and finish. For non-load bearing insulation on hot pipework up to 120oC, close butt to a high density phenolic or polyisocyanurate pipe support.

For non-load bearing insulation on cold pipework, close butt to high density phenolic foam pipe supports.

Ensure the vapour barrier is maintained.

Y50.3240 INSTALLATION WHERE INSULATION IS NOT CARRIED THROUGH PIPELINE OR DUCTLINE SUPPORT: Provide end caps to match applied finish.

Y50.3250 INSTALLATION WHERE INSULATION IS CARRIED THROUGH DUCTWORK SUPPORT: Provide insulation between duct and support using high density phenolic foam strips. Butt insulation to spacer and carry over finish by 40mm and tape joint. Provide a sheet metal protecting sleeve.

Y50.3260 LIQUID VAPOUR BARRIERS:

Apply vapour seal solution evenly by brush in accordance with manufacturer's instructions; use solution which dries to a colour distinctive from insulating material.

Y50.3270 INTEGRITY OF VAPOUR BARRIERS:

Where a vapour barrier is indicated ensure its integrity throughout. Repair immediately any damage to vapour barriers and where such barriers have been applied off site, repair to manufacturer's instructions. Where aluminium sheeting is used for protection, submit proposals for securing sheeting without impairing the integrity of the vapour seal for approval.

Y50.3280 WATER TANKS:

Y50.3130A INSTALLATION OF SHEET METAL FINISH ON PIPEWORK:

Secure insulation with metal bands at each end of section and at maximum centres of 450mm. Form sheet metal to fit tightly over the outer circumference of insulation with a longitudinal overlap of at least 40mm. Secure the outer part of overlap with self tapping screws or rivets at centres of not more than 150mm. Not on pipes with vapour barrier; or metal bands of same material.

Ensure circumferential overlaps are at least 50mm, secured with self tapping screws or rivets. Make provision to accommodate expansion and contraction at intervals. Ensure all joints are lapped to shed liquids and seal all joints exposed to weather or spillage. Cover all bends and fittings with matching sheet metal, tailored to fit and sealed as appropriate. Fit pre-insulated, purpose-designed boxes to valves, flanges, etc.

Y50.3140# INSTALLATION OF SHEET METAL FINISH ON DUCTWORK, TANKS AND VESSELS:

- Form sheet metal to fit tightly over the insulation with a longitudinal overlap of at least 40mm. Secure the outer part of overlap with
 - self tapping screws or rivets at centres of not more than 150mm. • Not on vapour sealed ducts.
 - self tapping screws or rivets at centres of not more than 100mm. ٠ Not on vapour sealed ducts.
- metal bands of same material.
- Ensure circumferential overlaps are at least 50mm, secured with self tapping screws or rivets. Make provision to accommodate expansion and contraction at intervals. Ensure all joints are lapped to shed liquids and seal all joints exposed to weather or spillage. Cover all bends and fittings with matching sheet metal, tailored to fit and sealed as appropriate.

Y50.3140A INSTALLATION OF SHEET METAL FINISH ON DUCTWORK. TANKS AND VESSELS: Form sheet metal to fit tightly over the insulation with a longitudinal overlap of at least 40mm. Secure the outer part of overlap with self tapping screws or rivets at centres of not more than 150mm. Not on vapour sealed ducts: or metal bands of same material.

Ensure circumferential overlaps are at least 50mm, secured with self tapping screws or rivets. Make provision to accommodate expansion and contraction at intervals. Ensure all joints are lapped to shed liquids and seal all joints exposed to weather or spillage. Cover all bends and fittings with matching sheet metal, tailored to fit and sealed as appropriate.

Y50.3150 INSTALLATION OF CANVAS PROTECTION:

Cover the whole with 4.5oz (minimum) canvas with at least 50mm overlaps. Seal joints. Give two coats of class 'O' polymer solution. Fit aluminium bands where indicated.

Y50.3160 INSTALLATION OF ROOFING FELT PROTECTION:

Apply directly to insulating material with an overlap of at least 50mm on all joints, made to shed water. Secure in position with galvanized wire netting, of 1mm x 25mm mesh. Finish with two coats of black bituminous paint.

Y50.3170 INSTALLATION OF ALUMINIUM SHEETING PROTECTION:

Secure lapped joints (at least 40mm) by means of pop rivets at a maximum spacing of 150mm. For cold piping use matching aluminium straps at maximum spacing of 225mm. On piping operating below ambient temperature seal all joints against moisture. For external use make joints shed water and use sheets with treated surface.

Where `lockform' seams are used submit proposals for dealing with surfaces curved in three dimensions.

Y50.3180 INSTALLATION OF ALUMINIUM-ZINC COATED STEEL PROTECTION: Install aluminium-zinc coated steel protection, in accordance with manufacturer's instructions.

Y50.3190 INSTALLATION OF RIGID PVC PROTECTION:

Apply rigid PVC sheet and pre-formed fittings directly to insulation with an overlap of at least 40mm on longitudinal and circumferential joints. Secure longitudinal laps with plastic rivets at 150mm centres. Ensure rigid PVC is not installed in contact with heat sources.

Y50.3195 INSTALLATION OF LAMINATED FOIL/FILM PROTECTION:

• up to 120°C, close butt to a section of load bearing calcium silicate material 100mm long.

Arrange insulation and finish to allow removal of access covers and/or tank top.

Y51 TESTING AND COMMISSIONING

Y51.1000 GENERAL

Y51.2010 PRESSURE TESTING - GENERAL: Comply with procedures given in HVCA TR/6 Guide to Good Practice for Site Pressure Testing of Pipework. Ensure safety precautions detailed in HSE Guidance Note GS4 Safety in Pressure Testing are adopted.

Provide a blanked connection to accommodate a check gauge in addition to the accurate gauge fitted to section under test.

Test concealed or buried pipework before any permanent covering is applied. Advise appropriate personnel, in advance, of the time pressure tests may be witnessed.

Y51.2020 PRESSURE TESTING - WATER CIRCULATING AND SUPPLY SYSTEMS AND STEAM AND CONDENSE LINES:

Carry out Hydraulic Pressure Testing as described in HVCA TR/6 Guide to good Practice for Site Pressure Testing of Pipework. Test section by section for one hour, as the work proceeds and prior to application of thermal insulation as follows

Operating gauge pressure less than 3.5 bar, test gauge one and a half times operating pressure. Operating gauge pressure 3.5 - 7.0 bar, test gauge pressure twice operating pressure. Operating gauge pressure greater than 7.0 bar, test gauge pressure 14.0 bar or one and a half

times operating pressure, whichever is the greater.

Y51.2030A PRESSURE TESTING - UNDERGROUND PIPEWORK, 1 HOUR: Test to a gauge pressure not less than twice the operating pressure for 1 hour.

Y51.2030B PRESSURE TESTING - UNDERGROUND PIPEWORK, 4 HOURS: Test to a gauge pressure twice the operating pressure or 7 bar, whichever the greater, for 4 hours.

Y51.2040 PRESSURE TESTING - WATER MAINS: Test to Local Authority requirements. Ensure the provisions laid down in HVCA TR/6 Guide to Good Practice for Site Pressure Testing of Pipework for testing underground CWS mains are carried out.

Y51.2050 PRESSURE TESTING - FIRE RISERS: Test hydraulically to a pressure of 10 bar (gauge) measured at the top outlet to maintain pressure for not less than 15 minutes. Demonstrate to Fire Brigade when tests are satisfactory. Carry out flow tests after satisfactory pressure testing.

Y51.2055A PRESSURE TESTING - REFRIGERANT PIPEWORK, STRENGTH PRESSURE TEST: Test refrigerant pipework using the strength test procedure as detailed in Clause R6.4 of the CIBSE Commissioning Code R: 2002.

Y51.2055B PRESSURE TESTING - REFRIGERANT PIPEWORK, LEAK TEST: Test refrigerant pipework using the leak test procedure as detailed in Clause R6.5 of the CIBSE Commissioning Code R: 2002.

Y51.2055C PRESSURE TESTING - REFRIGERANT PIPEWORK, DEEP VACUUM TEST: Test refrigerant pipework using the deep vacuum test method as detailed in Clause R6.6 of the CIBSE Commissioning Code R: 2002.

Y51.2060A PRESSURE TESTING - GAS PIPEWORK - HVCA GUIDE: Carry out a pneumatic leak test followed by a pneumatic pressure test as described in HVCA Guide to Good Practice for Site Pressure Testing of Pipework TR6.

Y51.2060B PRESSURE TESTING - GAS PIPEWORK TO BS EN 12327: Pressure test gas supply pipework in accordance with BS EN 12327.

Y51.2060C PRESSURE TESTING - GAS PIPEWORK TO IGE/UP/1: Comply with IGE/UP/1 Strength and tightness testing and direct purging of industrial and commercial gas installations.

Y51.2060D PRESSURE TESTING - GAS PIPEWORK TO IGE/UP/1A: Comply with IGE/UP/1A Strength and tightness testing and direct purging of small low pressure industrial and commercial Natural Gas installations.

Y51.2070 PRESSURE TESTING - PIPED MEDICAL SERVICES: Test in accordance with requirements of Health Technical Memorandum 2022.

Y51.2080 PRESSURE TESTING - SOIL, WASTE, VENTILATION, ANTI-SYPHON AND RAINWATER **PIPEWORK:**

Test section by section as the work proceeds and subsequently on completion with all sanitary fittings fixed and working. Submit systems to two separate tests, Air test and Hydraulic Performance test in accordance with BS EN 12056-2.

Y51.2090 PRESSURE TESTING - UNDERSLAB DRAINAGE:

Test section by section as the work proceeds and subsequently after completion of backfilling and compaction to the satisfaction of the Engineers and the local Authority. Individually test sections which will be permanently embedded in the structure or concealed in ducts or

voids.

Submit sections to two separate tests Water test and Test for Straightness and Obstruction in accordance with BS EN 752.

Y51.2100 VACUUM TESTING:

Test vacuum mains in accordance with HVCA TR/6 Guide to Good Practice for Site Pressure Testing of Pipework, Table 1.

Y51.2110 TESTING RECORDS:

 Distribution Keep a systematic record of tests. Distribute records as indicated.

Y51.3010 CLEANING DUCTWORK SYSTEMS: Clean ductwork before plant is first run, using access openings in ductwork.

Y51.3020 COMMISSIONING CODES:

Carry out commissioning of installations in accordance with the procedures, checks and tolerances given in the BSRIA Application Guides for water systems and air systems to achieve the standards set in the CIBSE Commissioning Codes.

Y51.3030A COMMISSIONING WATER DISTRIBUTION SYSTEMS INCLUDING BSRIA PRE-COMMISSIONING CHECKLIST:

Preliminary checks

Carry out checks and procedures as detailed in CIBSE Commissioning Code W, Section W1. Ensure system is statically complete as defined in section B4 of BSRIA Application Guide 2/89 Commissioning of water systems in buildings.

Use pre-commissioning checklist from BSRIA Application guide 2/89.

Setting to work and regulation

Set to work and regulate water distribution systems in accordance with CIBSE Commissioning Code W, Sections W2 and W3, and sections C3 and C4 in BSRIA Application Guide 2/89. Measurement

Use instruments for measurement detailed in BSRIA Application Guide 2/89.

Y51.3040A COMMISSIONING AIR DISTRIBUTION SYSTEMS INCLUDING BSRIA PRE-COMMISSIONING CHECKLIST:

Preliminary checks

Carry out checks and procedures as detailed in CIBSE Commissioning Code A, Section A1. Ensure system is statically complete as defined in section B4 of BSRIA Application Guide 3/89 Commissioning of air systems in buildings.

Use pre-commissioning checklist in BSRIA Application guide 3/89. Setting to work and regulation

Use instruments for measurement and methods of measurement detailed in BSRIA Application Guide 3/89 and CIBSE commissioning guide, section A3.

Y51.3040B COMMISSIONING VAV AIR DISTRIBUTION SYSTEMS INCLUDING BSRIA PRE-COMMISSIONING CHECKLIST: Preliminary checks

Carry out checks and procedures as detailed in CIBSE Commissioning Code A, Section A1. Ensure system is statically complete as defined in section B4 of BSRIA Application Guide 3/89 Commissioning of air systems in buildings.

Use pre-commissioning checklist in BSRIA Application guide 3/89. Setting to work and regulation

Set to work and regulate air distribution systems in accordance with CIBSE Commissioning Code A, Section A2, and sections C3, C4 and C5 in BSRIA Application Guide 3/89. For regulation of Variable Air Volume Systems follow routine in BSRIA Application Guide 1/91 The Commissioning of VAV Systems.

Measurement of air flow

Use instruments for measurement and methods of measurement detailed in BSRIA Application Guide 3/89 and CIBSE commissioning guide, section A3.

Y51.3050 COMMISSIONING BOILER PLANT:

Follow the procedures laid down for carrying out Preliminary Checks and Start Operation in accordance with CIBSE Commissioning Code B and manufacturers instructions. Apparatus and Instruments

Use Apparatus and Instruments detailed in CIBSE Commissioning Code B, Appendix B3.1. Apply tolerances defined in Appendix B3.2.

Y51.3055 COMMISSIONING OF GAS PLANT AND SYSTEMS: Commission gas fired plant on industrial and commercial premises in accordance with IGE/UP/4. Commission gas supply systems in accordance with BS EN 12327.

Y51.3060 COMMISSIONING REFRIGERATING SYSTEMS: Follow the procedures given for use and handling of refrigerants, pressure and leak testing, evacuation and dehydration, charging and lubrication of refrigerating systems in CIBSE Commissioning Code R and manufacturer's instructions. Pre-commissioning:

Carry out the procedures for pre-commissioning detailed in CIBSE Commissioning Code R. Section R5.

Combined pressure and leak testing:

Carry out the procedures for combined pressure and leak testing, including refrigerant charging, detailed in CIBSE Commissioning Code R, Section R6. Setting to work and adjusting

Carry out the procedures for setting to work and adjusting detailed in CIBSE Commissioning Code R7.

Absorption Systems.

Carry out the procedures for Preliminary Checks, Testing and Charging, and Setting to Work and adjusting detailed in CIBSE Commissioning Code R, Section R10. Apparatus and Instruments

Use Apparatus and Instruments detailed in CIBSE Commissioning Code R, Section R8. Apply tolerances defined in Section R8.6.

Y51.3070 COMMISSIONING AUTOMATIC CONTROL SYSTEMS: Carry out commissioning of Automatic Control Systems in accordance with Manual prepared by the controls equipment manufacturer. Carry out the Checking and Setting-Up procedure detailed in the CIBSE Commissioning Code C, Section C1. Measurement

Carry out measurements in accordance with CIBSE Commissioning Code C. Appendix C2.1.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE TESTING AND COMMISSIONING

Y51.3080 COMMISSIONING PLANT ITEMS:		
Comply with the manufacturer's recommendations for setting to work.	Y51.3120 BMS COMMIS	SIONING - PRE-COMMISS
	Ensure that as much pre-	commissioning work as pos
TOT.3090A INSTRUMENTS AND GAUGES. Ensure instruments are correctly calibrated. Record details of instruments on record shoets	Table 15 Pro-commission	is ionowed.
Submit evidence of correct calibration of instruments to be used in connection with commissioning and		ing requirements
testing	Pro-commissioning action	Pro-commissioning off-si
testing.	Fie-commissioning action	T Fle-commissioning on-si
Y51.3100A AIR SYSTEMS COMMISSIONING RECORDS TO BSRIA AG 3/89.3:	Control application	Ves (final commissioning
Keep a systematic record of commissioning results and distribute as indicated.	software	site)
For air systems	oonware	
Use record sheets as described in BSRIA Application Guide 3/89.3 Commissioning air systems in	User interface software	Yes (final commissioning
buildings.		site)
Y51.3100B WATER SYSTEMS COMMISSIONING RECORDS TO BSRIA AG 2/89.3:	Control panels	Yes (final commissioning
Keep a systematic record of commissioning results and distribute as indicated.		site)
For water systems		
Use record sneets as detailed in BSRIA Application Guide 2/89.3 Commissioning water systems	Terminal units (fan coil	Yes (final commissioning
in buildings.	units, etc)	site)
Y51 3110 BMS COMMISSIONING - CONTROL SYSTEM SPECIFICATION DETAILS BEOLIIBED		
FOR COMMISSIONING:	Wiring	No
Ensure that the following information is supplied to the commissioning engineer:		
A network schematic providing a record of the overall control system architecture.	Communications network	No
Schematics of the systems to be controlled indicating the location of sensors and actuators.		
A written description of the configured control strategies.	Sensors	No
Control strategy logic diagrams in the form of logic flow charts.		
Set-points and other control settings such as initial default parameters for control loops relating to	Actuators	No
the control strategies.		
Criteria relating to control accuracy and stability.	Integration gateways	Partial
A points list including digital inputs/outputs and analogue inputs/outputs.		
Control panel drawings. RMS operator workstation graphics and associated point data displaying monitored conditions	Ensure that a record of a	Il settings, set-points and off
Trond logging archiving requirements and alarm routing	commissioning period.	
The scope of operational and specified functionality of management software, e.g. utility monitoring.	Ensure that all final physic	cal adjustments to the field of
and targeting software	Ensure that all packaged	plant interfaced with the BIV
Functional requirements of any occupant interfaces.	manufacturer or Installer.	re commissioned in coorde
Details of any hard-wired interfaces from, or to, other control devices.	Codo C (Commissioning	of automatic control system
Functionality and scope of data to be transferred over any gateway for use as part of an integrated	Table 16 CIBSE Code C	automatic control systems n
system.		automatic control systems p
Functional profiles for any direct interoperability integration.	Pre-commissioning action	1 CIBSE Code C sect
Ensure that the following is included in the BMS commissioning specification:-		reference
A clear description of the division of responsibility between the various parties.		
Off-site and on-site pre-commissioning procedures.	Control applications software	vare C5.2
On-site commissioning procedures.		L
valves) and other plant tests where the controls need to be overridden	Control panels	C5.3
A requirement for any point-by-point verification of correct operation	· · · · ·	I
Requirements for evaluation of control loop performance/loop tuning	Wiring	C5.4
Requirements for the BMS operator workstation for assistance in the commissioning of plant.	¥	
Arrangement for the management of delays.	Communications network	s C5.5
Phased completion requirements.		·
Requirements for demonstration/witness testing on the basis of a percentage of points or on a	Sensors	C5.6
point-by-point basis. Ensure that the witnessing requirement includes the identification of those		
responsible.	Actuators and valves	C5.7
Requirement for software/configuration data back-up.		·
Requirement for, and involvement in, any complete system and sub-system performance testing.	Digital inputs/outputs	C5.8
Requirement for system documentation.		
Requirement for operator training requirements.	Pneumatic actuation with	C5.9
Requirement for post occupancy checks.	microprocessor control	

KJ TAIT ENGINEERS

COMMISSIONING: ork as possible is performed off-site:



nts and offsets are maintained throughout the pre-

the field devices are indelibly marked. vith the BMS is fully tested and commissioned by the

in accordance with the following requirements of CIBSE rol systems).

systems pre-commissioning requirements

tion			
]		
]		
]		
]		
]		
]		
]		
]		

Y51

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **TESTING AND COMMISSIONING**

Interruption of electrical power supplies - C6.12

Valves - C7.1 Dampers - C7.2

Fans - single speed - C7.3

Field control devices	C5.10
Y51.3130A BMS COMMISS Confirm that the following pla commissioning:	IONING - PLANT READY FOR CONTROL SYSTEM COMMISSIONING: ant commissioning has been performed before commencing the final BMS
Water systems	
The system is cleaned and	d flushed to remove any debris.
All regulating, isolating an	d control valves in place and operating correctly.
That all flow measuring de	evices are in place and in the correct location for accurate measurement
(including pressure tappings).
The system is vented.	
That the proportional bala	ncing is completed to obtain the branch flow rates in the correct ratio to
each other (or through the us	se of and setting of self-balancing valves).
I nat the pump flow rate h	as been adjusted to provide the specified flow rate.
Air systems	I from the air distribution system
That dampers are in the c	perroct location and fully functional
That dampers are in the c	
Test holes have been drill	ed and sealed with removable plugs
That in-situ flow measurin	a devices have been installed.
Ductwork air leakage testi	ing has been performed (if specified).
Completion of proportiona	I balancing of regulating dampers so that terminals share the air flow in
the correct proportions.	
Regulation of the fan(s) to	provide the specified flow rate.
Packaged equipment	
Ensure that plant and con	trols have been fully commissioned and are functional, ready for
integration with other plant/s	ystems.
I hat control equipment in	puts/outputs are in the specified format for connection to the main control
system.	minimum in accordance with:
Air distribution systems	Imissioned in accordance with:
Boilor plant CIBSE Code	R R
Befrigeration systems CII	BSE Code B
Water distribution systems	s CIBSE Code W
Commissioning water sys	tems, Application principles, AG 89.3/2, BSBIA
Commissioning air system	ns. Application systems for buildings. AG 89.3/3. BSRIA.
Y51.3140 BMS COMMISSIC	ONING - CONTROL SYSTEM REQUIREMENTS FOR PLANT
COMMISSIONING:	
Ensure that the BMS is pre-	commissioned to allow the building services plant to operate under
"manual" running conditions.	
Ensure that the control valve	es can be manually set in their fully open position to allow the balancing of
pipework flows.	manually analysis allow the complexisting of significant
Ensure that dampers can be	manually opened to allow the commissioning of air systems.
V51 3150 BMS COMMISSIC	
Ensure that the BMS is com	missioned in accordance with the following requirements of CIBSE Code
C (Commissioning of automa	atic control systems)
Control strategy checking	- C6.2
Checking procedures for t	pasic control functions - C6.3
Lighting controls - C6.4	
Operator workstations - C	6.5
Occupant interfaces - C6.	6
Communication networks	- C6.7
Integrated systems - gate	ways - C6.8
Integrated systems - direc	t interoperability - C6.9
Integration with fire detect	tion systems - C6.10
Security systems - C6.11	

Fans - variable speed - C7.4 Pumps - C7.5 Y51.4010 SYSTEM PERFORMANCE TESTING: and of plants specified for future use.

Y51.4015 TESTING OF RESIDENTIAL VENTILATION SYSTEMS: Demonstrate the performance of residential ventilation systems through performance testing and installation checks in accordance with BS EN 14134.

Y51.4020# ENVIRONMENTAL TESTS:

- Carry out environmental testing to prove the performance of the systems.
- Apply artificial loads or provide test arrangements to simulate the full range of operating conditions and duties.
- Carry out ambient air quality tests in accordance with BS EN 13528-1, BS EN 13528-2 and BS EN • 13528-3.

Y51.4020A ENVIRONMENTAL TESTS, ARTIFICIAL LOADS: Carry out environmental testing to prove the performance of the systems. Apply artificial loads or provide test arrangements to simulate the full range of operating conditions and duties.

Y51.4020B ENVIRONMENTAL TESTS, AMBIENT AIR QUALITY Carry out environmental testing to prove the performance of the systems. Carry out ambient air quality tests in accordance with BS EN 13528-1, BS EN 13528-2 and BS EN 13528-3.

Y51.4030 RECORDERS:

- Seven day space temperature recorders
 - Number
 - For (weeks)
- Relative humidity recorders
 - Number

•

• For (weeks)

Provide and maintain on free loan portable seven day space temperature and relative humidity recorders, as indicated, together with adequate charts.

Y51.4040# TESTING TO SPECIFIED CONDITIONS:

- Rainwater Systems Demonstrate by flow tests that the systems give satisfactory performance.
- Sanitary Systems Comply with performance tests given in BS EN 12056.
- Cold Water Systems
- Demonstrate that outlets supply adequate rates of flow. Fire Fighting Systems
- Comply with requirements of the local Fire Authority and with the appropriate section of BS 5306.
- Hydraulic Systems -• Comply with requirements as indicated.
- Medical Gas and Air Systems
- Comply with Health Technical Memorandum 2022. Laboratory and Industrial Systems
- Comply with requirements as indicated. Gas Systems
- Comply with the requirements of the local Authority.

KJ TAIT ENGINEERS

Demonstrate the performance of installations including single, standby, multi-duty plants and systems,

- Silencers and Acoustic Treatment • Demonstrate by measured tests that noise criteria indicated have been achieved. Acoustic Enclosures
- Demonstrate that measured air leakage complies with scheduled values.

Y51.4040A RAINWATER SYSTEMS: Demonstrate by flow tests that the systems give satisfactory performance.

Y51.4040B SANITARY SYSTEMS: Comply with performance tests given in BS EN 12056.

Y51.4040C COLD WATER SYSTEMS: Demonstrate that outlets supply adequate rates of flow.

Y51.4040D FIRE FIGHTING SYSTEMS: Comply with requirements of the local Fire Authority and with the appropriate section of BS 5306.

Y51.4040E HYDRAULIC SYSTEMS: Requirements Comply with requirements as indicated.

Y51.4040F MEDICAL GAS AND AIR SYSTEMS: Comply with Health Technical Memorandum 2022.

Y51.4040G LABORATORY AND INDUSTRIAL SYSTEMS: Comply with requirements as indicated.

Y51.4040H GAS SYSTEMS: Comply with the requirements of the local Authority.

Y51.4040I SILENCERS AND ACOUSTIC TREATMENT: Demonstrate by measured tests that noise criteria indicated have been achieved.

Y51.4040J ACOUSTIC ENCLOSURES: Demonstrate that measured air leakage complies with scheduled values.

Y51.4050 PERFORMANCE TEST RECORDS:

Distribution Keep a systematic record of tests. Distribute records as indicated.

Y52 VIBRATION ISOLATION MOUNTINGS

Y52.1000 GENERAL DESIGN INTENT: 1010 Supply equipment indicated to ensure that vibration from equipment is not transmitted to building, other supporting structure, pipework or ductwork. 1020 SPRING ANTI VIBRATION MOUNTINGS: Select spring mounts with an overload capacity of 50%, for metal springs the outside diameter should be at least 75% of operating height. Permanently identify individual mounts with their load capacity. 1030 SPRING HANGERS: Provide spring hangers that allow the lower hanger rod to move laterally at least 15°.

Y52.1040 LOCKING FACILITY:

Where indicated, provide lockable levelling device.

Y52.2050A SYNTHETIC RUBBER HANGERS, TURRET COMPRESSION:

• 1040 LOCKING FACILITY: Where indicated, provide lockable levelling device.

Provide turret compression hangers fabricated from synthetic rubber incorporated with hanger box. Construct hanger box from steel (minimum thickness 1.6mm) complete with hole for suspension rod and enlarged lower hole for drop rod to equipment.

Y52.2050B NEOPRENE HANGERS, TURRET COMPRESSION: • 1040 LOCKING FACILITY:

Where indicated, provide lockable levelling device. Provide turret compression hangers fabricated from neoprene incorporated within hanger box. Construct hanger box from steel (minimum thickness 1.6mm) complete with hole for suspension rod and enlarged lower hole for drop rod to equipment.

Y52.2060 SPRING COMPRESSION HANGERS:

• 1040 LOCKING FACILITY:

Where indicated, provide lockable levelling device. Provide spring compression hangers comprising high strength low stress helical spring capped with steel pressure plate, on resilient base pad, mounted within hanger box. Construct hanger box from steel (minimum thickness 1.6mm) complete with hole for suspension rod and enlarged lower hole for drop rod to equipment.

Y52.2070A SYNTHETIC RUBBER HANGERS, COMBINED TURRET/SPRING COMPRESSION:

• 1040 LOCKING FACILITY:

Where indicated, provide lockable levelling device. Provide turret/spring compression hangers with turret fabricated from synthetic rubber and high strength low stress helical spring capped with steel pressure plate, on resilient base pad, incorporated within hanger box.

Construct hanger box from steel (minimum thickness 1.6mm) complete with hole for suspension rod and enlarged lower hole for drop rod to equipment.

Y52.2070B NEOPRENE HANGERS, COMBINED TURRET/SPRING COMPRESSION:

• 1040 LOCKING FACILITY:

Where indicated, provide lockable levelling device. Provide turret/spring compression hangers with turret fabricated from neoprene and high strength low stress helical spring capped with steel pressure plate, on resilient base pad, incorporated within hanger box.

Construct hanger box from steel (minimum thickness 1.6mm) complete with hole for suspension rod and enlarged lower hole for drop rod to equipment.

Y52.2100 VIBRATION ISOLATION HOSES:

Provide flexible hose couplings for connecting pipework comprising nylon fabric or steel mesh carcass with waterproof cover and internal lining of material to suit fluid conveyed, temperatures and pressures indicated.

Y51

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE VIBRATION ISOLATION MOUNTINGS

Y52,2120B MINERAL FIBRE PACKING PIPE WALL AND RISER SEALS: Provide pipe sleeves, minimum length 300mm, with minimum 52mm mineral fibre packing lining bonded internally.

Y52.3010 GENERAL: Install vibration isolation equipment and carry out levelling of equipment in accordance with manufacturer's instructions.

Y52.3020 CAST IN SITU BASES: Ensure bases are cast to achieve design static deflection.

Y52.3030 FIXING: Fix down vibration isolation mountings only where indicated.

Y52.3040 HORIZONTALLY RESTRAINED SPRING MOUNTINGS: Ensure snubbers for limiting excessive movement are installed out of contact during normal operation.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE **IDENTIFICATION - MECHANICAL**

Y54 IDENTIFICATION - MECHANICAL

Y54.1000 GENERAL REQUIREMENTS: 1010 Identify all pipework, ductwork, equipment, appliances and ancillaries comprising the various systems. 1020 NEW SYSTEMS: Comprehensively label and colour code throughout works as indicated. 1030 EXISTING SYSTEMS: Where identification details are incompatible with those required for new systems, obtain approval to mode of cross referencing. 1040 COLOURS: As indicated to colour ranges given in BS 381C and BS 4800. Y54.2010 PIPEWORK IDENTIFICATION: Standards - Colour code and label to BS 1710. Primary Identification Apply colour bands, 300mm wide, to each pipe at least Once in every room or enclosed area. At intervals not exceeding fifteen metres. At every junction. At every valve. At every inspection and access position into service shafts, false ceilings, bulkheads etc. Secondary Identification Apply colour bands, 50mm wide, and superimpose a legend identifying circuit, direction of fluid or gas flow, nominal pipe bore and, where appropriate, fluid or gas pressure. Legends Apply to colour bands by transfers of an approved type. Y54.2020 DUCTWORK IDENTIFICATION: Standards Generally colour code and label to HVCA Specification DW 144 (Appendix B). Primary Identification Apply colour bands, 300mm wide, to each duct at least Once in every room or enclosed area. At intervals not exceeding fifteen metres. At every junction. At every damper. At every inspection and access position into service shafts, false ceilings, bulkheads etc. Secondary Identification For ducts with longest side or diameter up to and including 225mm. Paint colour bands 50mm wide and superimpose legends. For ducts with longest side or diameter over 225mm. Paint or apply transfers to identification triangles, or triangular plates. Superimpose or incorporate legends. Triangular Plates Attach to buckle bands or stool pieces and fix to ducting, with apex indicating direction of airflow. Submit details of plates and fixings for approval before painting and marking. Use equilateral triangle of side 150mm minimum. Legends Apply transfers of an approved type to colour bands or triangles or triangular plates. Identify floor and space served, associated equipment reference and direction of airflow. Y54.2030A PLANT AND EQUIPMENT IDENTIFICATION, ENGRAVED PLATES: Standards Identify each item of equipment by name and, where appropriate, by agreed reference characters. Provide colour identification as called for in work sections and, in all cases, colour fire fighting equipment red. Identification Colours Use primary and secondary identification colours of associated system. Plates Use rectangular metal or laminated plastic, securely fixed to each item of equipment.

Y52

Lettering Engraved plates filled with paint. Legends Engrave plates with an approved text. Incorporate operating duty of equipment where this is not incorporated in other labelling. Y54.2030B PLANT AND EQUIPMENT IDENTIFICATION, LAMINATED PLATES: Standards Identify each item of equipment by name and, where appropriate, by agreed reference characters. Provide colour identification as called for in work sections and, in all cases, colour fire fighting equipment red. Identification Colours Use primary and secondary identification colours of associated system. Plates Use rectangular metal or laminated plastic, securely fixed to each item of equipment. Lettering Laminated plates, multi-coloured with outer layer removed for lettering. Legends Engrave plates with an approved text. Incorporate operating duty of equipment where this is not incorporated in other labelling. Y54.2030C PLANT AND EQUIPMENT IDENTIFICATION, BLACK FILLED PERSPEX: Standards Identify each item of equipment by name and, where appropriate, by agreed reference characters. Provide colour identification as called for in work sections and, in all cases, colour fire fighting equipment red. Identification Colours Use primary and secondary identification colours of associated system. Plates Use rectangular metal or laminated plastic, securely fixed to each item of equipment. Lettering Clear perspex back filled to reveal lettering. Legends Engrave plates with an approved text. Incorporate operating duty of equipment where this is not incorporated in other labelling. Y54.2035 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416: Graphical symbols for use on equipment to be created and applied in accordance with BS EN 80416-1. BS EN 80416-2. BS EN 80416-3. Y54,2040 VALVE AND COCK IDENTIFICATION: Standards Identify each valve, cock, stop valve, air vent, drain cock etc. with disc engraved with numerical reference. Except where exposed in occupied areas. Identification Colours Use primary and secondary identification colours of associated system for painted or self colour discs. Discs Securely attach metal or laminated plastic discs, minimum diameter 35mm, to each item. Legends Engrave discs with permanent characters, minimum height 6mm. Incorporate in operating instructions relating to regulating valves and flow measuring equipment, details of flow rate, pressure differential and setting, as appropriate. Y54.2050A MEDICAL GAS TERMINAL UNITS, HTM 02-01 PART A: Label and colour code to HTM 02-01, Part A. Y54.2050B MEDICAL GAS TERMINAL UNITS, BS EN ISO 407: Label and colour code cylinders to BS EN ISO 407.

Identification colours

Standards

discs.

Discs

Legends

Standards Identify each instrument by name and, where appropriate, by agreed reference characters. Plates

Y54.2060A LABORATORY OUTLETS, BS 1710:

Colour code and label to BS 1710.

Use rectangular metal or laminated plastic, securely fixed to each instrument. Legends

Engrave plates with an approved text.

Y54.2080 INSTRUMENT IDENTIFICATION:

Y54.2090 DANGER AND WARNING NOTICES:

Hazardous Systems

Executive Guidance Notes.

Y54.2100A SYSTEM IDENTIFICATION INSTALLATION CHARTS, PERSPEX GLAZED FRAME: System Schematics

equipment and ancillary schedules. Show scheduled information on diagram. Identify all items by appropriate reference characters.

Control Schematics Supply and fix a referenced schematic diagram (or diagrams) of all control systems as installed. including equipment and ancillary schedules. Show scheduled information on diagram. Identify all items by appropriate reference characters. Location

Fix in each boiler house, calorifier room, plant room or equipment room. Finish

Perspex sheet glazing with surrounding frame and mounting attachments.

Y54.2100B SYSTEM IDENTIFICATION INSTALLATION CHARTS, ACRYLIC GLAZED HARDWOOD FRAME:

System Schematics

Supply and fix a referenced schematic diagram (or diagrams) of all systems as installed, including equipment and ancillary schedules. Show scheduled information on diagram. Identify all items by appropriate reference characters. **Control Schematics**

Supply and fix a referenced schematic diagram (or diagrams) of all control systems as installed, including equipment and ancillary schedules. Show scheduled information on diagram. Identify all items by appropriate reference characters. Location

Fix in each boiler house, calorifier room, plant room or equipment room. Finish

Hardboard 3mm thick set in hardwood frame and glazed with1.5mm clear acrylic.

- Y54.2060B LABORATORY OUTLETS, BS EN 13792: Colour code and label taps and valves for use in laboratories to BS EN 13792.
- Y54.2070 AIR VOLUME REGULATING AND CONTROL DAMPER IDENTIFICATION:
 - Identify each regulating and control damper. Except where exposed in occupied areas. On ductwork dampers, clearly indicate commissioning set point.
 - Use primary and secondary identification colours of associated system for painted or self colour
 - Securely attach metal or laminated plastic discs, minimum diameter 35mm, to each item.
 - Engrave discs with permanent characters, minimum height 6mm.
 - Colour code and label hazardous systems and equipment to requirements of Health and Safety
 - Supply and fix a referenced schematic diagram (or diagrams) of all systems as installed, including

Y60 CONDUIT AND CABLE TRUNKING

Y60.1000 GENERAL 1010 STANDARDS: Provide conduit and cable trunking in accordance with the relevant British Standards and in particular the requirements of BS 7671 Requirements for Electrical Installations (The IEE Wiring Regulations).

Y54.2100C SYSTEM IDENTIFICATION INSTALLATION CHARTS, PLASTIC ENCAPSULATED: System Schematics

Supply and fix a referenced schematic diagram (or diagrams) of all systems as installed, including equipment and ancillary schedules. Show scheduled information on diagram. Identify all items by appropriate reference characters.

Control Schematics

Supply and fix a referenced schematic diagram (or diagrams) of all control systems as installed, including equipment and ancillary schedules. Show scheduled information on diagram. Identify all items by appropriate reference characters.

Location

Fix in each boiler house, calorifier room, plant room or equipment room.

Finish

Plastic encapsulated chart.

Y61 HV/LV CABLES AND WIRING

Y61.1000 GENERAL

1010 CABLE MANUFACTURE:

Use new cables, delivered to site with seals intact, manufactured not more than one year prior to delivery, labelled with manufacturer's name, size, description, BS number, classification, length, grade and date of manufacture.

1020 CABLE CERTIFICATION MARKING:

Mark all types of cables with CENELEC cable certification marking or if included in British Approvals Service for Cables (BASEC) in accordance with BASEC regulations.

Y63 SUPPORT COMPONENTS - CABLES

Y63.1000 GENERAL 1010 APPLICATION: Cables referred to in this section are only those types that can be installed without further mechanical protection.

Y71 LV SWITCHGEAR AND DISTRIBUTION BOARDS

Y71.1000 GENERAL

Y72 CONTACTORS AND STARTERS

Y72.1000 GENERAL

Y72.1010A 3 PHASE SUPPLY: Ensure all electrical equipment supplied and installed is suitable for 3 phase power supply to BS 7697.

Y72.1010B SINGLE PHASE ELECTRICAL SUPPLY: Ensure all electrical equipment supplied and installed is suitable for single phase power supply to BS 7697. Y72.2130A MOTOR STARTERS - MOTORS BELOW 0.37 KW: Provide fuses or circuit breakers for motors below 0.37 kW. Y72.2130B MOTOR STARTERS - MOTORS OF 0.37KW AND ABOVE: Provide starters incorporating overcurrent protection for motors of 0.37kW and above. Provide starter with manual reset, adjustable, inverse time delay, and ambient temperature compensated thermal overcurrent release to BS EN 60947-4-1. Ensure overcurrent release is compatible with starting, accelerating and running characteristics of motor, starter and driven machine combination. Use phase unbalance protection on three phase equipment.

Y72.2140 CURRENT LIMITING MOTOR STARTERS: Use static type thyristor voltage control starter to provide reduced current starting. Provide adjustable ramp times.

Provide contactor for switching and disconnector for isolation. Provide details of harmonic distortion content prior to ordering.

Y72.2150 DIRECT-ON-LINE MOTOR STARTERS: Use direct-on-line starter to BS EN 60947-4-1, with single phase motors and three phase motors.

Y72.2160 STAR DELTA MOTOR STARTERS: Use star delta starter to BS EN 60947-4-1 with three phase motors. Incorporate adjustable time delay contactor relays, to control star delta changeover, ensuring electrical endurance compatible with starter contactors. Ensure starting sequence activated on voltage restoration.

Y72.2170A AUTO-TRANSFORMER MOTOR STARTERS: Use auto-transformer starter to BS EN 60947-4-1 with three phase motors. Provide 2 step closed transition auto transformers suitable for 3 operating cycles per hour. Provide auto transformers with three tappings for selection of motor starting voltage. Arrange tappings to limit motor starting current to 80 per cent, 65 per cent and 50 per cent of full voltage starting current. Incorporate adjustable time delay contactor relays, to control automatic changeover from selected

reduced voltage to full voltage, having an electrical endurance compatible with starter contactors. Ensure starting sequence activated on voltage restoration.

Y72.2190A CONTROL PANEL INVERTOR MOTOR STARTERS: Supply inverters to control speed of standard AC Squirrel cage motors. Inverter type - Digital PWM. Location - Control panel. Control range - 0.5 to 120 Hz Power factor - 0.95 or better. Starting current - Not to exceed 1 x FLC. Characteristics

Ensure acceleration and deceleration ramps are independently adjustable. Allow connection to a turning motor without braking to a standstill. Allow connection to a reverse windmilling fan without causing tripping and return fan to correct

speed. Ensure inverters require no additional means for starting. Supply inverters that do not require electrical matching to motor. Ensure inverters are capable of running motors in parallel.

EMC characteristics to BS EN 61800. Mains interruption

Ensure inverter does not cause tripping through a mains interruption of 200 msec. Protection

Ensure inverter incorporates the following protection to cause electronic shut down without operating circuit protective devices.

Motor phase to phase fault; motor phase to earth fault; overvoltage; undervoltage; inverter overheat; motor overheat; loss of control signal; loss of auxiliary control voltage; current limit. Inverter controls - Local/remote facility.

Display

Make provision for inverter to display externally, external and internal faults following a failure. Show 1st, 2nd and 3rd up sequential faults.

Provide digital readout to show output frequency Hz; reference 1 (Hand); reference 2 (Auto); motor current (% or Amps); fault memory.

Provide volt free remote signalling contacts to indicate common fault; running/stopped conditions; healthy/tripped conditions.

Ensure parameters can be set and fault memory interrogated with door closed, and without additional instrumentation.

Y72.2200 AUTOMATIC CHANGEOVER FOR RUN/STANDBY DUTY - SINGLE POWER SUPPLY:

Provide system malfunction audible alarm.

Fit a control switch to starter enclosure arranged to select either motor for "run" or "standby" duty. Indicate selection of respective motor by illumination of indicator lights on starter enclosure. Provide facilities for connection of remote indicator lights to indicate selection/operation of system and for connection of a system malfunction audible alarm where indicated.

Arrange for selected "run" duty motor to operate in response to system controls, and in event of operation of duty motor starter overcurrent trip, for automatic changeover to "standby" motor. Control power supply to starter by an air break isolating switch interlocked with starter enclosure access door.

Y72.2210 AUTOMATIC CHANGEOVER FOR RUN/STANDBY DUTY - DUAL POWER SUPPLY:

Provide system malfunction audible alarm.

Fit a control switch to starter enclosure arranged to select either motor for "run" or "standby" duty. Indicate selection of respective motor and availability of the two power supplies by illumination of indicator lights on starter enclosure.

Provide facilities for connection of remote indicator lights to indicate selection/operation of system and for connection of a system malfunction audible alarm where indicated.

Arrange for selected "run" duty motor to operate in response to system controls, and on loss of power supply to "run" duty motor or operation of motor starter overcurrent trip, for automatic changeover to "standby" motor.

Control the two power supplies by a single air break multiple isolating switch interlocked with starter enclosure access door.

Y72.3010 INSTALLATION:

Install control panels, motor control centres, contactors and starters in accordance with BS EN 60947 and manufacturer's recommendations.

Y74 ACCESSORIES FOR ELECTRICAL SERVICES

Y74.1000 GENERAL:

APPLICATION: 1010 Supply fixed electrical wiring accessories for use with fixed and portable peripheral equipment using either power or signalling cables. 1020 SAMPLES:

 Submit samples of proposed materials and equipment for approval before work is started. Label each sample with name, catalogue number and reference to the use or services.

Y80 EARTHING AND BONDING

Y80.1000 GENERAL

1010 MATERIALS GENERALLY:

Use materials and installations methods in accordance with BS EN 62305, BS 7671, BS 7430, Electricity Safety, Quality and Continuity Regulations and Local Electricity Supply Authority Requirements as appropriate.

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE TESTING AND COMMISSIONING OF ELECTRICAL SERVICES

Y81 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES

Y81.1000 GENERAL

Y80

1010 INSPECTION AND TEST PROCEDURE:
Comply with BS 7671 Requirements for Electrical Installations (the IEE Wiring Regulations), IEE Guidance Notes Number 3 Inspection Testing and other British Standards as appropriate.
1020 SUPPLY CHARACTERISTICS:
Obtain information called for in BS 7671 about supply characteristics from Supplier, other than where to be measured as part of testing procedure.
1030 DESIGN INFORMATION:
Obtain all design assumptions, calculations and any other information to enable compliance with BS 7671 to be verified.

Y82 IDENTIFICATION - ELECTRICAL

Y82.1000 GENERAL

Y90 FIXING TO BUILDING FABRIC

Y90.1000 GENERAL PREPARATION: 1010 Mark-out, set-out and firmly fix all equipment, components and necessary brackets and supports. 1020 MANUFACTURER'S DRAWINGS: Use manufacturer's drawings and templates for purposes of marking and setting out. 1030 FIXINGS: Ensure structure and fixings are suitable for items to be fixed. 1040 LOADING DETAILS: Provide loading details for all fixing types. 1050 BUILDING-IN BY OTHERS: Provide all necessary assistance to enable any item of building-in type to be built in by others. 1060 SIZE OF FIXING: Use largest size of bolt, screw or other fixing permitted by diameter of hole in item to be fixed. 1070 GREASING OF FIXINGS: Ensure all bolts, screws or other fixings used are greased or lubricated in accordance with manufacturer's instructions. Y90.2010 STANDARDS: Ensure that fixings such as expanding anchors are tested for tensile loading in accordance with BS 5080-1. Y90.2020 PLUGS: Use plugs of suitable size and length for fixings. Use plastic, fibrous or soft metal non-deteriorating plugs to suit application. Do not use wood plugs. Ensure that when screw is in place, threaded length is in plug. Ensure plugs used for screw fixing are set-in to correct depth prior to final tightening. Y90.2030 SCREWS: Use screws to BS 1210. Generally use sherardized steel wood screws for fixing to concrete, brickwork or blockwork. In damp or exposed situations use greased brass wood screws. Y90.2040 CAST-IN FIXINGS: Where cast-in fixings are permitted, mark out and set fixings in accordance with manufacturer's instructions. Y90.2050 SHOT FIRED FIXINGS: Obtain approval prior to using shot fired type fixings. Y90.2060 SELF ADHESIVE FIXINGS: Obtain approval prior to using self adhesive type fixings. Y90.2070 PROPRIETARY CHANNEL INSERTS: Provide proprietary channel inserts for casting in where indicated. Y90.2080 NON-PENETRATIVE SUPPORT SYSTEMS FOR ROOF MOUNTED EQUIPMENT: Manufacturer and reference Or approved equivalent Obtain approval prior to using non-penetrative support systems for roof mounted equipment. Y90.3010 DRILLING: Drill holes squarely. Use drills of requisite size and depth, and appropriate to fabric. Do not flame-cut holes in metal work.

Y90.3020 PROPRIETARY FIXINGS: Comply with manufacturer's instructions for all fixings.

Y90.3030 FIXING TO REINFORCED CONCRETE:

Y82

Y82/477

KJ TAIT ENGINEERS

Take precautions to avoid fixing through reinforcement.

Y90.3040 FIXING TO BRICKWORK:

Do not fix to unsound material or mortar between brickwork courses.

Y90.3050 FIXING TO TIMBER RAILS:

Fix equipment, brackets and supports by drilling hole through timber rail and fixing with bolt, back plate, washer and loose nut.

Y90.3060A FIXING TO HOLLOW STUD/TILE/BLOCK WALLS:

Fix equipment, brackets and supports where there is access at rear of wall, by drilling hole through wall and fixing with bolt, back-plate, washer and loose nut.

Fix equipment, brackets and supports where there is no access at rear of wall, drill hole and use screw anchor type fixing or gravity type toggle fixing.

Y90.3070A FIXING TO CONCRETE, BRICKWORK OR BLOCKWORK:

Fix equipment, brackets and supports using wood screws in plugs or, as appropriate, drill holes and fix using steel bolts of grouted bolt type or expanding bolt type fixing.

Y90.3080A FIXING TO METALWORK:

Fix equipment, brackets and supports by drilling holes and fixing using set screws or bolts complete with washers, shakeproof washers and loose nuts.

Y90.3090A FIXING TO STRUCTURAL STEELWORK AND CONCRETE STRUCTURES: Provide manufacturer's information on recommended fixing. Obtain approval for any fixing to structure steel work and concrete structures.

Generally use proprietary fixings to structural steelwork and concrete structures. Obtain approval to cut holes in structural steelwork or concrete structures or weld to structural steelwork.

Y90.3100# NON-PENETRATIVE SUPPORT SYSTEMS FOR ROOF MOUNTED EQUIPMENT: Provide manufacturer's information on recommended support systems.

- Obtain the necessary approvals to use non-penetrative support systems as follows: •
 - Ensure that the roof surface is compatible with non-penetrative supports
 - Ensure that necessary approval is given by
 - The Structural Engineer
 - The Architect
- Mounting positions
- Roof loading parameters
 - Wind Loadings
 - Point Loads
 - Pressures
- Components
 - Support leg type
 - Support frame type
- Maintenance
 - Ensure that future maintenance access to roof finish is provided under support system.

KJ TAIT ENGINEERS

accordance with BS EN ISO 4618.

Y91 PAINTING AND ANTI-CORROSION TREATMENTS

Y91.1000 GENERAL: 1010

GENERAL REQUIREMENTS: Ensure, where particular methods of finish and painting are not specified, the following requirements are met.

Protect all metal work, plant, equipment, pipelines, ductlines, ancillaries, brackets and supports against corrosion and oxidization.

Provide ferrous metals, machined or otherwise with protective coatings at manufacturer's works. Ensure all items requiring on-site decorative finishes are provided primed to suit base material and required finish.

1020 DAMAGED FINISHES:

Following delivery to site, storage on site and installation make good any damage to finishes, by cleaning, degreasing and re-furbishing.

Y91.2010A PAINT MATERIALS:

Use the following materials as appropriate

Solvent borne priming paint to BS 7956 for bare woodwork. Red Oxide priming paint for bare iron and steelwork.

Zinc Chromate priming paint for bare ferrous and non-ferrous metals. Calcium Plumbate priming paint to BS 3698 for galvanized steel or composite wood/metal components.

Undercoating paint for previously primed or painted surfaces before the application of finishing coats.

Gloss finishing paint for previously primed or painted/undercoated surfaces. Epoxy resin paint for specialist coatings requiring resistance to acids, alkalis, oils, solvents, abrasion or high humidity.

Aluminium paint to BS 388 for structural steelwork, storage vessels, heated metallic surfaces and similar applications where moisture and heat resistant properties are required.

Cold galvanizing paint for making good damage to previously galvanized surfaces and protection to galvanized materials modified during installation.

Zinc-rich metallic to BS 4652 for bare iron and steelwork where electrical conductivity has to be assured.

Black tar-based paint to BS 1070 for moisture resistant protection to metal surfaces where decorating appearance is not important.

Bitumen based coatings for cold application to BS 3416 protection to iron and steel, particularly pipelines and fittings for use in contact with potable water. Bitumen based coatings for cold application to BS 6949 not to be used in contact with potable water.

Y91.2020 PAINT QUALITY:

Ensure paints used are of quality and type to suit application and that:primers have good adhesion, covering power, rust-inhibiting and grain filling properties. gloss finishing paints are of machine finish grade having high adhesion and high resistance to solvents, mineral oils, cutting oils, detergents, chipping and impact damage.

Y91.2030 HEAT RESISTANT PAINT:

Y91.3020 WEATHER AND OTHER CONDITIONS:

Use heat resistant paints for applications to surfaces over 80°C.

Y91.3010 GENERAL:

effect upon finish or paint.

Ensure paints are applied in accordance with manufacturer's instructions and to BS 6150.

Do not apply paints where weather, temperature, humidity or other conditions may have a damaging

Y91.3030A CLEANING AND PREPARING STEEL SURFACES FOR PAINTING:

Ensure metal surfaces are thoroughly cleaned, all mill and weld scale removed and finally degreased. Clean steel surfaces in accordance with BS EN ISO 8503 and prepare surfaces for painting in

Ensure metal surfaces are thoroughly cleaned, all mill and weld scale removed and finally degreased.

Wherever possible ensure paint finishes applied by component manufacturers are spray applied.

Apply paint evenly and ensure finish shows no excessive brush marks, grinning, runs, sagging,

Repair damage to galvanized components due to installation process, i.e. following cutting, drilling or

Do not remove protective coatings unless required for installation, testing or commissioning purposes

Repair any damaged protective coating or bright machined part, or where necessary replace damaged

Y91.3030B CLEANING AND PREPARING SURFACES FOR PAINTING:

Prepare surfaces for painting in accordance with BS EN ISO 4618.

welding, by applying 2 no. substantial coats of cold galvanizing paint.

Apply a protective coating to all bright machined parts before despatch from works.

Complete where possible all welding, drilling, bending and other work before metal coating.

Use and apply metal coatings in accordance with manufacturer's instructions.

Y91.3070 PROTECTION OF BRIGHT MACHINE PARTS:

and in such cases reinstate upon completion.

Y91.3040 APPLICATION OFF-SITE:

ropiness or other application defects.

Y91.3060 COLD GALVANIZING:

Y91.3050 APPLICATION:

component.

Y91

Y92 MOTOR DRIVES - ELECTRIC

1000 GENERAL STANDARDS: 1010 Supply and install motors in accordance with BS 4999, BS EN 50347 and BS EN 60034, as appropriate and local supply authority regulations. 1020 ELECTRICAL SUPPLY: Ensure all electrical equipment supplied and installed is suitable for power supply indicated. 1030 PERFORMANCE CHARACTERISTIC DETAILS: Provide details of electrical input, starting and performance characteristics of all motors above 750W to an agreed format. 1033 MOUNTING: When duplicate motors are required for automatic changeover, mount separately, ensure each is complete with drive and guard and make due allowance for power loss of idling motor. 1035 KEYS:

Ensure motors and drives are supplied complete with keys and keyways.

1040A MANUFACTURER FITTED SURGE SUPPRESSORS: Supply surge suppressors to star connected motors and to all motors subject to star-delta starting to limit peak voltage to 1200 volts. Fitted by manufacturer.

1050A MANUFACTURER FITTED TRANSIENT SUPPRESSORS: Supply transient suppressors in the form of resistor and capacitor networks across the starter contactor coils. Fitted by manufacturer.

2010A STANDARD OPERATING CONDITIONS:

Ensure motors, starters and ancillary equipment are suitable for operation at full capacity at heights above sea level not exceeding 1000m, with air cooling at an average temperature over 24 hours not exceeding 35°C dry bulb with maximum conditions of 40°C dry bulb and 50 per cent RH.

2020 MOTORS - GENERAL:

Standard

Use motors which conform to BS 2048-1, BS 4999, BS EN 50347 and BS EN 60034, as applicable, which operate at lowest possible speed, compatible with performance requirements. Ratings

Select maximum continuous rating (MCR) such that

Driven machine operates at correct speed or speeds at design duty.

When running continuously at design rated duty, the temperature of the motor parts is within limits defined in BS EN 60034-1.

When provided with excess motor current (over-load) protection of thermal overcurrent release type, ensure operation is within tolerances of tripping as defined in BS EN 60947-4-1. Insulation

Use motors with Class 130 or 155 to BS EN 60085 insulation, with temperature rise as defined in BS EN 62114.

Conduit entry

Fit motor bodies with conduit entry terminal box or cable gland as required, and to suit type and size of cable being terminated.

2025A CLASS 1 MOTOR EFFICIENCY:

Supply a Class Eff 1 High Efficiency Motor (HEM) with a stated efficiency as European Motor efficiency classes table below.

Power kW	Min Eff Class 2 (%)		Min Eff Class 1 (%)	
	2 Pole	4 Pole	2 Pole	4 Pole
	21010	41010	21010	41010
1.1	76.2	76.2	82.2	83.8

KJ TAIT ENGINEERS

KJ TAIT ENGINEERS

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE MOTOR DRIVES - ELECTRIC

1.5	78.5	78.5	84.1	85.0
		-	-	
2.2	81.0	81.0	85.6	86.4
		1	r	
3.0	82.6	82.6	86.7	87.4
4.0	84.2	84.2	87.6	88.3
5.5	85.7	85.7	88.5	89.2
7 6	07.0	07.0	00.5	
7.5	87.0	87.0	89.5	90.1
11.0	00 /	00 /	00.6	01.0
11.0	00.4	00.4	90.0	91.0
15.0	89.4	89.4	91.3	91.8
10.0	00.4	00.4	01.0	01.0
18.5	90.0	90.0	91.8	92.2
22.5	90.5	90.5	92.2	92.6
		•		
30.0	91.4	91.4	92.9	93.2
37.0	92.0	92.0	93.3	93.6
		1	r	
45.0	92.5	92.5	93.7	93.9
	1		1	· · · · · · · · ·
55.0	93.0	93.0	94.0	94.2
75.0	93.6	93.6	94.6	94.7

2025B CLASS 2 MOTOR EFFICIENCY:

Supply a Class Eff 2 High Efficiency Motor (HEM) with a stated efficiency as European Motor efficiency class table below.

Power	Min Eff	Class 2	Min Eff Class 1	
NVV	(/0)		(/0)	
	2 Pole	4 Pole	2 Pole	4 Pole
1.1	76.2	76.2	82.2	83.8
				0010
1.5	78.5	78.5	84.1	85.0
	1	1	1	
2.2	81.0	81.0	85.6	86.4
3.0	82.6	82.6	86.7	87.4
4.0	84.2	84.2	87.6	88.3
			J	
5.5	85.7	85.7	88.5	89.2
	-	-	-	
7.5	87.0	87.0	89.5	90.1
	1			,
11.0	88.4	88.4	90.6	91.0
	1	1	1	
15.0	89.4	89.4	91.3	91.8

18.5	90.0	90.0	91.8	92.2
22.5	90.5	90.5	92.2	92.6
30.0	91.4	91.4	92.9	93.2
37.0	92.0	92.0	93.3	93.6
45.0	92.5	92.5	93.7	93.9
55.0	93.0	93.0	94.0	94.2
75.0	93.6	93.6	94.6	94.7

2030 SLIDE RAILS:

Fit motors on slide rails or other suitable means of adjustment to facilitate correct alignment and belt tension.

2040 PLINTHS:

Where plinths are built in by others, provide all necessary assistance and information.

2050A MOTOR RATINGS - UP TO AND INCLUDING 0.75KW: Single or three phase, totally enclosed, frame cooled or fan cooled. For duty and torque requirements of driven machine.

2050B MOTOR RATINGS - ABOVE 0.75KW UP TO AND INCLUDING 4KW: Three phase, squirrel cage induction type, totally enclosed, frame cooled or fan cooled. To BS EN 60034-5 and BS EN 60034-6 IP44 - IC 01.411.

2050C MOTOR RATINGS - ABOVE 4KW SQUIRREL CAGE, DRIP-PROOF: Three phase, squirrel cage, induction type, drip-proof enclosure. To BS EN 60034-5 and BS EN 60034-6 IP22S - IC 01.

2050D MOTOR RATINGS - ABOVE 4KW WOUND ROTOR, DRIP PROOF: Three Phase, wound rotor, slip type, drip-proof enclosure. To BS EN 60034- 5 and BS EN 60034-6 IP22S -IC 01.

2050E MOTOR RATINGS - ABOVE 4KW SQUIRREL CAGE, TOTALLY ENCLOSED: Three phase, squirrel cage, induction type, totally enclosed, frame or fan cooled. To BS EN 60034-5 and BS EN 60034-6 IP44 - IC 01.411.

2050F MOTOR RATINGS - ABOVE 4KW WOUND ROTOR, TOTALLY ENCLOSED: Three phase, wound rotor, slip ring type, totally enclosed, fan cooled. To BS EN 60034-5 and BS EN 60034-6 IP44 - IC 01.411 or IC 01.511 as applicable.

2050G MOTOR RATINGS - ABOVE 4KW SQUIRREL CAGE, SMOKESPILL: Three phase squirrel cage, induction type for smokespill applications. To BS EN 60034-5 and BS EN 60034-6 IP55, cooling as applicable.

2050H ABOVE 4KW SQUIRREL CAGE, ENERGY EFFICIENT DESIGN: Three phase, squirrel cage, induction type energy efficient design, totally enclosed, fan cooled to BS EN 60034-5 and BS EN 60034-6 IP55 - IC 01.411.

2060A MOTORS - OVER TEMPERATURE PROTECTION, THERMISTORS: Fit positive temperature coefficient thermistors to BS EN 60034-11. Provide a minimum of 3 PTC thermistors in each motor with 2 ends terminated in motor terminal box clearly and permanently marked.

KJ TAIT ENGINEERS

	C0605LMB Revised Stage E Mechanical Specification Including Agreed VE MOTOR DRIVES - ELECTRIC	Y92	C0605LMB Revised Stage E Mechanical	Specification APPENDIX
	For motors rated between 30kW and 75kW provide a single thermistor in each phase. For motors rated above 75kW provide two thermistors in each phase. Provide control unit to BS EN 60034 to motors fitted with thermistors. Interconnect control unit with thermistors and starter to trip starter when one or all of thermistors detect overheating.	_		
	2070A INDIRECT DRIVES WITH TOOTHED BELTS: Belts Use toothed wedge belts to BS 3790. Provide at least two matched belts for any drive, of anti- static type and rated to transmit full machine power with one belt removed. Pulleys Construct pulleys from approved materials and statically balance. Lock close limit bores by		Equipment	Preferred
	keys fitting into machinery shaft keyway. Pulley Adjustment Adjust pulley to give alignment and correct belt tension.			
			Acoustics and Vibration Control	A 11 -
	2070B INDIRECT DRIVES WITH FLAT BELTS: Belts		Acoustics Intake Panels	Allawa
	Use flat wedge belts to BS 3790. Provide at least two matched belts for any drive, of anti-static type and rated to transmit full machine power with one belt removed. Pulleys		Air Filters Air Handling Units	Allawa
	fitting into machinery shaft keyway. Pulley Adjustment			(
	Adjust pulley to give alignment and correct belt tension.			Er
	2080A DIRECT COUPLED DRIVES: Use an extended motor shaft coupled to machine or a flexible coupling connecting driving and driven shafts, incorporate suitable arrangements for aligning the two shafts. Mount motors on a substantial mild steel bed plate fixed to machine casing separately supported or		Autoclaves BMS Control Systems	Pr B M
	supported entirely from the machine casing.		D. N	
	2085 VARIABLE SPEED DRIVE: Use variable speed drive to match design and installed flow volumes.		Boilers	5
	2000 4 GUARDS:		Bulk Salt Saturator	A
	Totally protect drives and couplings. Fit purpose made guards around all exposed or otherwise accessible drive shafts, pulleys, 'V' belts or couplings.		Chillers	Г (
	Ensure guards comply with National or Local Safety Codes, Acts and Bye-Laws and incorporate following features.		Clean Steam Boilers	Ajax
	Stiffening within the guards to ensure rigidity and freedom from vibration.		Commissioning Services	Contracto
	Allowance for prime mover adjustment during belt tensioning procedures. Temporary access to all shafts for use of Tachometer.		Condensate Extract Hoods Constant Temperature Rooms Containment Devices:- Variable Volume Fume Cupboards	Approved Halton Adcock
			Containment Devices:- Microbiology Safety Cabinet's	۲ ۱
			Containment Devices:- Downdraught Tables	F
			Containment Devices:- Canopy Hoods Dejonised/Distilled Water System	Haltor B N
			Desiccant Dehumidifier	יי Pu Stulz Humidit

KJ TAIT ENGINEERS

Domestic Water Boilers

on Including Agreed VE

DIX A

<u>MANUFACTURERS LIST</u>

red Manufacturer

Comments

IAC vay Acoustics IAC ay Acoustics Camfil Woods With Semco Thermal Wheels York Carrier AHS nterprise riorclave M Weston LTE ICS TAC Acorn Hoval Broag Stokvis nderson Kinetico York Carrier (Aermac) Fulton ed Flame Boilers ors Supply Chain Sub-Contractor Nentmaster Refrigeration Fumair CAS Premier Walker CAS Premier CAS Premier on Ventilation Site Fabricated Britannia Millipore Pure Tech ity Control Systems Munters **H B Sorbtion** Lochinvar

C0605LMB Revised Stage E Mechanical Specification Including Agreed VE APPENDIX A

	Hoval		Water Boosters
Ductwork Systems	Contractors Supply Chain Approved Sub-Contractor		
Ductwork Special Extract Systems	Contractors Supply Chain Approved Sub-Contractor	Stainless Steel Ductwork	Water Filter/Strainers
Expansion Vessels and Fill Units	Armstrong		Water Tanks
	Grundfoss		Trator ranko
Extract Fans	Woods		
Fee Oall Halts	Nuaire		VAV Terminal Units
Fan Coll Units			
Flues	Midthorm		
	Keddy Pouioulat		
Gas Fire Suppression Systems	Chubb	Inergen or Argonite	
Fume Extract Fans	Woods		
	Central Fans		
	Vent Axia		
	Nuaire		
Gas and Water Detection Equip'	TBC		
Geothermal Heat Pump Systems	Geothermal International	System Complete	
	Earth Energy		
	Mitie Engineering		
Glass Washers	Lancer		
	Miele		
Crilles and Diffusers	BIVIN Weston		
Grilles and Diffusers	Gilberts		
	Moducel		
	Halton		
Heat Pumps	Supplied in Geothermal Package	Contractors Supply Chain Approved Sub-Contractor	
Humidifiers	JS Humidifiers (Armstrong)		
	Spirax Sarco		
	Stultz		
Insulation Contractors	Contractors Supply Chain		
	Approved Sub-Contractor		
Lab Gases Bulk	BOC		
Lab Gases Bollie	UK Gastech K&H Medical		
	Cambridge Fluid Systems		
Pumps	Armstrong		
	Wilo		
	Grundfoss		
Pipework Systems	Contractors Supply Chain		
	Approved Sub-Contractor		
Pipework Deaerators	Engineering Appliances		
Pipework Expansion	Engineering Appliances		
Pipework Flushing /Water	Contractors Supply Chain	Contractor Preference	
I reatment	Approved Sub-Contractor		
nainwaler Ouliels and Unannels Storage Vessels	Wade Bycroft		
Steam Equipment	Spirax		
Sump Pumps	Armstrong		
camp r ampo	New Haden		
	Wilo		
Trace Heating tapes	Raychem		
~ 1	Alben Heat		
	JAM Ltd		

Armstrong Alan Aqua Wilo Grundfoss Airpel Spirax Sarco Balmoral Brimar Braithwaite Trox Gilberts Moducel Halton

APPENDIX A / 488

APPENDIX B

PIPEWORK SPECIFICATIONS

Section	<u>Service</u>	Material	Manufacturer	<u>System</u>
R10	Rainwater System	Stainless Steel	Blucher Saint Gabain	Europipe
R10	Rainwater System	Stainless Steel	Blucher	Europipe
R11	Vertical Soil	Cast Iron Stainless Steel	Blucher	Ensign Europipe
R11	System Horizontal Soil	Cast Iron Plastic/Stainless	Saint Gobain Marley/Blucher	Ensign Marley/Europipe
R13	Laboratory Waste	Co polymer	Durapipe	Vulcathene
S10	Cold Water Service	PVC-C & MDPE Multilayered	Durapipe Henco	Friatherm/MDPE
S11	Hot Water Service	PE-Xc/AL/PE-Xc PVC-C & MDPE Multilayered PE Xo(AL/PE Xo	Durapipe Henco	Friatherm/MDPE
S20	Deionised Water	ABS	Durapipe	ABS
S32	Natural Gas	Welded Steel/MDPE		
S34	Lab Gases	De-greased copper		
S41	Fuel Oil	Steel/Polythene- Polaymide	Durapipe	PLX
S52	Steam & Condensate	Welded Steel / Copper		
S52	Clean Steam	Schedule 10 Stainless Steel		
S61	Dry Riser	Grooved Galvanised Steel		
S65	Fire Hydrants	MDPE		
T20/31	LPHW Heating up to 50 dia	Screwed Steel/ PVC-C	Durapipe	Vulcathene
T20/31	LPHW Heating over 65 dia	Grooved Steel/Welded Steel		
T61/69	Chilled Water up	Screwed Steel/ABS	Durapipe	ABS
T61/69	Chilled Water	Grooved Steel/Welded	Durapipe	ABS
T71	Cold Room Refrigeration	Refrigerant Grade		
Note:-	riongeration	Copper		
	والمرابع والمعادية والمعادية والمرابع	and the set of the second second set of the second	_	

Grooved steel pipework only allowed in plant areas and risers.

APPENDIX C

VALVE SCHEDULE

	Heating & Cl	hilled Water Servic	es		Valve Type	Size	Manufacturer	Fig No	Comments
Valve Type	Size	Manufacturer	Fig No	Comments	I				
					Service isolation Valves	15-25 mm	Hattersley	108	WRAS Approved
		L La Dia sa La	00)/		Isolating – Gate Valve	15-50 mm	Hattersley	33X	WRAS Approved
Isolating – Gate Valve	15-50 mm	Hattersley	33X	WRAS Approved	Isolating – Ball Valve	15-50 mm	Hattersley	100	WRAS Approved
Isolating – Ball Valve	15-50 mm	Hattersley	100	WRAS Approved	Isolating – Gate Valve	65-300 mm	Hattersley	M541 PN16	WRAS Approved
Isolating – Gate Valve	65-300 mm	Hattersley	M541 PN16	WRAS Approved	Isolating – Wafer	65-300 mm	Hattersley	970W PN16	Fully Lugged Wafer
Isolating – Water	65-300 mm	Hattersley	970W PN16	Fully Lugged Water	Non Return Valve (Swing)	15-50 mm	Hattersley	47	WRAS Approved
Non Return Valve (Flap)	15-50 mm	Hattersley	47	WRAS Approved	Non Return Valve (Swing)	65-300 mm	Hattersley	M651 PN16	WRAS Approved
Non Return Valve (Flap)	65-300 mm	Hattersley	M651 PN16	WRAS Approved	Non Return Valve Wafer	65-300 mm	Hattersley	850 PN16	WRAS Approved
Non Return Valve Wafer	65-300 mm	Hattersley	850 PN16	WRAS Approved	Strainer	15-50 mm	Hatterslev	907	WRAS Approved
Fixed Orifice	15-50 mm	Hattersley	1732	WRAS Approved	Strainer	65-300 mm	Hattersley	910 PN16	+ Blow Down Valve
Eived Orifice	65-300 mm	Hattorelov	M2733DB	WBAS Approved	Double Regulating	15-50 mm	Hattersley	1432	WRAS Approved
Commissioning Set	00-000 mm	Tratterstey	WZ7 SSDT		Drain Cocks	15 mm	Hattersley	371	WRAS Approved
Fixed Orifice Commissioning Set	300-400 mm	Hattersley	4973DR + M200	WRAS Approved	Pressure Reducing Valves	15- 50 mm	Hattersley	430 Cold 440 Hot	WRAS Approved
Double Regulating	15-50 mm	Hattersley	1432	WRAS Approved	TM3 Mixing Valves	15 mm	Hattersley	77	WRAS Approved
Double Regulating	65-300 mm	Hattersley	M733DR	WRAS Approved	Water Hammer Arrestors		Wade	WSC 500 & 700	WRAS Approved
Strainer	15-50 mm	Hattersley	907	WRAS Approved	Storage Tank Float Valves		Keraflo	KA	
Strainer	65-300 mm	Hattersley	910 PN16	+ Blow Down Valve	Ŭ				
Compact VAV Hook Up	15-25 mm	Hattersley	168 (H or C)	Part No Changes 2009		Stea	am & Condensate		
Hose Union Drain Cocks	15-25 mm	Hattersley	81HU						
Drain Cocks	15 mm	Hattersley	371	WRAS Approved	Valve Type	Size	Manufacturer	Fig No	Comments
Natural Gas Valves	15-50 mm	Hattersley	100YL		Eabricated Trap Station	15 mm	Spirax	STS17/DF2	
Natural Gas Valves	65-150 mm	Hattersley	971 YL		Quick Fit Thermodynamic Trap with Integral Strainer		Spirax	UTD30H	Mains Drainage
					Quick Fit Float Trap		Spirax	UFT14-4.5	Equipment Drainage
					Trap Monitoring System		Spirax	Sipratec	
					Steam Stop Valve	15-250 mm	Spirax	BSA2T	
					Y Type Strainer	15-150 mm	Spirax	37	
					Separator	40-200 mm	Spirax	S13	
					Pressure Reducing Valves	15-80 mm	Spirax	DP143	
					Pipeline Steam Filters	15-80 mm	Spirax	CSF 16H	Elements to suit specification S52
					Safety Valve	20-150 mm	Spirax	SV607	

Domestic Hot & Cold Water Services

APPENDIX C/ 492

APPENDIX D

BOREHOLE TEST RESULTS



Scale Scale Status	Drawing		Date	A 14/11/08	
gnumber SK - 032	Cambridge - LMI	Site Sketch SK03	Revision	Tower crane radius added	
Checked Seen Seen Rev.		N	Dm. Seen	AW Chk.	



geothermal international

Geothermal Conductivity Test Report

Project MARS, Cambridge

Results

ground source heating, cooling + hot water

geothermal international Itd Spencer Court

143 Albany Road Coventry CV5 6ND United Kingdom T +44 (0) 24 7667 3131 F +44 (0) 24 7667 9999 E enquiries@geoheat.co.uk

www.geoheat.co.uk

Registered in England Company No. 5397984 Clear Skies Registration No. 2120822 VAT No. 864 447 986



Sole distributors of WaterFurnace products

Contents

- 1 Report Summary
- 2 Results Summary
- 3 Appendix 1 Testing Procedure
- 4 Appendix 2 Drill Log
- 5 Appendix 3 Supporting Charts
- 6 Appendix 4 Data
Report Summary

1.1 Introduction

This report presents the findings of a conductivity tests at the geothermal bore field planned for the MARS Project, Cambridge. Geothermal International and associated companies conducted the test during October 2008.

1.2 *Method of Investigation*

Appendix 1 outlines the procedure for the conductivity test. The test was conducted on one trial bore with completed depth of 100m. The loop was installed to the full depth.

1.3 Geological Findings

The geological conditions of the Cambridge area are generally acknowledged to be variable however the conditions encountered were as expected in broad terms.

1.4 Conductivity Test Results

Appendix 3 contains the results in graphical form with Appendix 4, a raw data print, included for reference. The charts are interpreted as follows,

The "Raw Data" chart shows the data capture process was clean and without interruption during the period of the test. This indicates, with a high degree of certainty, that the results are good.

The "All Data" logarithmic plot is used to determine by inspection the point at which the hole "saturates" and the graph approximates a straight line.

The "Straight Line Portion" is used to determine the gradient (inversely proportional to the conductivity) and error margin associated with the test.

The results are presented in the summary page in section 2.

1.5 Results Interpretation

Two test runs were conducted. The first run was terminated prematurely due to generator failure and did not result in enough data to derive reliable conductivity measurement, it was therefore used to measure the undisturbed ground temperature only. The second test run produced good quality data and was used to derive the conductivity value.

The 100.0m active length trial bore hole produced a conductivity value of 1.472 $\text{Wm}^{-1}\text{K}^{-1}$, +/- 0.008 $\text{Wm}^{-1}\text{K}^{-1}$. The very small margin of error indicates an excellent level of confidence in the result.

The undisturbed ground temperature was measured as 12.5 $^{\circ}C$ +/- 0.2 $^{\circ}C$. Again the margin of error is well within acceptable limits.

Report Prepared by:

Chris Davidson BSc (Hons), ARCS, AIOP, CGD (IGSHPA)

Technical Director

Geothermal International

12 October 2008

geothermal international



Results Summary

Quantity	Start	End	Result	
Power into Test Hole	1121 1378		257.00	kWh
			257000	Wh
Test Duration	39	2610.00	Minutes	
			43.50	Hours
Average Power	5908.05	W		
Test Hole Depth	100	m		
Slope Straight Line Po	rtion		1.5967	
Conductivity			1.472	Wm ⁻¹ K ⁻¹
Margin of Error			0.008	+/- Wm ⁻¹ K ⁻¹
Undisturbed Ground T	12.5	°C		
Margin of Error	0.2	+/- °C		

geothermal international



Appendix 1 - Testing Procedure

As Approved by the International Ground Source Heat Pump Association (IGSHPA)

A1.1 Introduction

Thermal conductivity (k) for soil and rock varies as a function of density and moisture content. Thus knowing the soil / rock type alone is insufficient to determine the thermal conductivity, the single most important element in geothermal ground loop design. In-situ conductivity testing is the most reliable method by which thermal conductivity can be measured accurately. This accurate measurement allows the geothermal designer to avoid over sizing the ground loop to cover potential variations in conductivity on any particular site. The conductivity test also provides an accurate measurement of the undisturbed ground temperature which is also important to geothermal design.

The concept of the in-situ thermal conductivity testing is to drill a bore hole at the location of the proposed ground loop, install an individual loop and grout it, connect a constant heat source to the water being circulated through the loop and measure the energy input and inlet and outlet temperatures. With these values a line source equation model can be applied to the data to determine the thermal conductivity.

A1.2 In-Situ Test Equipment

Equipment required for the test is the following,

Ground heat exchanger grouted in place Constant hot water source Data acquisition system to measure and record against time, Temperature In Temperature Out

Flow Rate

Power Used by Heater



This is housed in an insulated travelling case to protect the equipment during transport and testing.

A1.3 Test Procedure

The test procedure is as follows,

- 1 Locate in-situ equipment near completed bore to minimise above ground exposure.
- 2 Flush loop to remove all debris, cap and set overnight to obtain the most accurate undisturbed ground temperature.
- 3 Connect ground loop to equipment.
- 4 Insulate loop leads to reduce temperature bias.
- 5 Fill in-situ equipment with water.
- 6 Start data acquisition using good computing practices and with an appropriate recording interval.
- ⁷ Turn on the pump and circulate the water for 20 minutes to obtain an average undisturbed ground temperature and to purge any air from the system.
- 8 Pressurise loop to a static pressure of 70 to 100 kPa.
- 9 Adjust flow rate to provide turbulent (Reynolds Number > 2,500) and stable flow. As a rule of thumb this is 22 l/min for 32 mm and 34 l/min for 40 mm pipe sizes.
- 10 Turn on heater to desired power value. Power values range from 60 W to 100 W per meter of pipe installed in bore depending on the anticipated conductivity range.
- 11 During conductivity testing the following should be monitored,
 - a Any anomalies in data, e.g. wild fluctuations, very rapid changes or infinite readings.
 - To Follow Development of minor leaks and any topping up. If large quantities of water are added, the test procedure should be aborted and begun again after the leaks are repaired.
 - c Electricity supply to the equipment.
- 12 After the scheduled test duration, typically between 24 to 48 hours depending on the anticipated conductivity, the heaters should then be shut off. With the pump still running, the temperature decay should then be measured for a further test period to establish the heat dissipation properties of the strata. This is a qualitative indication of the diffusivity and is only significant in heat store applications.
- 13 Shut the pump off and save the data in accordance with good computing practice.
- 14 The equipment can then be dismantled and removed from site. The bore hole itself can then be used as part of the final installation.

Appendix 2 - Drill Log

Ground Level: 14.250AOD GR: E54589.498 N255114.684 Date: 29.09.08 GL to 7.5m 30.09.08 7.5 to 75.5m 1.10.08 75.5 to 100m Borehole cased to 7.5mbgl Hole dia. 127mm Casing dia. 150mm Rig: Comacchio 450, 6.5 tonne pull back 4.5 tonne feed.

	mbgl			
From	То	Strata Description	Drilling Method and Comment	
GL	1.0	MADE GROUND: Light grey and white clay with gravels and cobbles of chalk		
	1.0	Liebt brown closes are all fine to come CAND. Crevel is fine to come fligt and challs	Cae here easing to 7 Fm	┥╃╃╄╄╄╄
1.0		Light brown clayey gravely fine to coarse SAND. Gravel is fine to coarse fint and chaik	Geo-bore casing to 7.5m	
	5 2			
	5.2			
5.2		Light grey and white CHALK (Lower Chalk)	Open hole drilling from 7.5m with 127mm	
			drag bit. Water flush with soda ash and Easy	
			Mud Gold to reduce sweling potential of	
	12.0		Gault Clay	
42.0	12.9			
12.9		Grey MUDSTONE and CLAY (Gault Clay)	Drill rate in Gault Clay: 6 mins per 3 m runs, 5	
			mins to develop and flush the rods.	
	53.9			
53.9		Grey greem fine to medium grained SANDSTONE. (Lower Green Sands)	Pull out of hole, changed to rock roller, hard	
			strata. Drill rate 3m in 9mins, developing 5	
			mins per rod	
			linis per lou.	
	75 5			
	75.5			
//.0		Light grey and white Limestone (Oolite?). Hard ground	וויזט rate 12 to 15 mins per 3 m rod.	┢╋╋╋╋╋
				┝╋╋╋╋╋
	90.8			
00.8	50.0	Light grow calcaroous MUDSTONE	Drill rate 2 mins for 2 m	
90.ð	02.1			
	93.1			
93.1	045	Light grey and white LIMESTONE	Drill rate 12 to 15 mins per 3 m rod.	
	94.5			
94.5	95.0	Light get calcareous MUDSTONE	Drill rate 1m in 1m	
95.0		Light grey and white LIMESTONE	Drill rate 12 to 15 mins per 3 m rod.	┢╋╋╋╋╋
				┝╋╋╋╋╇
	100.0			
		END of borehole		

Mud pump, on board triplex pump 2001/min, 40 bar

Returns resonable through Gault Clay, slight reduction in Greensand.

Water brought to site with 500 gallon bowsers via hydrant supply, 2000 gallons of water used, slow loss during drilling

Loop installed to 99.5m, installation 10 mins

Grouting 1:5 bentogrout:silica sand mix, 2hrs to backfill

25kg bentogrout: 125kg sand with 60 litres of water

15 mixes used

375kg bentonite and 1875kg of sand







Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
0		12 596	12 521	12 445	-0 151	
1	0	12.500	12.021	12 38	-0 132	
2	0 693147181	12.512	12.110	12.00	-0 127	
3	1 008612280	12.00	12.407	12.403	-0.13/	
3	1.030012203	12.003	12.530	12.471	-0.134	
5	1.000294001	12.590	12.529	12.40	-0.130	
5	1.009437912	12.54	12.474	12.407	-0.133	
0	1.791759469	12.04	12.407	12.434	-0.106	
/	1.945910149	12.603	12.538	12.473	-0.130	
8	2.079441542	12.58	12.509	12.437	-0.143	
9	2.19/2245//	12.565	12.500	12.435	-0.130	
10	2.302585093	12.569	12.507	12.445	-0.124	
11	2.397895273	13.091	12.768	12.445	-0.646	
12	2.48490665	17.754	15.095	12.436	-5.318	HEATERS ON
13	2.564949357	18.003	15.219	12.434	-5.569	
14	2.63905733	18.041	15.246	12.451	-5.590	
15	2.708050201	18.084	15.272	12.46	-5.624	
16	2.772588722	18.099	15.282	12.464	-5.635	
17	2.833213344	18.089	15.281	12.473	-5.616	
18	2.890371758	18.132	15.309	12.486	-5.646	
19	2.944438979	18.503	15.739	12.974	-5.529	
20	2 995732274	19 255	16 439	13 622	-5 633	
21	3 044522438	19 577	16 735	13 893	-5 684	
21	3 091042453	19.774	16 913	14 051	-5 723	
22	3 135/0/216	10.046	17.060	14.001	-5 772	
23	2 17005202	19.940	17.000	14.174	-5.772	
24	3.17003303	20.070	17.109	14.202	-5.614	
25	3.218875825	20.153	17.243	14.333	-5.820	
26	3.258096538	20.238	17.324	14.409	-5.829	
27	3.295836866	20.364	17.460	14.556	-5.808	
28	3.33220451	20.562	17.655	14.747	-5.815	
29	3.36729583	20.712	17.804	14.895	-5.817	
30	3.401197382	20.854	17.936	15.018	-5.836	
31	3.433987204	20.982	18.055	15.127	-5.855	
32	3.465735903	21.092	18.158	15.224	-5.868	
33	3.496507561	21.185	18.245	15.305	-5.880	
34	3.526360525	21.254	18.318	15.381	-5.873	
35	3.555348061	21.366	18.417	15.467	-5.899	
36	3.583518938	21.477	18.517	15.557	-5.920	
37	3.610917913	21.574	18.608	15.641	-5.933	
38	3.63758616	21.667	18.695	15.722	-5.945	
39	3.663561646	21.753	18.776	15.799	-5.954	
40	3.688879454	21.835	18.854	15.873	-5.962	
41	3,713572067	21.917	18.929	15.941	-5.976	
42	3,737669618	21 994	18 998	16 001	-5 993	
43	3 761200116	22.071	19.068	16.064	-6.007	
40	3 78/18063/	22.071	10.000	16 1 20	-6.023	
44	3 80666240	22.102	10.211	16 101	-6.030	
45	2 9296/1206	22.23	10.276	16.25	-0.039	
40	3.020041390	22.302	19.270	16.20	-0.052	
47	3.030147002	22.301	19.335	10.300	-0.055	
48	3.071201011	22.42	19.391	10.302	-0.058	
49	3.891820298	22.473	19.446	16.418	-6.055	
50	3.912023005	22.492	19.483	10.4/4	-6.018	
51	3.931825633	22.552	19.541	16.53	-6.022	
52	3.951243719	22.621	19.604	16.586	-6.035	
53	3.970291914	22.684	19.662	16.64	-6.044	
54	3.988984047	22.747	19.720	16.693	-6.054	
55	4.007333185	22.8	19.772	16.744	-6.056	
56	4.025351691	22.859	19.828	16.796	-6.063	
57	4.043051268	22.91	19.877	16.843	-6.067	
58	4.060443011	22.941	19.912	16.882	-6.059	
59	4.077537444	22.988	19.957	16.925	-6.063	

$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Time	All Data	Flow	Average	Return	Delta T	
60 4.094344562 23.031 20.001 16.97 -6.061 61 4.11073864 23.083 20.049 17.016 -6.072 63 4.143134726 23.182 20.149 17.016 -6.072 64 4.15885030 22.233 20.149 17.145 -6.088 65 4.17438727 22.231 20.232 17.733 -6.106 67 4.204892619 23.373 20.316 17.228 -6.106 67 4.204892619 23.373 20.355 17.336 -6.124 69 4.23100505 23.464 20.397 17.33 -6.154 71 4.248495242 23.555 20.473 17.405 -6.164 74 4.200489441 23.651 17.469 -6.164 -7.74 75 4.307334 23.765 20.476 17.705 -6.165 75 4.3074042 23.717 17.603 -6.164 -7.74 74 4.304040503 23.868	Minutes	Ln (Time)	°C	°C	°C	С°	
60 4.094344562 23.031 20.049 17.014 -6.069 61 4.110273864 23.032 20.049 17.014 -6.069 63 4.143134726 23.182 20.049 17.014 -6.068 64 4.15883083 23.233 20.141 17.11 -6.068 65 4.1743827 23.232 20.232 17.183 -6.098 66 4.199654742 23.372 20.241 17.228 -6.115 68 4.214605705 23.417 20.355 17.233 -6.144 70 4.24695242 23.555 20.436 17.364 -6.144 71 4.2262679877 23.545 20.561 17.469 -6.164 74 4.30465603 23.688 20.561 17.869 -6.173 76 4.307334 23.743 20.665 17.538 -6.173 76 4.307334 23.743 20.655 17.858 -6.173 77 4.36570827 23.8							
61 4.11073364 23.032 20.049 17.04 -6.0672 63 4.143734726 23.132 20.049 17.06 -6.072 64 4.15883032 23.233 20.189 17.145 -6.088 65 4.17439727 23.221 20.274 17.221 -6.106 67 4.204092019 23.373 20.356 17.233 -6.124 69 4.21400605 23.442 20.352 17.733 -6.124 69 4.24409242 23.505 20.436 17.366 -6.139 71 4.268078077 23.545 20.473 17.401 -6.144 72 4.27666119 23.589 20.512 17.435 -6.164 73 4.30046203 23.688 20.565 17.503 -6.165 76 4.307334 23.743 20.0685 17.604 -6.162 76 4.307334 23.743 20.0685 17.604 -6.162 77 4.36070827 23.88	60	4.094344562	23.031	20.001	16.97	-6.061	
62 4.127134365 23.182 20.096 17.06 -6.072 63 4.143134726 23.182 20.141 17.1 6.082 64 4.15982083 23.233 20.199 17.145 -6.082 65 4.1743877 23.231 20.232 17.183 -6.098 66 4.199564742 23.372 20.234 17.226 -6.116 67 4.20480219 23.373 20.355 17.233 -6.134 69 4.24105050 23.464 20.397 17.33 -6.134 70 4.242648242 23.505 20.435 17.603 -6.164 72 4.27666119 23.586 20.581 17.603 -6.166 74 4.30406603 23.686 20.585 17.603 -6.166 75 4.317488114 23.711 20.655 17.603 -6.166 75 4.317488114 23.711 20.656 17.604 -6.174 77 4.33605422 23.783 20.753 17.664 -6.174 78 4.36046069 23.881 </td <td>61</td> <td>4.110873864</td> <td>23.083</td> <td>20.049</td> <td>17.014</td> <td>-6.069</td> <td></td>	61	4.110873864	23.083	20.049	17.014	-6.069	
63 4.143134726 23.122 20.149 17.145 -6.088 65 4.17438727 23.221 20.232 17.183 -6.088 66 4.19854742 23.327 20.316 17.221 -6.106 67 4.204802619 23.373 20.316 17.224 -6.106 68 4.219507705 23.442 20.355 17.933 -6.124 69 4.224106505 23.442 20.355 17.306 -6.139 71 4.2426078977 23.545 20.473 17.401 -6.144 72 4.206050817 23.645 20.561 17.669 -6.164 74 4.30405003 23.666 20.565 17.563 -6.173 76 4.3307334 23.743 20.655 17.668 -6.174 77 4.349044122 23.760 20.753 17.664 -6.162 78 4.36070827 23.89 20.717 17.764 -6.162 78 4.36070827 23.89 20.852 17.786 -6.161 78 4.36070827 23.	62	4.127134385	23.132	20.096	17.06	-6.072	
64 4.16883008 22.323 20.199 17.183 6.008 65 4.1743827 23.281 20.232 17.83 6.008 66 4.196964742 23.327 20.274 17.258 6.115 67 4.20466216 23.373 20.376 17.258 6.151 68 4.23406560 23.444 20.335 17.233 6.124 70 4.244965242 23.505 20.436 17.366 6.139 71 4.26267977 23.545 20.473 17.401 6.144 72 4.270468414 23.599 20.511 17.406 6.164 73 4.26045043 23.668 20.586 17.503 6.164 74 4.30405093 23.668 20.685 17.604 6.164 77 4.3307334 23.743 20.656 17.604 6.162 78 4.35670827 23.83 20.753 17.604 6.162 79 4.360447852 23.838 20.776 17.731 6.165 82 4.406719247 23.394 <	63	4.143134726	23.182	20.141	17.1	-6.082	
66 4.1738727 22.321 17.183 -6.086 67 4.206602619 23.373 20.274 17.221 -6.106 68 4.219507705 23.417 20.355 17.233 -6.134 69 4.23400505 23.444 20.397 17.336 -6.134 70 4.24695242 23.505 20.473 17.401 -6.144 72 4.27666611 23.589 20.512 17.435 -6.154 73 4.290459441 23.689 20.551 17.649 -6.164 74 4.300465043 23.668 20.566 17.503 -6.165 75 4.317484114 23.711 20.656 17.604 -6.174 76 4.33073334 23.743 20.656 17.604 -6.165 78 4.356708827 23.8 20.751 17.604 -6.164 78 4.356708827 23.8 20.761 17.701 -6.150 81 4.3924491652 24.082 17.789 -6.165 82 4.067719247 23.934 20.852 17	64	4.158883083	23.233	20.189	17.145	-6.088	
66 4.18654742 23.237 20.274 17.221 -6.106 67 4.20469219 23.373 20.316 17.258 -6.115 68 4.234105605 23.444 20.3355 17.233 -6.124 70 4.2462679877 23.545 20.473 17.701 -6.144 72 4.276666119 23.569 20.551 17.435 -6.164 73 4.204059441 23.633 20.551 17.435 -6.164 74 4.30405492 23.766 20.686 17.503 -6.173 76 4.317438114 23.711 20.625 17.538 -6.174 77 4.34307334 23.743 20.766 17.694 -6.162 78 4.35670827 23.83 20.753 17.696 -6.161 78 4.38004635 23.891 20.813 17.735 -6.156 82 4.406719247 23.34 20.852 17.769 -6.161 83 4.418484056 24.086	65	4.17438727	23.281	20.232	17.183	-6.098	
67 4.20460219 23.373 20.316 17.293 6.114 68 4.218507700 23.444 20.397 17.333 6.134 70 4.24495224 23.505 20.436 17.366 6.139 71 4.262679877 23.545 20.473 17.401 -6.144 72 4.276666114 23.569 20.551 17.469 -6.164 74 4.30065093 23.668 20.561 17.503 -6.165 75 4.31748114 23.713 20.656 17.659 -6.174 76 4.33743314 23.743 20.656 17.659 -6.174 77 4.36947652 23.86 20.753 17.668 -6.170 79 4.36947652 23.861 20.776 17.701 -6.166 81 4.39449155 23.981 20.813 17.793 -6.186 82 4.406719247 23.984 20.890 17.86 -6.170 84 4.43081799 24.012 20.971 17.335 -6.186 83 4.416840008 23.982<	66	4.189654742	23.327	20.274	17.221	-6.106	
68 4 21907705 23.417 20.355 17.233 -6.124 70 4 234060505 23.464 20.397 17.33 -6.139 71 4 22667877 23.545 20.473 17.401 -6.144 72 4.276666119 23.569 20.551 17.401 -6.154 73 4.20458041 23.569 20.551 17.403 -6.164 74 4.30405093 23.668 20.565 17.503 -6.174 76 4.3307333 23.763 20.685 17.604 -6.162 77 4.33805422 23.3766 20.685 17.604 -6.162 78 4.35670827 23.83 20.753 17.636 -6.170 80 4.3802635 23.851 20.776 17.33 -6.165 81 4.3804795 23.838 20.873 17.856 -6.185 82 4.4067162 24.086 29.982 17.857 -6.186 82 4.43261261 21.071 <t< td=""><td>67</td><td>4.204692619</td><td>23.373</td><td>20.316</td><td>17.258</td><td>-6.115</td><td></td></t<>	67	4.204692619	23.373	20.316	17.258	-6.115	
69 4.234106505 23.464 20.397 17.336 6-134 70 4.248495242 23.505 20.436 17.366 6-144 72 4.26667191 23.589 20.512 17.465 6-144 73 4.290459441 23.633 20.551 17.469 6-164 74 4.30406503 23.668 20.566 17.503 6-164 75 4.317488114 23.713 20.656 17.559 6-174 76 4.33073342 23.743 20.656 17.559 6-174 77 4.366070827 23.8 20.751 17.763 6-164 78 4.356470827 23.88 20.776 17.701 6-155 81 4.39449155 23.891 20.775 17.701 6-156 82 4.406719247 23.934 20.892 17.785 6-165 83 4.41840608 23.98 20.893 17.86 6-200 84 4.42081799 24.012 20.927 17.83 6-165 84 4.423041799 24.028	68	4.219507705	23.417	20.355	17.293	-6.124	
70 4.248495242 23.505 20.436 17.366 -6.139 71 4.256769877 23.549 20.512 17.435 -6.154 73 4.290459441 23.633 20.551 17.469 -6.164 74 4.304065093 23.666 20.566 17.503 -6.165 75 4.317488114 23.711 20.625 17.538 -6.174 77 4.33605422 23.766 20.685 17.604 -6.162 78 4.35670827 23.83 20.776 17.701 -6.150 80 4.382026635 23.851 20.776 17.701 -6.161 79 4.369447852 23.834 20.873 17.769 -6.165 81 4.394444155 23.891 20.813 17.759 -6.165 82 4.406719247 23.934 20.862 17.867 -6.162 83 4.418840608 23.982 20.990 17.85 -6.165 84 4.430215726 24.086 20.9963 17.85 -6.200 87 4.465930819 <	69	4.234106505	23.464	20.397	17.33	-6.134	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	70	4.248495242	23.505	20.436	17.366	-6.139	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	71	4.262679877	23.545	20.473	17.401	-6.144	
734.23045944123.63320.55117.469-6.164744.33040509323.66820.56617.503-6.165754.31748811423.71120.62517.538-6.173764.330733423.74320.66617.604-6.162774.34380542223.76320.68517.604-6.162784.35670882723.820.77617.701-6.150804.38202663523.85120.77617.735-6.156814.3944915523.88120.77617.735-6.165824.40671924723.93420.85217.769-6.165834.41884060823.9820.89217.857-6.211844.43081679924.02120.92717.833-6.188854.44265125624.06820.96617.866-6.200874.46590811924.1221.01717.914-6.206884.47733681424.16721.06617.946-6.201904.4986996724.16421.09417.993-6.201914.54028478224.29721.20318.108-6.188924.52178857724.23821.14418.056-6.188934.5325949324.42921.23618.108-6.189944.5432477224.29721.20318.108-6.189954.55387689224.33621.28618.135-6.201964.563461419124.369<	72	4.276666119	23.589	20.512	17.435	-6.154	
74 4.304065093 23.668 20.566 17.503 -6.165 75 4.31748114 23.713 20.656 17.569 -6.174 77 4.34306422 23.763 20.685 17.604 -6.162 78 4.366708827 23.83 20.718 17.608 -6.170 79 4.369447852 23.838 20.776 17.706 -6.150 80 4.382026635 23.851 20.776 17.707 -6.156 82 4.406719247 23.934 20.852 17.789 -6.165 83 4.418840608 23.98 20.890 17.83 -6.180 84 4.430816799 24.021 20.927 17.833 -6.180 85 4.44651256 24.066 20.986 17.886 -6.200 87 4.466908119 24.12 21.017 17.914 -6.201 88 4.47336814 24.151 21.046 17.965 -6.202 90 4.4863637 24.167 21.1066 17.965 -6.201 91 4.510859507 24	73	4.290459441	23.633	20.551	17.469	-6.164	
754.31748811423.71120.62517.538-6.173764.33033323.74320.65617.569-6.174774.34380642223.76620.68517.604-6.162784.35670882723.820.778317.636-6.164794.36944765223.83820.775317.636-6.164794.36944765223.835120.77617.701-6.150804.38202663523.85120.77617.701-6.150814.39444915523.89120.81317.735-6.166824.40671924723.93420.85217.789-6.165834.4184060823.9820.89317.857-6.211844.43081679924.02120.92717.833-6.188854.4425126624.06820.98617.886-6.200874.46590811924.1221.01717.914-6.220884.4773681424.15121.04617.945-6.202904.498096724.19421.09417.993-6.201914.508590724.21821.12018.025-6.188934.5325949324.26121.17118.081-6.189944.54329478224.29721.20318.108-6.189954.55347689224.36221.14418.05-6.189954.55347689224.36221.26718.164-6.205974.57471097924.395	74	4.304065093	23.668	20.586	17.503	-6.165	
76 4.3307334 23.743 20.656 17.669 -6.174 77 4.356708422 23.766 20.685 17.669 -6.162 78 4.356708427 23.8 20.718 17.636 -6.164 79 4.362047852 23.851 20.776 17.701 -6.160 80 4.38202685 23.851 20.776 17.701 -6.165 82 4.406719247 23.934 20.862 17.785 -6.186 84 4.430816799 24.021 20.927 17.837 -6.186 85 4.442526 24.068 20.986 17.857 -6.211 86 4.445347296 24.068 20.986 17.857 -6.211 86 4.447338614 24.151 21.046 17.941 -6.200 87 4.46590819 24.151 21.046 17.941 -6.201 88 4.47338614 24.151 21.046 17.943 -6.201 90 4.58269047 24.28 21.140 18.022 -6.180 92 4.503876892 24.36	75	4.317488114	23.711	20.625	17.538	-6.173	
774.34380542223.76620.68517.604-6.162784.35670882723.820.71817.636-6.164794.36844785223.83120.75317.668-6.170804.38202663523.85120.77617.701-6.150814.39444915523.89120.81317.735-6.166824.40671924723.93420.85217.769-6.165834.41884060823.9820.89017.8-6.188844.43081679924.02120.92717.833-6.188854.44265126624.06820.96317.867-6.211864.4543472624.06220.96317.867-6.211864.45630811924.1221.01717.914-6.206874.46590811924.1221.01717.914-6.206884.47733681424.15721.06617.965-6.202904.4998096724.1821.100417.993-6.201914.51085950724.21821.12018.022-6.186924.52178657724.23821.14418.05-6.188934.53259943324.26121.17118.081-6.180944.5432478224.29721.26718.164-6.205974.574709724.39521.26718.164-6.208984.55847689224.3621.26718.164-6.208994.5951198524.46 <td< td=""><td>76</td><td>4.33073334</td><td>23.743</td><td>20.656</td><td>17.569</td><td>-6.174</td><td></td></td<>	76	4.33073334	23.743	20.656	17.569	-6.174	
78 4.36570827 23.8 20.718 17.636 -6.164 79 4.36944785 23.838 20.753 17.668 -6.170 80 4.382026635 23.851 20.776 17.701 -6.150 81 4.394449155 23.891 20.813 17.735 -6.156 82 4.406719247 23.394 20.852 17.769 -6.165 83 4.418840608 23.98 20.850 17.867 -6.180 84 4.43081679 24.021 20.927 17.837 -6.188 85 4.442651256 24.068 20.963 17.867 -6.211 86 4.442651256 24.068 20.963 17.867 -6.200 87 4.468036919 24.12 21.017 17.941 -6.202 90 4.49803697 24.194 21.094 17.993 -6.201 91 4.51085907 24.218 21.120 18.022 -6.188 92 4.5237682 24.336 21.236 18.108 -6.189 93 4.53376822 24.33	77	4.343805422	23.766	20.685	17.604	-6.162	
79 4.369447852 23.838 20.753 17.668 -6.170 80 4.382026635 23.851 20.776 17.701 -6.150 81 4.384449155 23.891 20.813 17.735 -6.156 82 4.406719247 23.934 20.852 17.789 -6.180 84 4.43081608 23.98 20.927 17.833 -6.180 84 4.430816799 24.021 20.927 17.886 -6.200 87 4.465908119 24.12 21.017 17.914 -6.200 88 4.477336814 24.151 21.066 17.985 -6.202 90 4.49880967 24.18 21.120 18.022 -6.196 91 4.503259432 24.24 21.120 18.022 -6.196 92 4.521788577 24.238 21.144 18.05 -6.189 93 4.532594943 24.297 21.203 18.164 -6.205 94 4.543249472 24.395 21.291 18.187 -6.204 94 4.553876892	78	4.356708827	23.8	20.718	17.636	-6.164	
804.38202683523.85120.77617.701-6.150814.39444915523.89120.81317.735-6.156824.40671924723.93420.85217.769-6.165834.41884060823.9820.89017.83-6.186844.43081679924.02120.92717.833-6.188854.44265125624.06820.96317.867-6.211864.45634729624.08620.98617.887-6.200874.46590811924.1221.01717.914-6.206884.47733681424.15121.04617.941-6.210894.4886363724.16721.09417.993-6.201904.498096724.19421.10418.022-6.196924.52178657724.23821.12018.022-6.188934.5325949324.26121.17118.081-6.180944.5432478224.29721.20318.108-6.180954.55367682224.36921.26718.164-6.205974.57471097924.39521.26718.164-6.205984.58496747924.46221.37518.258-6.2241004.60517018624.49221.37518.258-6.2341014.6150809224.5621.44918.326-6.2341024.62497281324.52921.41618.302-6.2271034.6347298824.61	79	4.369447852	23.838	20.753	17.668	-6.170	
814.3944915523.89120.81317.735-6.165824.40671924723.93420.85217.769-6.165834.4184060823.9820.89017.8-6.180844.43081679924.02120.92717.833-6.180854.4426512624.06820.96317.867-6.211864.45434729624.08620.98617.866-6.200874.46590811924.1221.01717.914-6.200884.47733681424.16121.06617.941-6.202904.4998096724.19421.09417.995-6.202904.4998096724.23821.14018.022-6.196924.52178857724.23821.14418.05-6.188934.53259949324.26121.17118.081-6.189944.54329478224.29721.20318.108-6.189944.56434819124.36921.26718.164-6.205974.5747109724.39521.26718.164-6.208984.58466747924.49221.32118.121-6.217994.5951198524.4621.34818.226-6.2341004.6512051724.50721.39318.279-6.2281024.62497281324.56221.46918.352-6.2341044.64439089924.56621.46918.352-6.2341054.6539603524.619 <td>80</td> <td>4.382026635</td> <td>23.851</td> <td>20.776</td> <td>17.701</td> <td>-6.150</td> <td></td>	80	4.382026635	23.851	20.776	17.701	-6.150	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	81	4.394449155	23.891	20.813	17.735	-6.156	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	82	4.406719247	23.934	20.852	17.769	-6.165	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	83	4.418840608	23.98	20.890	17.8	-6.180	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	84	4.430816799	24.021	20.927	17.833	-6.188	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	85	4.442651256	24.068	20.963	17.857	-6.211	
874.46590811924.1221.01717.914-6.206884.47733681424.15121.04617.941-6.210894.4886363724.16721.06617.965-6.202904.4998096724.19421.09417.993-6.201914.51085950724.21821.12018.022-6.196924.52178857724.23821.14418.05-6.188934.5325949324.26121.17118.081-6.180944.54329478224.29721.20318.108-6.189954.55387689224.33621.23618.135-6.201964.56434819124.36921.26718.164-6.205974.57471097924.39521.29118.187-6.208984.58496747924.42921.32118.212-6.217994.5951198524.4621.34818.236-6.2241004.60517018624.49221.37518.258-6.2341014.61512051724.50721.39318.279-6.2281024.62497281324.56221.44318.326-6.2341044.6443088924.58621.44318.326-6.2341044.6443088924.58621.44918.352-6.2341054.634729424.57018.445-6.2481064.66343909424.68421.52418.399-6.2481074.6242883424.671	86	4.454347296	24.086	20.986	17.886	-6.200	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	87	4.465908119	24.12	21.017	17.914	-6.206	
89 4.48863637 24.167 21.066 17.965 -6.201 90 4.49980967 24.194 21.094 17.993 -6.201 91 4.510859507 24.218 21.120 18.022 -6.196 92 4.521788577 24.238 21.144 18.05 -6.188 93 4.532599493 24.261 21.171 18.081 -6.180 94 4.543294782 24.297 21.203 18.108 -6.180 95 4.553876892 24.336 21.236 18.135 -6.201 96 4.564348191 24.369 21.267 18.164 -6.205 97 4.574710979 24.395 21.291 18.187 -6.208 98 4.584967479 24.429 21.321 18.212 -6.214 100 4.605170186 24.492 21.375 18.258 -6.224 100 4.654728988 24.567 21.443 18.302 -6.224 101 4.618120517 24.529 21.416 18.302 -6.224 102 4.624972813 24.529 21.446 18.352 -6.234 104 4.64339089 24.586 21.497 18.375 -6.248 105 4.65346035 24.619 21.577 18.375 -6.248 106 4.66336035 24.619 21.570 18.445 -6.249 107 4.673248834 24.671 21.577 18.423 -6.249 108 4.682131227 24.684 <td>88</td> <td>4.477336814</td> <td>24.151</td> <td>21.046</td> <td>17.941</td> <td>-6.210</td> <td></td>	88	4.477336814	24.151	21.046	17.941	-6.210	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	89	4.48863637	24.167	21.066	17.965	-6.202	
91 4.510859507 24.218 21.120 18.022 -6.196 92 4.521788577 24.238 21.144 18.05 -6.188 93 4.532599493 24.261 21.171 18.081 -6.180 94 4.543294782 24.297 21.203 18.108 -6.189 95 4.553876892 24.336 21.236 18.135 -6.201 96 4.564348191 24.369 21.267 18.164 -6.205 97 4.574710979 24.395 21.291 18.187 -6.208 98 4.584967479 24.429 21.321 18.212 -6.217 99 4.59511985 24.46 21.348 18.236 -6.224 100 4.605170186 24.492 21.375 18.258 -6.234 101 4.654972813 24.529 21.446 18.326 -6.227 103 4.634728988 24.566 21.443 18.326 -6.234 104 4.64390899 24.586 21.497 18.375 -6.249 105 4.653439094 24.648 21.524 18.399 -6.249 106 4.663439094 24.694 21.570 18.445 -6.249 107 4.624972813 24.671 21.497 18.375 -6.249 106 4.662431227 24.694 21.570 18.445 -6.249 107 4.672828834 24.671 21.547 18.423 -6.248 108 4.682131227 24.694 </td <td>90</td> <td>4.49980967</td> <td>24.194</td> <td>21.094</td> <td>17.993</td> <td>-6.201</td> <td></td>	90	4.49980967	24.194	21.094	17.993	-6.201	
92 4.521788577 24.238 21.144 18.05 -6.188 93 4.532599493 24.261 21.171 18.081 -6.180 94 4.543294782 24.297 21.203 18.108 -6.189 95 4.553876892 24.336 21.236 18.135 -6.201 96 4.564348191 24.369 21.267 18.164 -6.205 97 4.574710979 24.395 21.291 18.187 -6.208 98 4.584967479 24.429 21.375 18.2212 -6.217 99 4.59511985 24.46 21.348 18.236 -6.224 100 4.605170186 24.492 21.375 18.258 -6.234 101 4.615120517 24.507 21.393 18.279 -6.228 102 4.624972813 24.5629 21.446 18.352 -6.234 103 4.634728988 24.56 21.4469 18.352 -6.234 104 4.644390899 24.586 21.4469 18.375 -6.244 105 4.65396035 24.619 21.497 18.375 -6.244 106 4.663439094 24.648 21.524 18.399 -6.249 107 4.67282834 24.671 21.547 18.423 -6.248 108 4.682131227 24.694 21.570 18.445 -6.256 110 4.700480366 24.746 21.617 18.487 -6.256 111 4.72387819 24.825	91	4.510859507	24.218	21.120	18.022	-6.196	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	92	4.521788577	24.238	21.144	18.05	-6.188	
94 4.543294782 24.297 21.203 18.108 -6.189 95 4.553876892 24.336 21.236 18.135 -6.201 96 4.564348191 24.369 21.267 18.164 -6.205 97 4.574710979 24.395 21.291 18.187 -6.208 98 4.584967479 24.429 21.321 18.212 -6.217 99 4.59511985 24.46 21.348 18.236 -6.224 100 4.605170186 24.492 21.375 18.258 -6.234 101 4.615120517 24.507 21.393 18.279 -6.228 102 4.624972813 24.529 21.446 18.302 -6.224 103 4.634728988 24.56 21.443 18.326 -6.234 104 4.644390899 24.586 21.469 18.352 -6.244 105 4.65396035 24.619 21.497 18.375 -6.244 106 4.663439094 24.648 21.524 18.399 -6.249 107 4.672828834 24.671 21.570 18.445 -6.249 108 4.682131227 24.694 21.570 18.445 -6.249 109 4.691347882 24.723 21.595 18.467 -6.256 1110 4.700480366 24.746 21.677 18.528 -6.297 1113 4.727387819 24.825 21.677 18.528 -6.297 1113 4.727387819 $24.$	93	4.532599493	24.261	21.171	18.081	-6.180	
95 4.553876892 24.336 21.236 18.135 -6.201 96 4.564348191 24.369 21.267 18.164 -6.205 97 4.574710979 24.395 21.291 18.187 -6.208 98 4.584967479 24.429 21.321 18.212 -6.217 99 4.59511985 24.46 21.348 18.236 -6.224 100 4.605170186 24.492 21.375 18.258 -6.234 101 4.615120517 24.507 21.393 18.279 -6.228 102 4.624972813 24.529 21.416 18.302 -6.234 103 4.634728988 24.56 21.443 18.326 -6.234 104 4.64390899 24.566 21.4497 18.375 -6.244 105 4.65396035 24.619 21.497 18.375 -6.244 106 4.663439094 24.648 21.524 18.399 -6.249 107 4.672828834 24.671 21.547 18.423 -6.248 108 4.682131227 24.694 21.570 18.445 -6.249 109 4.691347882 24.723 21.595 18.667 -6.256 110 4.70480366 24.746 21.617 18.528 -6.297 111 4.72387819 24.85 21.698 18.545 -6.305 1114 4.736198448 24.88 21.723 18.565 -6.315 1115 4.744932128 24.948	94	4.543294782	24.297	21.203	18.108	-6.189	
96 4.564348191 24.369 21.267 18.164 -6.205 97 4.574710979 24.395 21.291 18.187 -6.208 98 4.584967479 24.429 21.321 18.212 -6.217 99 4.59511985 24.46 21.348 18.236 -6.224 100 4.605170186 24.492 21.375 18.258 -6.234 101 4.615120517 24.507 21.393 18.279 -6.228 102 4.624972813 24.529 21.416 18.302 -6.227 103 4.634728988 24.56 21.443 18.326 -6.234 104 4.644390899 24.586 21.469 18.352 -6.234 105 4.65396035 24.619 21.497 18.375 -6.244 106 4.663439094 24.648 21.524 18.399 -6.249 107 4.672828834 24.671 21.547 18.423 -6.248 108 4.682131227 24.694 21.570 18.445 -6.248 109 4.691347882 24.723 21.595 18.467 -6.256 110 4.70480366 24.746 21.617 18.528 -6.287 111 4.727387819 24.85 21.698 18.545 -6.305 1114 4.736198448 24.88 21.723 18.565 -6.315 115 4.74932128 24.901 21.744 18.565 -6.322 117 <	95	4.553876892	24.336	21.236	18.135	-6.201	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	96	4.564348191	24.369	21.267	18.164	-6.205	
98 4.584967479 24.429 21.321 18.212 -6.217 99 4.59511985 24.46 21.348 18.236 -6.224 100 4.605170186 24.492 21.375 18.258 -6.234 101 4.615120517 24.507 21.393 18.279 -6.228 102 4.624972813 24.529 21.416 18.302 -6.227 103 4.634728988 24.56 21.443 18.326 -6.234 104 4.644390899 24.586 21.443 18.326 -6.234 105 4.65396035 24.619 21.497 18.375 -6.244 106 4.663439094 24.648 21.524 18.399 -6.249 107 4.672828834 24.671 21.547 18.423 -6.249 108 4.682131227 24.694 21.570 18.445 -6.249 109 4.691347882 24.723 21.595 18.467 -6.256 110 4.700480366 24.746 21.617 18.487 -6.259 111 4.709530201 24.925 21.652 18.508 -6.287 1112 4.718498871 24.825 21.677 18.528 -6.297 113 4.727387819 24.85 21.698 18.545 -6.305 114 4.736198448 24.88 21.723 18.565 -6.315 115 4.744932128 24.901 21.744 18.605 -6.322 116 4.770684624 $24.$	97	4.574710979	24.395	21.291	18.187	-6.208	
99 4.59511985 24.46 21.348 18.236 -6.224 100 4.605170186 24.492 21.375 18.258 -6.234 101 4.615120517 24.507 21.393 18.279 -6.228 102 4.624972813 24.529 21.416 18.302 -6.227 103 4.634728988 24.529 21.443 18.326 -6.234 104 4.644390899 24.586 21.469 18.352 -6.234 105 4.65396035 24.619 21.497 18.375 -6.249 106 4.663439094 24.648 21.524 18.399 -6.249 107 4.672828834 24.671 21.570 18.445 -6.249 108 4.682131227 24.694 21.570 18.445 -6.249 109 4.691347882 24.723 21.595 18.467 -6.256 110 4.700480366 24.746 21.617 18.487 -6.256 111 4.709530201 24.795 21.652 18.508 -6.287 112 4.718498871 24.825 21.677 18.528 -6.297 113 4.727387819 24.88 21.723 18.565 -6.315 114 4.736198448 24.88 21.723 18.665 -6.315 115 4.74932128 24.948 21.787 18.605 -6.320 117 4.70284624 24.971 21.807 18.643 -6.328	98	4.584967479	24.429	21.321	18.212	-6.217	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	99	4.59511985	24.46	21.348	18.236	-6.224	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	100	4.605170186	24.492	21.375	18.258	-6.234	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	101	4.615120517	24.507	21.393	18.279	-6.228	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	102	4.624972813	24.529	21.416	18.302	-6.227	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	103	4.634728988	24.56	21.443	18.326	-6.234	
105 4.65396035 24.619 21.497 18.375 -6.244 106 4.663439094 24.648 21.524 18.399 -6.249 107 4.672828834 24.671 21.547 18.423 -6.248 108 4.682131227 24.694 21.570 18.445 -6.249 109 4.691347882 24.723 21.595 18.467 -6.256 110 4.700480366 24.746 21.617 18.487 -6.259 111 4.709530201 24.795 21.652 18.508 -6.287 112 4.718498871 24.825 21.677 18.528 -6.297 113 4.727387819 24.85 21.698 18.545 -6.305 114 4.736198448 24.901 21.744 18.586 -6.315 115 4.744932128 24.901 21.765 18.605 -6.320 117 4.762173935 24.948 21.787 18.626 -6.328 118 4.770684624 24.971 21.807 18.643 -6.328	104	4.644390899	24.586	21.469	18.352	-6.234	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	105	4.65396035	24.619	21.497	18.375	-6.244	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	106	4.663439094	24.648	21.524	18.399	-6.249	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	107	4.672828834	24.671	21.547	18.423	-6.248	
1094.69134788224.72321.59518.467-6.2561104.70048036624.74621.61718.487-6.2591114.70953020124.79521.65218.508-6.2871124.71849887124.82521.67718.528-6.2971134.72738781924.8521.69818.545-6.3051144.73619844824.8821.72318.565-6.3151154.74493212824.90121.74418.586-6.3151164.75359019124.92521.76518.605-6.3201174.76217393524.94821.78718.626-6.3221184.77068462424.97121.80718.643-6.328	108	4.682131227	24.694	21.570	18.445	-6.249	
110 4.700480366 24.746 21.617 18.487 -6.259 111 4.709530201 24.795 21.652 18.508 -6.287 112 4.718498871 24.825 21.677 18.528 -6.297 113 4.727387819 24.85 21.698 18.545 -6.305 114 4.736198448 24.88 21.723 18.565 -6.315 115 4.744932128 24.901 21.744 18.586 -6.315 116 4.753590191 24.925 21.765 18.605 -6.320 117 4.762173935 24.948 21.787 18.626 -6.322 118 4.770684624 24.971 21.807 18.643 -6.328	109	4.691347882	24.723	21.595	18.467	-6.256	
111 4.709530201 24.795 21.652 18.508 -6.287 112 4.718498871 24.825 21.677 18.528 -6.297 113 4.727387819 24.85 21.698 18.545 -6.305 114 4.736198448 24.88 21.723 18.565 -6.315 115 4.744932128 24.901 21.744 18.586 -6.315 116 4.753590191 24.925 21.765 18.605 -6.320 117 4.762173935 24.948 21.787 18.626 -6.322 118 4.770684624 24.971 21.807 18.643 -6.328	110	4.700480366	24.746	21.617	18.487	-6.259	
112 4.718498871 24.825 21.677 18.528 -6.297 113 4.727387819 24.85 21.698 18.545 -6.305 114 4.736198448 24.88 21.723 18.565 -6.315 115 4.744932128 24.901 21.744 18.586 -6.315 116 4.753590191 24.925 21.765 18.605 -6.320 117 4.762173935 24.948 21.787 18.626 -6.322 118 4.770684624 24.971 21.807 18.643 -6.328	111	4.709530201	24.795	21.652	18.508	-6.287	
113 4.727387819 24.85 21.698 18.545 -6.305 114 4.736198448 24.88 21.723 18.565 -6.315 115 4.744932128 24.901 21.744 18.586 -6.315 116 4.753590191 24.925 21.765 18.605 -6.320 117 4.762173935 24.948 21.787 18.626 -6.322 118 4.770684624 24.971 21.807 18.643 -6.328	112	4,718498871	24.825	21.677	18.528	-6.297	
110 11121001010 121000 11000 101010 0.0000 114 4.736198448 24.88 21.723 18.565 -6.315 115 4.744932128 24.901 21.744 18.586 -6.315 116 4.753590191 24.925 21.765 18.605 -6.320 117 4.762173935 24.948 21.787 18.626 -6.322 118 4.770684624 24.971 21.807 18.643 -6.328	113	4 727387819	24 85	21.698	18 545	-6.305	
115 4.744932128 24.901 21.744 18.586 -6.315 116 4.753590191 24.925 21.765 18.605 -6.320 117 4.762173935 24.948 21.787 18.626 -6.322 118 4.770684624 24.971 21.807 18.643 -6.328	114	4.736198448	24.88	21.723	18.565	-6.315	
116 4.753590191 24.925 21.765 18.605 -6.320 117 4.762173935 24.948 21.787 18.626 -6.322 118 4.770684624 24.971 21.807 18.643 -6.328	115	4,744932128	24 901	21 744	18 586	-6 315	
117 4.762173935 24.948 21.787 18.626 -6.322 118 4.770684624 24.971 21.807 18.643 -6.328	116	4 753590191	24 925	21 765	18 605	-6.320	
118 4.770684624 24.971 21.807 18.643 -6.328	117	4.762173935	24.948	21.787	18.626	-6.322	
	118	4,770684624	24 971	21 807	18 643	-6.328	
119 4.779123493 24.99 21.827 18.663 -6.327	119	4.779123493	24.99	21.827	18.663	-6.327	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
	()		•		•	
120	4 787491743	25.01	21 848	18 686	-6 324	
121	4 795790546	25.033	21.866	18 698	-6.335	
121	4.804021045	25.000	21.867	18.697	-6 340	
122	4 812184355	25.037	21.867	18 697	-6 340	
123	4.820281566	25.037	21.007	18.607	-6.340	
124	4.020201300	25.037	21.007	19,607	6 3 4 0	
125	4.020313737	25.037	21.007	18.607	6 3 4 0	
120	4.030201907	25.037	21.007	10.097	-0.340	
127	4.044107000	25.037	21.007	18.697	6 3 4 0	
120	4.052030204	25.037	21.007	10.097	-0.340	
129	4.009012404	25.037	21.007	10.097	-0.340	
130	4.00703440	25.037	21.007	10.097	-0.340	
131	4.075197323	25.037	21.007	10.097	-0.340	
132	4.002001923	25.037	21.007	10.097	-0.340	
133	4.890349128	25.135	21.963	18.79	-0.345	
134	4.8978398	25.33	22.142	18.953	-0.377	
135	4.905274778	25.30	22.167	18.974	-0.380	
136	4.912654886	25.38	22.186	18.991	-6.389	
137	4.919980926	25.399	22.203	19.007	-6.392	
138	4.927253685	25.409	22.216	19.022	-6.387	
139	4.934473933	25.434	22.237	19.039	-6.395	
140	4.941642423	25.45	22.253	19.056	-6.394	
141	4.94875989	25.467	22.272	19.076	-6.391	
142	4.955827058	25.488	22.290	19.091	-6.397	
143	4.96284463	25.501	22.305	19.109	-6.392	
144	4.9698133	25.527	22.327	19.127	-6.400	
145	4.976733742	25.553	22.349	19.144	-6.409	
146	4.983606622	25.57	22.365	19.16	-6.410	
147	4.990432587	25.596	22.386	19.176	-6.420	
148	4.997212274	25.629	22.410	19.19	-6.439	
149	5.003946306	25.648	22.426	19.203	-6.445	
150	5.010635294	25.66	22.439	19.217	-6.443	
151	5.017279837	25.678	22.455	19.232	-6.446	
152	5.023880521	25.692	22.469	19.246	-6.446	
153	5.030437921	25.705	22.483	19.26	-6.445	
154	5.036952602	25.724	22.501	19.277	-6.447	
155	5.043425117	25.742	22.517	19.292	-6.450	
156	5.049856007	25.758	22.535	19.311	-6.447	
157	5.056245805	25.772	22.549	19.326	-6.446	
158	5.062595033	25.785	22.563	19.341	-6.444	
159	5.068904202	25.791	22.574	19.357	-6.434	
160	5.075173815	25.806	22.590	19.374	-6.432	
161	5.081404365	25.826	22.606	19.386	-6.440	
162	5.087596335	25.832	22.616	19.4	-6.432	
163	5.093750201	25.853	22.634	19.414	-6.439	
164	5.099866428	25.875	22.652	19.429	-6.446	
165	5.105945474	25.89	22.668	19.445	-6.445	
166	5.111987788	25.897	22.678	19.458	-6.439	
167	5.117993812	25.906	22.689	19.471	-6.435	
168	5.123963979	25.94	22.712	19.484	-6.456	
169	5.129898715	25.96	22.727	19.493	-6.467	
170	5.135798437	25.972	22.739	19.506	-6.466	
171	5.141663557	25.991	22.754	19.517	-6.474	
172	5.147494477	26.016	22.774	19.532	-6.484	
173	5.153291594	26.025	22.785	19.544	-6.481	
174	5.159055299	26.046	22.801	19.556	-6.490	
175	5.164785974	26.089	22.828	19.567	-6.522	
176	5.170483995	26.103	22.841	19.578	-6.525	
177	5.176149733	26.115	22.853	19.591	-6.524	
178	5.18178355	26.124	22.864	19.604	-6.520	
179	5.187385806	26.129	22.874	19.618	-6.511	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	°C	°C	°C	
Wintates		0	0	U	0	
180	5 102056851	26 152	22 803	10.634	-6 518	
191	5 109/07021	20.132	22.095	10.649	-0.510	
101	5.190497031	20.170	22.912	10.66	-0.520	
102	5.204000007	20.190	22.920	19.00	-0.550	
183	5.209486153	26.213	22.943	19.673	-6.540	
184	5.214935758	26.232	22.960	19.688	-6.544	
185	5.220355825	26.238	22.971	19.704	-6.534	
186	5.225746674	26.241	22.978	19.715	-6.526	
187	5.231108617	26.261	22.993	19.725	-6.536	
188	5.236441963	26.273	23.005	19.736	-6.537	
189	5.241747015	26.306	23.027	19.748	-6.558	
190	5.247024072	26.328	23.045	19.762	-6.566	
191	5.252273428	26.343	23.059	19.775	-6.568	
192	5.257495372	26.357	23.072	19.787	-6.570	
193	5.262690189	26.37	23.086	19.801	-6.569	
194	5.267858159	26.383	23.097	19.811	-6.572	
195	5.272999559	26.391	23.106	19.821	-6.570	
196	5.278114659	26.406	23.119	19.832	-6.574	
197	5.283203729	26.418	23.132	19.846	-6.572	
198	5.288267031	26.431	23.145	19.859	-6.572	
199	5 293304825	26 441	23 157	19 872	-6 569	
200	5 298317367	26 461	23 174	19.886	-6 575	
200	5 30330/008	26.475	23.174	10.000	-6 576	
201	5 308267607	20.473	23.107	10.013	-6.578	
202	5.300207097	20.491	23.202	10.024	-0.570	
203	5.313203979	20.499	23.212	19.924	-0.373	
204	5.316119994	20.513	23.225	19.930	-0.577	
205	5.323009979	26.54	23.243	19.946	-6.594	
206	5.32/8/6169	26.551	23.255	19.958	-6.593	
207	5.332/18/93	26.565	23.268	19.971	-6.594	
208	5.33753808	26.578	23.279	19.979	-6.599	
209	5.342334252	26.592	23.293	19.993	-6.599	
210	5.347107531	26.603	23.305	20.006	-6.597	
211	5.351858133	26.617	23.318	20.018	-6.599	
212	5.356586275	26.62	23.324	20.028	-6.592	
213	5.361292166	26.628	23.333	20.038	-6.590	
214	5.365976015	26.638	23.347	20.055	-6.583	
215	5.370638028	26.657	23.362	20.066	-6.591	
216	5.375278408	26.666	23.371	20.076	-6.590	
217	5.379897354	26.682	23.388	20.093	-6.589	
218	5.384495063	26.695	23.399	20.102	-6.593	
219	5.38907173	26.706	23.411	20.115	-6.591	
220	5.393627546	26.721	23.424	20.127	-6.594	
221	5.398162702	26.73	23,434	20.138	-6.592	
222	5.402677382	26.742	23.446	20.149	-6.593	
223	5.407171771	26.756	23.458	20.16	-6.596	
224	5 411646052	26 767	23 469	20 171	-6 596	
225	5 416100402	26 776	23 479	20 182	-6 594	
226	5 420534999	26 791	23 492	20.102	-6 598	
220	5 424950017	26.806	23 505	20.100	-6 602	
221	5 429345620	26.816	23.516	20.204	-6 601	
220	5 422722004	20.010	23.510	20.213	-0.001	
223	5 /22070200	20.024	23.020	20.220	-0.090	
230	5.430079309	20.039	23.000	20.231	-0.002	
231	5.442417711	20.070	23.003	20.249	800.0-	
232	5.446/3/3/2	20.8/3	23.566	20.259	-0.014	
233	5.451038454	26.881	23.5/5	20.269	-6.612	
234	5.455321115	26.892	23.586	20.279	-6.613	
235	5.459585514	26.896	23.593	20.289	-6.607	
236	5.463831805	26.908	23.604	20.299	-6.609	
237	5.468060141	26.916	23.614	20.311	-6.605	
238	5.472270674	26.934	23.628	20.322	-6.612	
239	5.476463552	26.942	23.637	20.331	-6.611	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
240	5.480638923	26.956	23.650	20.343	-6.613	
241	5.484796933	26.969	23.660	20.351	-6.618	
242	5.488937726	26.979	23.671	20.363	-6.616	
243	5.493061443	26.991	23.682	20.372	-6.619	
244	5.497168225	26.999	23.691	20.382	-6.617	
245	5.501258211	27.013	23.703	20.393	-6.620	
246	5.505331536	27.018	23.710	20.401	-6.617	
247	5.509388337	27.03	23.721	20.412	-6.618	
248	5.513428746	27.045	23.734	20.423	-6.622	
249	5.517452896	27.052	23.742	20.432	-6.620	
250	5.521460918	27.065	23.753	20.441	-6.624	
251	5.525452939	27.077	23.764	20.451	-6.626	
252	5.529429088	27.084	23.772	20.46	-6.624	
253	5.533389489	27.094	23.782	20.47	-6.624	
254	5.537334267	27.103		20.48	-6.623	
255	5.541263545	27.116	23.804	20.491	-6.625	
256	5.545177444	27.129	23.815	20.501	-6.628	
257	5.549076085	27.138	23.824	20.51	-6.628	
258	5,552959585	27.151	23.836	20.521	-6.630	
259	5.556828062	27.159	23.845	20.531	-6.628	
260	5,560681631	27.165	23.852	20.539	-6.626	
261	5.564520407	27.177	23.864	20.55	-6.627	
262	5.568344504	27.19	23.875	20.559	-6.631	
263	5.572154032	27.199	23.885	20.57	-6.629	
264	5 575949103	27 213	23 895	20.577	-6 636	
265	5 579729826	27 225	23 907	20.588	-6 637	
266	5.583496309	27.23	23.913	20.596	-6.634	
267	5 587248658	27 245	23.926	20.606	-6 639	
268	5 590986981	27 253	23 934	20.614	-6 639	
269	5 59471138	27 265	23 944	20.623	-6 642	
270	5 598421959	27 276	23 954	20.632	-6 644	
271	5 602118821	27 281	23.960	20.639	-6 642	
277	5.605802066	27.201	23.000	20.000	-6 642	
272	5.609471795	27 302	23.980	20.658	-6 644	
270	5 613128106	27.302	23,990	20.668	-6 643	
275	5.616771098	27.319	23.000	20.000	-6 642	
276	5.620400866	27.313	23.330	20.077	-6.649	
270	5.624017506	27.334	24.010	20.000	-6.648	
278	5.627621114	27.342	24.010	20.094	-6.651	
270	5.621021114	27.352	24.027	20.701	-6.648	
213	5.634780603	27.333	24.035	20.711	-6.651	
200	5.639354660	27.371	24.040	20.72	-0.051	
201	5.030334009	27.379	24.054	20.729	-0.050	
202	5.041907071	27.307	24.002	20.737	-0.000	
203	5.043440696	27.397	24.071	20.745	-0.032	
204	5.0409/4230	27.403	24.079	20.754	-0.049	
200	5.05240910	27.413	24.000	20.763	-0.000	
200	5.055991011	27.423	24.097	20.771	-0.032	
207	5.059462210	27.435	24.100	20.70	-0.000	
288	5.66296048	27.448	24.119	20.789	-0.059	
289	5.666426688	27.456	24.126	20.796	-6.660	
290	5.669880923	27.462	24.133	20.803	-6.659	
291	5.673323267	27.467	24.140	20.812	-6.655	
292	5.676753802	27.46	24.141	20.821	-6.639	
293	5.680172609	27.467	24.148	20.829	-6.638	
294	5.6835/9/6/	27.472	24.156	20.839	-6.633	
295	5.686975356	27.484	24.167	20.849	-6.635	
296	5.690359454	27.491	24.175	20.859	-6.632	
297	5.693732139	27.505	24.188	20.87	-6.635	
298	5.697093487	27.512	24.195	20.877	-6.635	
299	5.700443573	27.523	24.206	20.888	-6.635	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	ଂଠ	°C	°C	
- Miniatoo		0	•		•	
200	E 70270247E	27 527	24.216	20.904	6 6 4 2	
300	5.703762475	27.337	24.210	20.694	-0.043	
301	5.707110265	27.545	24.223	20.901	-6.644	
302	5.710427017	27.552	24.230	20.907	-6.645	
303	5.713732806	27.56	24.238	20.915	-6.645	
304	5.717027701	27.576	24.249	20.922	-6.654	
305	5.720311777	27.586	24.258	20.93	-6.656	
306	5,723585102	27,596	24,267	20.937	-6.659	
307	5 726847748	27 602	24 273	20 944	-6 658	
308	5 730000783	27.611	24.282	20.011	-6 659	
300	5.730033703	27.011	24.202	20.952	-0.059	
309	5.755541277	27.010	24.209	20.959	-0.039	
310	5.736572297	27.62	24.294	20.967	-6.653	
311	5.739792912	27.626	24.300	20.974	-6.652	
312	5.743003188	27.636	24.310	20.983	-6.653	
313	5.746203191	27.641	24.316	20.991	-6.650	
314	5.749392986	27.65	24.325	20.999	-6.651	
315	5,752572639	27.66	24.335	21.009	-6.651	
316	5 755742214	27 671	24 343	21.015	-6 656	
317	5 758001774	27.683	24.040	21.010	-6 650	
210	5.756901774	27.003	24.354	21.024	-0.059	
318	5.762051383	27.691	24.362	21.032	-6.659	
319	5.765191103	27.695	24.368	21.04	-6.655	
320	5.768320996	27.702	24.374	21.046	-6.656	
321	5.771441123	27.705	24.379	21.053	-6.652	
322	5.774551546	27.713	24.387	21.061	-6.652	
323	5.777652323	27.717	24.392	21.067	-6.650	
324	5 780743516	27 733	24 405	21.076	-6 657	
325	5 783825182	27.744	21.100	21.070	-6 660	
325	5 796907291	27.755	24.414	21.004	-0.000	
320	5.700097301	21.155	24.424	21.093	-0.002	
327	5.789960171	27.767	24.434	21.101	-0.000	
328	5.793013608	27.771	24.439	21.107	-6.664	
329	5.796057751	27.782	24.449	21.115	-6.667	
330	5.799092654	27.783	24.453	21.123	-6.660	
331	5.802118375	27.791	24.459	21.127	-6.664	
332	5.805134969	27.798	24.466	21.134	-6.664	
333	5.80814249	27.812	24.478	21.144	-6.668	
334	5 811140993	27 817	24 484	21 151	-6 666	
225	5 91/120522	27.017	24.404	21.101	6.664	
226	5.014130332	27.023	24.491	21.155	-0.004	
330	5.0000000	27.033	24.500	21.100	-0.007	
337	5.82008293	27.842	24.509	21.176	-6.666	
338	5.823045895	27.845	24.514	21.182	-6.663	
339	5.826000107	27.853	24.522	21.191	-6.662	
340	5.828945618	27.862	24.529	21.195	-6.667	
341	5.831882477	27.869	24.537	21.205	-6.664	
342	5.834810737	27.876	24.545	21.214	-6.662	
343	5 837730447	27 882	24 550	21 218	-6 664	
344	5 840641657	27.805	24.562	21.210	-6 667	
245	5.040041037	27.095	24.502	21.220	-0.007	
343	5.043344417	27.902	24.370	21.237	-0.005	
346	5.846438775	27.911	24.578	21.244	-6.667	
347	5.84932478	27.915	24.582	21.249	-6.666	
348	5.85220248	27.923	24.590	21.256	-6.667	
349	5.855071922	27.927	24.595	21.263	-6.664	
350	5.857933154	27.937	24.604	21.27	-6.667	
351	5.860786223	27.941	24.610	21.278	-6.663	
352	5 863631176	27 95	24 618	21 285	-6 665	
353	5 866/68057	27.06	21.010	21.200	2000.0 200 A_	
333 254	5 960206042	27.30	24.020	21.292	-0.000 6 677	
304	0.009290913	21.911	24.039	21.3	-0.077	
355	5.8/211//89	27.99	24.648	21.306	-0.684	
356	5.874930731	27.993	24.653	21.313	-6.680	
357	5.877735782	27.993	24.657	21.321	-6.672	
358	5.880532986	27.999	24.663	21.326	-6.673	
359	5.883322388	28.013	24.672	21.331	-6.682	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
	, , ,					
360	5.886104031	28.023	24.680	21.337	-6.686	
361	5.888877958	28.026	24.685	21.343	-6.683	
362	5.891644212	28.022	24.687	21.351	-6.671	
363	5.894402834	28.031	24.696	21.36	-6.671	
364	5.897153868	28.044	24.707	21.369	-6.675	
365	5.899897354	28.047	24.712	21.376	-6.671	
366	5.902633333	28.056	24.719	21.381	-6.675	
367	5.905361848	28.066	24.727	21.388	-6.678	
368	5.908082938	28.071	24.734	21.396	-6.675	
369	5.910796644	28.085	24.745	21.404	-6.681	
370	5.913503006	28.086	24.748	21.41	-6.676	
371	5.916202063	28.092	24.753	21.414	-6.678	
372	5.918893854	28.094	24.758	21.421	-6.673	
373	5.92157842	28.103	24.766	21.428	-6.675	
374	5.924255797	28.108	24.772	21.435	-6.673	
375	5.926926026	28.115	24.778	21.441	-6.674	
376	5.929589143	28.064	24.757	21.449	-6.615	
377	5.932245187	28.041	24.751	21.46	-6.581	
378	5.934894196	28.055	24.765	21.474	-6.581	
379	5.937536205	28.06	24.773	21.485	-6.575	
380	5.940171253	28.053	24.776	21.498	-6.555	
381	5.942799375	28.065	24.787	21.508	-6.557	
382	5.945420609	28.079	24.800	21.521	-6.558	
383	5.948034989	28.091	24.813	21.534	-6.557	
384	5.950642553	28.102	24.823	21.544	-6.558	
385	5.953243334	28.103	24.825	21.547	-6.556	
386	5.955837369	28.076	24.813	21.55	-6.526	
387	5.958424693	28.088	24.824	21.559	-6.529	
388	5.96100534	28.094	24.831	21.567	-6.527	
389	5.963579344	28.098	24.836	21.573	-6.525	
390	5.966146739	28.097	24.838	21.578	-6.519	
391	5.96870756	28.112	24.851	21.589	-6.523	
392	5.97126184	28.12	24.859	21.597	-6.523	
393	5.973809612	28.128	24.867	21.606	-6.522	
394	5.976350909	28.129	24.870	21.61	-6.519	
395	5.978885765	28.126	24.869	21.611	-6.515	
396	5.981414211	28.139	24.879	21.618	-6.521	
397	5.983936281	28.155	24.891	21.626	-6.529	
398	5.986452005	28.159	24.895	21.631	-6.528	
399	5.988961417	28.159	24.898	21.636	-6.523	
400	5.991464547	28.17	24.906	21.642	-6.528	
401	5.993961427	28.179	24.915	21.65	-6.529	
402	5.996452089	28.184	24.919	21.654	-6.530	
403	5.998936562	28.192	24.926	21.659	-6.533	
404	6.001414878	28.198	24.931	21.664	-6.534	
405	6.003887067	28.202	24.937	21.671	-6.531	
406	6.00635316	28.21	24.943	21.675	-6.535	
407	6.008813185	28.213	24.947	21.681	-6.532	
408	6.011267174	28.222	24.955	21.687	-6.535	
409	6.013715156	28.236	24.965	21.694	-6.542	
410	6.01615716	28.245	24.972	21.699	-6.546	
411	6.018593214	28.249	24.978	21.707	-6.542	
412	6.021023349	28.254	24.982	21.71	-6.544	
413	6.023447593	28.257	24.986	21.715	-6.542	
414	6.025865974	28.266	24.993	21.719	-6.547	
415	6.02827852	28.274	25.000	21.725	-6.549	
416	6.03068526	28.278	25.004	21.729	-6.549	
417	6.033086222	28.279	25.008	21.736	-6.543	
418	6.035481433	28.282	25.013	21.743	-6.539	
419	6.03787092	28.299	25.025	21.751	-6.548	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
420	6.040254711	28.311	25.035	21.758	-6.553	
421	6.042632834	28.298	25.031	21.764	-6.534	
422	6.045005314	28.257	25.014	21.771	-6.486	
423	6.047372179	28.23	25.006	21.781	-6.449	
424	6.049733455	28.237	25.016	21.794	-6.443	
425	6.052089169	28.248	25.026	21.804	-6.444	
426	6.054439346	28.259	25.038	21.816	-6.443	
427	6.056784013	28.275	25.050	21.824	-6.451	
428	6.059123196	28.284	25.061	21.838	-6.446	
429	6.061456919	28.287	25.068	21.849	-6.438	
430	6.063785209	28.254	25.056	21.858	-6.396	
431	6.06610809	28.257	25.060	21.862	-6.395	
432	6.068425588	28.263	25.064	21.864	-6.399	
433	6.070737728	28.264	25.068	21.872	-6.392	
434	6.073044534	28.271	25.076	21.88	-6.391	
435	6.075346031	28.235	25.062	21.889	-6.346	
436	6.077642243	28.235	25.068	21.9	-6.335	
437	6.079933195	28.251	25.082	21.913	-6.338	
438	6 08221891	28 258	25 090	21 921	-6.337	
439	6 084499413	28 254	25 091	21.927	-6.327	
440	6 086774727	28 266	25 100	21 933	-6.333	
441	6 089044875	28 278	25 109	21.94	-6.338	
442	6 091309882	28 279	25 113	21.947	-6.332	
442	6.00356077	28.203	25.113	21.047	-6 340	
443	6.005824562	20.295	25.125	21.905	-6.341	
444	6.09074292	20.290	25.120	21.955	6 22/	
445	6 100218052	20.293	25.120	21.959	6 2 2 9	
440	0.100310932	20.302	20.100	21.904	-0.330	
447	6.102558595	28.325	25.147	21.969	-0.350	
448	6.104793232	28.333	25.152	21.97	-6.363	
449	6.107022888	28.349	25.162	21.975	-6.374	
450	6.109247583	28.366	25.173	21.979	-6.387	
451	6.11146734	28.354	25.168	21.982	-6.372	
452	6.11368218	28.361	25.175	21.989	-6.372	
453	6.115892125	28.374	25.184	21.994	-6.380	
454	6.118097198	28.379	25.188	21.996	-6.383	
455	6.120297419	28.389	25.194	21.999	-6.390	
456	6.12249281	28.396	25.200	22.003	-6.393	
457	6.124683391	28.407	25.207	22.007	-6.400	
458	6.126869184	28.409	25.212	22.015	-6.394	
459	6.12905021	28.422	25.220	22.018	-6.404	
460	6.131226489	28.424	25.222	22.019	-6.405	
461	6.133398043	28.424	25.224	22.023	-6.401	
462	6.135564891	28.436	25.232	22.028	-6.408	
463	6.137727054	28.448	25.242	22.035	-6.413	
464	6.139884552	28.458	25.250	22.041	-6.417	
465	6.142037406	28.462	25.252	22.041	-6.421	
466	6.144185634	28.464	25.255	22.046	-6.418	
467	6.146329258	28.473	25.261	22.048	-6.425	
468	6.148468296	28.477	25.267	22.056	-6.421	
469	6.150602768	28.48	25.269	22.058	-6.422	
470	6.152732695	28.494	25.278	22.061	-6.433	
471	6.154858094	28.499	25.283	22.067	-6.432	
472	6.156978986	28.509	25.290	22.07	-6.439	
473	6,159095388	28.514	25,295	22.075	-6.439	
474	6 161207322	28 519	25 299	22 079	-6 440	
475	6 163314804	28 528	25 305	22.082	-6 446	
476	6 165417854	28.53	25 308	22.002	-6 444	
470	6 167516491	28 545	25 318	22.000	-6 455	
478	6 169610732	28 561	25 327	22.00	-6 468	
	6 171700507	28 571	25 323	22.035	-6 477	
	0.1111000001	20.071	20.000	22.004	0.711	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	ଂମ	°C.	°C.	
Williacos		0	0		0	
480	6 173786104	28 573	25 336	22.099	-6 474	
481	6 17586727	28 581	25.330	22.000	-6 481	
482	6 177944114	28 584	25.345	22.1	-6 479	
402	6 180016654	28.504	25.343	22.100	-6.486	
403	6 182084007	20.090	25.352	22.103	-6.403	
404	6 18/1/8891	28.613	25.350	22.111	-6.500	
486	6 186208624	28.612	25.366	22.113	-6.00	
480	6 18826/123	20.012	25.300	22.12	-6.492	
407	6 100315406	20.02	25.372	22.123	-6.497	
400	6 102262490	20.023	25.370	22.120	-0.495	
409	6 104405201	20.023	25.377	22.131	-0.492	
490	6 106444129	20.032	25.300	22.139	-0.493	
491	6 109444120	20.037	20.091	22.144	-0.493	
492	0.1904/0/10	20.040	20.090	22.149	-0.497	
493	0.200509174	20.052	25.402	22.152	-0.300	
494	0.202030017	28.000	25.407	22.158	-6.497	
495	0.204007703	20.000	20.411	22.103	-0.495	
496	6.206575927	28.663	25.415	22.167	-6.496	
497	6.208590026	28.668	25.419	22.17	-6.498	
498	6.210600077	28.677	25.426	22.175	-6.502	
499	6.212606096	28.686	25.433	22.179	-6.507	
500	6.214608098	28.706	25.445	22.183	-6.523	
501	6.216606101	28.712	25.450	22.187	-6.525	
502	6.21860012	28.719	25.455	22.191	-6.528	
503	6.22059017	28.721	25.457	22.192	-6.529	
504	6.222576268	28.73	25.463	22.196	-6.534	
505	6.224558429	28.732	25.466	22.2	-6.532	
506	6.226536669	28.721	25.461	22.201	-6.520	
507	6.228511004	28.724	25.466	22.208	-6.516	
508	6.230481448	28.733	25.473	22.212	-6.521	
509	6.232448017	28.743	25.481	22.218	-6.525	
510	6.234410726	28.739	25.482	22.225	-6.514	
511	6.23636959	28.748	25.490	22.232	-6.516	
512	6.238324625	28.757	25.498	22.238	-6.519	
513	6.240275845	28.766	25.504	22.242	-6.524	
514	6.242223265	28.779	25.514	22.249	-6.530	
515	6.244166901	28.783	25.518	22.253	-6.530	
516	6.246106765	28.789	25.523	22.256	-6.533	
517	6.248042875	28.792	25.526	22.26	-6.532	
518	6.249975242	28.796	25.531	22.265	-6.531	
519	6.251903883	28.796	25.532	22.268	-6.528	
520	6.253828812	28.795	25.534	22.272	-6.523	
521	6.255750042	28.798	25.537	22.275	-6.523	
522	6.257667588	28.805	25.543	22.281	-6.524	
523	6.259581464	28.79	25.540	22.289	-6.501	
524	6.261491684	28.797	25.546	22.295	-6.502	
525	6.263398263	28.802	25.553	22.304	-6.498	
526	6.265301213	28.815	25.563	22.311	-6.504	
527	6.267200549	28.828	25.573	22.317	-6.511	
528	6.269096284	28.837	25.579	22.32	-6.517	
529	6.270988432	28.836	25.580	22.323	-6.513	
530	6.272877007	28.836	25.582	22.328	-6.508	
531	6 274762021	28 843	25 589	22 334	-6.509	
532	6 276643489	28 848	25 592	22,335	-6.513	
533	6 278521/2/	28.855	25.502	22.000	-6 515	
534	6 280305830	28.862	25.603	22.34	-6 518	
535	6 282266747	20.002	25.003	22.044	-6 512	
535	6 28/12/161	20.009	25.003	22.041	-0.512	
530	6 285002005	20.009	25.012	22.004	-0.515	
539	6 28785956	20.004	25.011	22.001	-0.507	
530	6 20074EE74	20.000	20.010	22.002	-0.000	
539	0.209/100/1	∠0.0/J	∠0.0ZU	22.300	-0.307	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	С°	°C	°C	°C	
540	6.29156914	28.863	25.617	22.37	-6.493	
541	6.293419279	28.866	25.620	22.374	-6.492	
542	6.295266001	28.877	25.629	22.381	-6.496	
543	6.29710932	28.886	25.635	22.384	-6.502	
544	6.298949247	28.894	25.642	22.39	-6.504	
545	6.300785795	28.902	25.649	22.395	-6.507	
546	6.302618976	28.913	25.657	22.4	-6.513	
547	6.304448802	28.929	25.665	22.401	-6.528	
548	6.306275287	28.941	25.671	22.401	-6.540	
549	6.308098442	28.938	25.670	22.402	-6.536	
550	6.309918278	28.948	25.676	22.403	-6.545	
551	6.311734809	28.951	25.678	22.405	-6.546	
552	6.313548046	28.958	25.683	22.407	-6.551	
553	6.315358002	28.957	25.683	22.409	-6.548	
554	6.317164687	28.964	25.689	22.413	-6.551	
555	6.318968114	28.967	25.692	22.417	-6.550	
556	6.320768294	28.972	25.698	22.423	-6.549	
557	6.32256524	28.981	25.705	22.428	-6.553	
558	6.324358962	28.995	25.714	22.433	-6.562	
559	6.326149473	29.006	25.722	22.437	-6.569	
560	6.327936784	29.014	25.728	22.442	-6.572	
561	6.329720906	29.012	25.728	22.443	-6.569	
562	6.33150185	29.012	25.728	22.444	-6.568	
563	6.333279628	29.023	25.736	22.448	-6.575	
564	6.335054251	29.021	25.735	22.449	-6.572	
565	6 336825731	29.02	25 737	22 453	-6.567	
566	6.338594078	29.026	25.743	22,459	-6.567	
567	6 340359304	29.039	25 752	22 464	-6 575	
568	6 342121419	29 041	25 755	22 468	-6 573	
569	6 343880434	29.05	25 760	22.100	-6 580	
570	6 345636361	29.057	25 766	22 474	-6.583	
571	6 34738921	29.059	25 768	22.171	-6 582	
572	6 349138991	29.066	25.775	22.477	-6 583	
573	6 350885717	29.000	25.773	22.405	-6 578	
574	6 352629396	29.000	25.776	22.400	-6 577	
575	6 354370041	29.004	25.770	22.407	-6 575	
576	6 356107661	29.004	25.771	22.405	-6.570	
577	6 3578/2267	29.000	25.701	22.400	-6 572	
578	6 350573860	29.071	25.700	22.433	-6.572	
570	6 361302478	29.070	25.790	22.304	-6.575	
580	6 36302470	29.000	25.799	22.517	-6.572	
591	6.364750757	29.009	25.005	22.517	6 572	
592	6 266 470 4 49	29.092	25.800	22.52	-0.572	
592	6 269197196	29.093	25.809	22.525	-0.508	
503	6.26000002	29.009	25.009	22.529	-0.500	
504	0.309900903	29.095	20.010	22.004	-0.301	
500	0.3/101104/	29.093	20.010	22.537	-0.000	
500	6.37331979	29.102	20.022	22.342	-0.300	
500	0.37302462	29.102	20.024	22.340	-0.000	
588	0.370720948	29.105	25.829	22.552	-0.553	
589	6.378426184	29.106	25.832	22.557	-6.549	
590	6.380122537	29.115	25.838	22.56	-0.555	
591	6.381816017	29.126	25.844	22.562	-6.564	
592	6.383506635	29.133	25.850	22.567	-6.566	
593	6.385194399	29.14	25.856	22.571	-6.569	
594	6.3868/9319	29.141	25.858	22.574	-6.567	
595	6.388561406	29.141	25.860	22.579	-6.562	
596	6.390240667	29.147	25.866	22.585	-6.562	
597	6.391917113	29.113	25.851	22.588	-6.525	
598	6.393590754	29.063	25.830	22.596	-6.467	
599	6.395261598	29.069	25.836	22.603	-6.466	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)		°C	°€	°€	
WIITULES		0	C		U	
	0.000000055	00.070	05.047	00.040	0.400	
600	0.396929655	29.078	25.847	22.010	-6.462	
601	6.398594935	29.084	25.854	22.624	-6.460	
602	6.400257445	29.104	25.870	22.635	-6.469	
603	6.401917197	29.111	25.876	22.641	-6.470	
604	6.403574198	29.117	25.883	22.648	-6.469	
605	6.405228458	29.122	25.889	22.655	-6.467	
606	6.406879986	29.127	25.890	22.653	-6.474	
607	6.408528791	29.125	25.890	22.654	-6.471	
608	6.410174882	29.123	25.889	22.655	-6.468	
609	6.411818268	29.127	25,894	22.66	-6.467	
610	6 413458957	29 134	25 900	22 666	-6 468	
611	6 / 15096959	20.101	25.000	22.000	-6.472	
612	6 416732283	29.144	25.900	22.072	-6.472	
612	0.410732203	29.147	25.911	22.075	-0.472	
013	0.410304930	29.149	25.914	22.070	-0.471	
614	6.419994928	29.147	25.913	22.679	-6.468	
615	6.421622268	29.151	25.918	22.685	-6.466	
616	6.423246964	29.151	25.919	22.687	-6.464	
617	6.424869024	29.163	25.927	22.691	-6.472	
618	6.426488457	29.172	25.934	22.695	-6.477	
619	6.428105273	29.183	25.942	22.7	-6.483	
620	6.429719478	29.19	25.948	22.705	-6.485	
621	6.431331082	29.2	25.955	22,709	-6.491	
622	6 432940093	29 195	25 951	22 707	-6 488	
623	6 434546519	29 196	25 953	22 709	-6 487	
624	6 436150368	20.100	25.053	22.703	-6 477	
625	6 42775165	29.191	25.555	22.714	-0.477	
025	0.43773103	29.204	25.902	22.719	-0.400	
626	6.439350371	29.211	25.967	22.122	-6.489	
627	6.440946541	29.217	25.972	22.726	-6.491	
628	6.442540166	29.219	25.976	22.732	-6.487	
629	6.444131257	29.223	25.980	22.737	-6.486	
630	6.445719819	29.228	25.986	22.743	-6.485	
631	6.447305863	29.234	25.990	22.746	-6.488	
632	6.448889394	29.235	25.992	22.749	-6.486	
633	6.450470422	29.233	25.991	22.749	-6.484	
634	6.452048954	29.238	25.995	22.752	-6.486	
635	6.453624999	29.25	26.005	22.759	-6.491	
636	6.455198563	29.254	26.008	22.762	-6.492	
637	6 456769656	29 257	26.011	22 765	-6 492	
638	6 458338283	20.201	26.017	22.700	-6 / 9/	
620	6 450004454	29.204	26.011	22.11	6 402	
640	0.409904404	29.207	20.021	22.774	-0.493	
040	0.401400170	29.271	20.025	22.770	-0.493	
641	6.463029457	29.272	26.027	22.781	-6.491	
642	6.464588304	29.287	26.036	22.784	-6.503	
643	6.466144724	29.298	26.042	22.785	-6.513	
644	6.467698726	29.297	26.044	22.79	-6.507	
645	6.469250317	29.292	26.042	22.791	-6.501	
646	6.470799504	29.295	26.046	22.796	-6.499	
647	6.472346295	29.302	26.051	22.799	-6.503	
648	6.473890696	29.303	26.054	22.805	-6.498	
649	6.475432717	29.306	26.058	22.81	-6.496	
650	6,476972363	29.312	26.063	22.813	-6.499	
651	6.478509642	29.321	26.070	22.819	-6.502	
652	6 48004/562	20.32/	26.073	22.872	-6 502	
652	6 / 91 5 7 7 4 0 0 2	20.024	20.013	22.022	-0.30Z	
003	0.4010//129	29.333	20.000	22.826	-0.01/	
654	0.40310/351	29.342	26.085	22.828	-0.514	
655	6.484635236	29.342	26.086	22.83	-6.512	
656	6.486160789	29.342	26.087	22.832	-6.510	
657	6.487684018	29.344	26.090	22.836	-6.508	
658	6.489204931	29.348	26.094	22.84	-6.508	
659	6.490723535	29.35	26.098	22.845	-6.505	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	С°	°C	°C	°C	
660	6.492239835	29.345	26.097	22.848	-6.497	
661	6.49375384	29.354	26.104	22.854	-6.500	
662	6.495265556	29.359	26.108	22.857	-6.502	
663	6.49677499	29.365	26.113	22.861	-6.504	
664	6.498282149	29.369	26.118	22.866	-6.503	
665	6.499787041	29.373	26.122	22.87	-6.503	
666	6.501289671	29.371	26.122	22.872	-6.499	
667	6.502790046	29.382	26.129	22.876	-6.506	
668	6.504288174	29.39	26.135	22.88	-6.510	
669	6.50578406	29.401	26.141	22.881	-6.520	
670	6.507277712	29.401	26.143	22.885	-6.516	
671	6.508769137	29.412	26.150	22.888	-6.524	
672	6.510258341	29.415	26.154	22.892	-6.523	
673	6.51174533	29.419	26.157	22.894	-6.525	
674	6.513230111	29.425	26.163	22.9	-6.525	
675	6.514712691	29.434	26.167	22.9	-6.534	
676	6.516193076	29.434	26.168	22.902	-6.532	
677	6.517671273	29.434	26.170	22.906	-6.528	
678	6.519147288	29.441	26.175	22.909	-6.532	
679	6.520621128	29.449	26.180	22.91	-6.539	
680	6.522092798	29.439	26.176	22.913	-6.526	
681	6.523562306	29.437	26.178	22.919	-6.518	
682	6.525029658	29.444	26.184	22.924	-6.520	
683	6.52649486	29.457	26.192	22.927	-6.530	
684	6 527957918	29 451	26 192	22 932	-6 519	
685	6 529418838	29.45	26 193	22.936	-6 514	
686	6 530877628	29 452	26 196	22,939	-6 513	
687	6 532334292	29 459	26 201	22.943	-6.516	
688	6 533788838	29 462	26 206	22 949	-6.513	
689	6 535241271	29 445	26 198	22.951	-6 494	
690	6 536691598	29.44	26 199	22.957	-6 483	
691	6 538139824	29 447	26.100	22.961	-6 486	
602	6 530585056	20.447	26.204	22.001	-6.483	
693	6 541029999	29.400	26.212	22.07	-6 475	
694	6 542471961	20.440	26.211	22.978	-6 471	
605	6 5/30118/6	29.449	26.214	22.970	-6.466	
696	6 54534966	29.456	26.210	22.905	-6.468	
607	6 5/6785/11	29.450	20.222	22.900	-6.466	
608	6 5/8210103	29.401	20.220	22.995	-6.474	
600	6 540650742	29.409	20.232	22.995	-6.474	
700	6 551080335	29.400	20.235	22.997	-6.463	
700	6 552507997	29.407	20.230	23.004	-0.403	
701	6 552022404	29.403	20.230	23.000	-0.455	
702	0.000900404	29.47	20.240	23.01	-0.400	
703	0.000000000	29.315	20.200	23.014	-0.301	
704	0.00077000	29.527	20.270	23.013	-0.314	
705	0.000197003	29.53	20.272	23.014	-0.510	
706	0.009010207	29.520	20.272	23.017	-0.509	
707	0.501030000	29.516	26.267	23.018	-6.498	
708	0.562444094	29.518	26.269	23.02	-6.498	
709	0.503855527	29.512	26.267	23.022	-6.490	
710	6.56526497	29.523	26.274	23.024	-6.499	
711	0.50007243	29.523	26.275	23.027	-6.496	
712	6.568077911	29.521	26.278	23.034	-6.487	
713	6.56948142	29.519	26.280	23.041	-6.478	
714	6.570882962	29.525	26.287	23.049	-6.476	
/15	6.572282543	29.526	26.289	23.052	-6.474	
716	6.573680167	29.531	26.293	23.055	-6.476	
717	6.575075841	29.534	26.297	23.059	-6.475	
718	6.576469569	29.54	26.302	23.063	-6.477	
719	6.577861358	29.55	26.308	23.066	-6.484	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
720	6.579251212	29.553	26.311	23.068	-6.485	
721	6.580639137	29.554	26.313	23.072	-6.482	
722	6.582025139	29.547	26.311	23.074	-6.473	
723	6.583409222	29.549	26.313	23.076	-6.473	
724	6.584791392	29.54	26.312	23.083	-6.457	
725	6.586171655	29.547	26.318	23.088	-6.459	
726	6.587550015	29.535	26.314	23.093	-6.442	
727	6.588926478	29.536	26.317	23.098	-6.438	
728	6.590301048	29.539	26.322	23.104	-6.435	
729	6.591673732	29.545	26.327	23.108	-6.437	
730	6.593044534	29.557	26.335	23.113	-6.444	
731	6.59441346	29.566	26.343	23.119	-6.447	
732	6.595780514	29.573	26.348	23.122	-6.451	
733	6.597145702	29.572	26.348	23.124	-6.448	
734	6.598509029	29.57	26.350	23.13	-6.440	
735	6.599870499	29.565	26.348	23.131	-6.434	
736	6.601230119	29.578	26.355	23.132	-6.446	
737	6.602587892	29.562	26.348	23.134	-6.428	
738	6.603943825	29.567	26.352	23.137	-6.430	
739	6.605297921	29.573	26.358	23.142	-6.431	
740	6.606650186	29.577	26.363	23.149	-6.428	
741	6.608000625	29.587	26.370	23.153	-6.434	
742	6.609349243	29.587	26.373	23,158	-6.429	
743	6 610696045	29 598	26,380	23 162	-6 436	
744	6 612041035	29.603	26 384	23 164	-6 439	
745	6 613384218	29.607	26.387	23 166	-6 441	
746	6 6147256	29.607	26 386	23 165	-6 442	
740	6 616065185	29.603	26.385	23 167	-6 436	
747	6 617/02078	29.604	26.387	23.107	-6 /3/	
740	6 61873808/	29.004	26.307	23.17	-6.434	
743	6 620073207	29.003	26.392	23.175	-6.431	
751	6 621/05652	20.621	26.000	23.10	-6 /38	
752	6 622726224	29.021	26.402	23.103	-0.430	
752	6 624065228	29.03	20.409	23.107	-6.443	
753	6.625202268	29.000	20.413	23.100	-0.430	
734	0.020392300	29.042	20.410	23.194	-0.440	
755	6.620/11/49	29.043	20.420	23.190	-0.447	
700	0.020041370	29.037	20.417	23.190	-0.441	
/5/	0.029303253	29.647	26.423	23.198	-6.449	
758	6.630683386	29.639	26.420	23.2	-6.439	
759	6.632001777	29.64	26.422	23.204	-6.436	
760	6.633318433	29.647	26.427	23.207	-6.440	
761	6.634633358	29.656	26.434	23.212	-6.444	
762	6.635946556	29.662	26.439	23.215	-6.447	
763	6.637258031	29.669	26.445	23.22	-6.449	
764	6.638567789	29.675	26.448	23.221	-6.454	
765	6.639875834	29.675	26.449	23.222	-6.453	
/66	6.64118217	29.679	26.453	23.226	-6.453	
/6/	6.642486801	29.684	26.455	23.226	-6.458	
/68	6.643789733	29.685	26.456	23.227	-6.458	
769	6.64509097	29.681	26.456	23.23	-6.451	
//0	6.646390515	29.685	26.461	23.236	-6.449	
771	6.647688374	29.695	26.468	23.24	-6.455	
772	6.64898455	29.696	26.469	23.242	-6.454	
773	6.650279049	29.72	26.483	23.245	-6.475	
774	6.651571874	29.743	26.495	23.247	-6.496	
775	6.652863029	29.75	26.500	23.249	-6.501	
776	6.65415252	29.75	26.499	23.248	-6.502	
777	6.65544035	29.746	26.497	23.248	-6.498	
778	6.656726524	29.74	26.495	23.249	-6.491	
779	6.658011046	29.736	26.494	23.252	-6.484	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	С°	°C	°C	°C	
780	6.65929392	29.725	26.490	23.254	-6.471	
781	6.66057515	29.728	26.492	23.256	-6.472	
782	6.661854741	29.739	26.501	23.262	-6.477	
783	6.663132696	29.75	26.510	23.269	-6.481	
784	6.66440902	29.752	26.513	23.274	-6.478	
785	6.665683718	29.762	26.521	23.28	-6.482	
786	6.666956792	29.771	26.527	23.282	-6.489	
787	6.668228248	29.775	26.530	23.285	-6.490	
788	6.66949809	29.771	26.527	23.283	-6.488	
789	6.670766321	29.772	26.528	23.283	-6.489	
790	6.672032945	29.775	26.530	23.285	-6.490	
791	6.673297968	29.785	26.537	23.288	-6.497	
792	6.674561392	29.787	26.541	23.294	-6.493	
793	6.675823222	29.799	26.548	23.297	-6.502	
794	6.677083461	29.801	26.551	23.3	-6.501	
795	6.678342115	29.806	26.555	23.303	-6.503	
796	6.679599186	29.813	26.559	23.305	-6.508	
797	6.680854679	29.808	26.558	23.307	-6.501	
798	6.682108597	29.819	26.565	23.31	-6.509	
799	6.683360946	29.826	26.570	23.314	-6.512	
800	6.684611728	29.828	26.573	23.317	-6.511	
801	6.685860947	29.835	26.578	23.32	-6.515	
802	6.687108608	29.835	26.579	23.322	-6.513	
803	6.688354714	29.845	26.585	23.325	-6.520	
804	6.689599269	29.84	26.585	23.329	-6.511	
805	6.690842277	29.843	26.587	23.331	-6.512	
806	6.692083743	29.843	26.589	23.335	-6.508	
807	6.693323668	29.851	26.595	23.339	-6.512	
808	6.694562059	29.854	26.597	23.34	-6.514	
809	6.695798917	29.86	26.603	23.345	-6.515	
810	6.697034248	29.864	26.606	23.348	-6.516	
811	6.698268054	29.867	26.608	23.349	-6.518	
812	6.69950034	29.874	26.614	23.354	-6.520	
813	6.70073111	29.88	26.618	23.355	-6.525	
814	6.701960366	29.882	26.621	23.359	-6.523	
815	6.703188113	29.882	26.621	23.36	-6.522	
816	6.704414355	29.891	26.627	23.363	-6.528	
817	6.705639095	29.887	26.628	23.369	-6.518	
818	6.706862337	29.896	26.634	23.371	-6.525	
819	6.708084084	29.898	26.635	23.371	-6.527	
820	6.70930434	29.899	26.637	23.374	-6.525	
821	6.710523109	29.902	26.640	23.377	-6.525	
822	6.711740395	29.909	26.645	23.381	-6.528	
823	6.712956201	29.913	26.649	23.384	-6.529	
824	6.71417053	29.92	26.654	23.387	-6.533	
825	6.715383386	29.924	26.657	23.389	-6.535	
826	6.716594774	29.927	26.660	23.392	-6.535	
827	6.717804695	29.936	26.665	23.393	-6.543	
828	6.719013154	29.939	26.668	23.397	-6.542	
829	6.720220155	29.938	26.668	23.398	-6.540	
830	6.721425701	29.945	26.673	23.4	-6.545	
831	6.722629795	29.95	26.676	23.402	-6.548	
832	6.723832441	29.954	26.679	23.404	-6.550	
833	6.725033642	29.956	26.682	23.407	-6.549	
834	6.726233402	29.964	26.687	23.409	-6.555	
835	6.727431725	29.97	26.691	23.411	-6.559	
836	6.728628613	29.972	26.693	23.413	-6.559	
837	6.72982407	29.977	26.696	23.415	-6.562	
838	6.7310181	29.978	26 698	23 418	-6 560	
839	6.732210706	29.981	26.701	23.42	-6.561	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	°C	°C	°C	
Wintates		0	0	U	<u> </u>	
840	6 733/01802	20.078	26 700	23 422	-6 556	
9/1	6 73450166	29.970	26.700	23.422	-0.550	
041	6 725790014	29.979	20.703	23.427	-0.552	
042	0.735760014	29.965	20.090	23.427	-0.000	
843	6.736966958	29.968	26.700	23.431	-6.537	
844	6.738152495	29.972	26.706	23.439	-6.533	
845	6.739336627	29.974	26.708	23.442	-6.532	
846	6.74051936	29.977	26.712	23.446	-6.531	
847	6.741700695	29.979	26.716	23.452	-6.527	
848	6.742880636	29.972	26.714	23.455	-6.517	
849	6.744059186	29.972	26.715	23.458	-6.514	
850	6.745236349	29.973	26.717	23.461	-6.512	
851	6.746412129	29.979	26.720	23.461	-6.518	
852	6.747586527	29.984	26.726	23.467	-6.517	
853	6.748759547	29,984	26.727	23,469	-6.515	
854	6,749931194	29,988	26,730	23.472	-6.516	
855	6 751101469	29 993	26 734	23 474	-6.519	
856	6 752270376	30	26.739	23.478	-6 522	
857	6 753/37010	20,000	26.733	23.470	-6 516	
007	0.755457919	29.999	20.741	23.405	-0.510	
808	6.754604099	30.002	26.744	23.485	-0.517	
859	6.755768922	30.007	26.747	23.487	-6.520	
860	6.756932389	30.009	26.749	23.489	-6.520	
861	6.758094504	30.008	26.750	23.491	-6.517	
862	6.759255271	30.007	26.751	23.495	-6.512	
863	6.760414691	30.02	26.759	23.497	-6.523	
864	6.761572769	30.025	26.762	23.499	-6.526	
865	6.762729507	30.025	26.764	23.502	-6.523	
866	6.763884909	30.031	26.767	23.503	-6.528	
867	6.765038977	30.034	26.770	23.506	-6.528	
868	6 766191715	30.037	26 773	23 509	-6 528	
869	6 767343125	30.041	26.777	23 512	-6 529	
870	6 768493212	30.044	26.779	23 513	-6 531	
871	6 7606/1077	30.047	26.781	23.515	-6.532	
071	6.709041977	30.047	20.701	23.515	-0.552	
072	0.770709424	30.055	20.700	23.319	-0.034	
073	0.771930000	30.055	20.700	23.521	-0.534	
874	6.773080376	30.058	26.790	23.522	-6.536	
875	6.774223886	30.064	26.795	23.526	-6.538	
876	6.775366091	30.061	26.795	23.528	-6.533	
877	6.776506992	30.07	26.801	23.532	-6.538	
878	6.777646594	30.072	26.804	23.536	-6.536	
879	6.778784898	30.081	26.809	23.536	-6.545	
880	6.779921907	30.081	26.810	23.538	-6.543	
881	6.781057626	30.085	26.813	23.541	-6.544	
882	6.782192056	30.085	26.815	23.545	-6.540	
883	6.783325201	30.092	26.820	23.547	-6.545	
884	6.784457063	30.097	26.824	23.55	-6.547	
885	6.785587645	30.098	26.825	23.552	-6.546	
886	6 786716951	30 101	26.828	23 554	-6 547	
887	6 787844982	30 101	26.829	23 556	-6 545	
888	6 788971743	30 103	26.832	23.56	-6 543	
880	6 700007236	30 105	26.833	23.561	-6 544	
800	6 701001200	30.105	20.000	23.301	-0.044	
090	6 702244427	20.100	20.000	20.000	-0.040	
091	0.192344421	30.111	20.040	23.300	-0.043	
892	6.793466133	30.117	26.844	23.5/1	-6.546	
893	6.794586581	30.121	26.846	23.571	-6.550	
894	6.795705775	30.129	26.853	23.576	-6.553	
895	6.796823718	30.13	26.854	23.578	-6.552	
896	6.797940413	30.126	26.854	23.581	-6.545	
897	6.799055862	30.126	26.855	23.584	-6.542	
898	6.800170068	30.128	26.857	23.585	-6.543	
899	6.801283034	30.125	26.855	23.585	-6.540	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
900	6.802394763	30.125	26.856	23.587	-6.538	
901	6.803505258	30.13	26.862	23.593	-6.537	
902	6.80461452	30.134	26.866	23.597	-6.537	
903	6.805722553	30.145	26.873	23.601	-6.544	
904	6.80682936	30.148	26.876	23.603	-6.545	
905	6.807934944	30.153	26.878	23.603	-6.550	
906	6.809039306	30.145	26.875	23.604	-6.541	
907	6.81014245	30.147	26.877	23.606	-6.541	
908	6.811244379	30.146	26.877	23.607	-6.539	
909	6.812345094	30.156	26.883	23.61	-6.546	
910	6.8134446	30.16	26.886	23.612	-6.548	
911	6.814542897	30.161	26.888	23.614	-6.547	
912	6.81563999	30.166	26.891	23.616	-6.550	
913	6.816735881	30.166	26.893	23.62	-6.546	
914	6.817830571	30.165	26.895	23.624	-6.541	
915	6.818924065	30.198	26.912	23.626	-6.572	
916	6.820016365	30.211	26.918	23.625	-6.586	
917	6.821107472	30.215	26.919	23.623	-6.592	
918	6.822197391	30.215	26.919	23.622	-6.593	
919	6.823286122	30.224	26.923	23.622	-6.602	
920	6.82437367	30.223	26.924	23.624	-6.599	
921	6.825460036	30.224	26.924	23.623	-6.601	
922	6.826545224	30.225	26.924	23.623	-6.602	
923	6.827629235	30.228	26.927	23.625	-6.603	
924	6.828712072	30.225	26.928	23.63	-6.595	
925	6 829793738	30 228	26.932	23 635	-6 593	
926	6.830874235	30.233	26.936	23.638	-6.595	
927	6 831953566	30.23	26.936	23 641	-6 589	
928	6 833031733	30 228	26.937	23 646	-6.582	
929	6 834108739	30 228	26.939	23 649	-6 579	
930	6 835184586	30 231	26.942	23 652	-6.579	
931	6 836259277	30 235	26.945	23 654	-6 581	
932	6.837332815	30 235	26.948	23.66	-6 575	
933	6 838405201	30.24	26.952	23.664	-6 576	
034	6 839476438	30.24	26.954	23.667	-6 573	
035	6 840546529	30.24	26.955	23.67	-6 570	
936	6 841615476	30.24	26.955	23.674	-6.570	
037	6.842683282	30.243	26.000	23.675	-6 566	
038	6 8/37/00/0	30.241	20.330	23.670	-6.565	
930	6 8//815/70	30.244	20.902	23.079	-6.566	
939	6 8/5870875	30.240	20.905	23.002	-6.565	
0/1	6 8/60/31/	30.249	26.907	23.004	-6.560	
042	6 8/8005275	30.257	26.973	23.000	-6.566	
0/3	6.840066283	30.250	26.975	23.09	-6.572	
943	6.950126166	30.200	26.900	23.094	-0.572	
944	6 951194027	30.203	20.979	23.095	-0.500	
945	6 952242560	30.200	20.903	23.090	-0.570	
940	6 952200003	30.207	20.904	23.701	-0.500	
947	0.000299090	30.272	20.907	23.701	-0.371	
940	0.004304002	30.276	20.991	23.703	-0.373	
949	0.000400799	30.261	26.993	23.705	-0.370	
950	0.000401900	30.281	26.994	23.700	-0.373	
951	0.007014003	30.20	26.994	23.707	-0.373	
952	0.0500000000000000000000000000000000000	30.287	26.998	23.708	-0.579	
953	0.859614904	30.285	26.998	23./11	-6.574	
954	0.0000030/1	30.293	27.002	23.711	-0.582	
955	6.861/1134	30.295	27.005	23./14	-6.581	
956	6.862/57913	30.293	27.006	23./18	-6.575	
957	6.863803391	30.299	27.010	23.72	-6.579	
958	6.864847778	30.297	27.012	23.727	-6.570	
959	6.865891075	30.25	26.990	23.729	-6.521	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
960	6.866933284	30.246	26.990	23.734	-6.512	
961	6.867974409	30.258	27.000	23.741	-6.517	
962	6.869014451	30.264	27.006	23.747	-6.517	
963	6.870053412	30.27	27.012	23.753	-6.517	
964	6.871091295	30.274	27.017	23.759	-6.515	
965	6.872128101	30.274	27.020	23.765	-6.509	
966	6.873163834	30.279	27.026	23.772	-6.507	
967	6.874198495	30.28	27.028	23.775	-6.505	
968	6.875232087	30.28	27.026	23.772	-6.508	
969	6.876264612	30.279	27.027	23.774	-6.505	
970	6.877296071	30.284	27.032	23.779	-6.505	
971	6.878326468	30.289	27.035	23.781	-6.508	
972	6.879355804	30.286	27.035	23.783	-6,503	
973	6.880384082	30.291	27.039	23.787	-6,504	
974	6.881411304	30.298	27.045	23.791	-6.507	
975	6.882437471	30.302	27.049	23.795	-6.507	
976	6.883462586	30.307	27.052	23.796	-6.511	
977	6.884486652	30.306	27.052	23.797	-6.509	
978	6 88550967	30 313	27.057	23.8	-6 513	
979	6.886531643	30.316	27.059	23.802	-6.514	
980	6 887552572	30 314	27 059	23 804	-6 510	
981	6 88857246	30 319	27.062	23 805	-6 514	
982	6 889591308	30 319	27.063	23,806	-6 513	
983	6 89060912	30 327	27.068	23,808	-6 519	
984	6 891625897	30 327	27.000	23.812	-6 515	
985	6 892641641	30 332	27.070	23.815	-6 517	
986	6 893656355	30 344	27.081	23.817	-6 527	
987	6 894670039	30 353	27.086	23,819	-6 534	
088	6 895682698	30 351	27.086	23.82	-6 531	
989	6 896694332	30 356	27.000	23.02	-6 539	
990	6 897704943	30 359	27.007	23.821	-6 538	
001	6 80871/53/	30.36	27.000	23.021	-6 537	
002	6 900722107	20.364	27.092	23.023	-0.537	
003	6 900730664	30.304	27.094	23.024	-6.540	
004	6 001737207	30.373	27.030	23.023	-6.545	
994	6.002742727	20.27	27.101	23.020	-0.545	
995	6.003742737	30.37	27.100	23.03	-6.540	
990	6.00475077	20.270	27.104	23.035	-0.541	
997	0.90473077	30.379	27.107	23.035	-0.344	
996	6.905753276	30.30	27.109	23.037	-0.040	
999	0.900734779	30.370	27.109	23.04	-0.000	
1000	0.907755279	30.362	27.113	23.043	-0.559	
1001	6.906754779	30.362	27.114	23.640	-0.330	
1002	0.909753262	30.360	27.110	23.049	-0.037	
1003	0.910/50/66	30.393	27.123	23.652	-0.341	
1004	6.9117473	30.398	27.126	23.854	-6.544	
1005	6.91274282	30.39	27.124	23.857	-6.533	
1006	6.913/3/351	30.402	27.131	23.859	-6.543	
1007	6.914730893	30.399	27.130	23.861	-6.538	
1008	6.915723449	30.405	27.135	23.864	-6.541	
1009	6.91671502	30.402	27.134	23.866	-6.536	
1010	6.91770561	30.409	27.139	23.868	-6.541	
1011	6.918695219	30.418	27.145	23.871	-6.547	
1012	6.91968385	30.43	27.152	23.873	-6.557	
1013	6.920671504	30.431	27.153	23.874	-6.557	
1014	6.921658184	30.427	27.151	23.875	-6.552	
1015	6.922643891	30.416	27.147	23.877	-6.539	
1016	6.923628628	30.414	27.148	23.881	-6.533	
1017	6.924612396	30.422	27.153	23.884	-6.538	
1018	6.925595197	30.422	27.153	23.884	-6.538	
1019	6.926577033	30.423	27.155	23.887	-6.536	

Minutes Ln (Time) °C °C °C °C °C 1020 6.322557406 30.428 27.160 23.892 -6.536 1021 6.329557416 30.430 27.168 23.997 -6.536 1022 6.39064766 30.447 27.172 23.902 -6.636 1024 6.39044766 30.447 27.175 23.903 -6.548 1025 6.39247802 30.447 27.175 23.908 -6.539 1026 6.39247802 30.447 27.178 23.908 -6.548 1028 6.393547266 30.443 27.118 23.908 -6.548 1030 6.393547646 30.443 27.118 23.911 -6.643 1031 6.394022468 30.447 27.190 23.914 -6.649 1033 6.394022469 30.47 27.200 23.924 -6.548 1034 6.34025026 30.47 27.190 23.934 -6.651 10356 6.34025027	Time	All Data	Flow	Average	Return	Delta T	
Image Image Image Image Image Image Image 1020 6 20755706 30 432 27 165 23 897 6 536 1022 6 209516771 30 438 27 175 23 302 6 539 1024 6 3047160 30 441 27 175 23 302 6 539 1024 6 3047160 30 441 27 175 23 303 6 542 1025 6 3047160 30 445 27 174 23 303 6 542 1026 6 30342702 30 445 27 174 23 303 6 542 1028 6 30342704 30 453 27 183 23 11 6 543 1023 6 30324424 30 454 27 183 23 11 6 544 1033 6 5325444 30 453 27 183 23 11 6 544 1034 6 34216570 30 477 27 120 23 22 6 544 1035 6 34216570 30 477 27 120 23 23 4 6 551 1036 6 34216570	Minutes	In (Time)	°C	ଂମ	°C.	°C	
$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	Mindeo		U	0	0	0	
1021 0.59250740 0.0430 27.165 2.0487 46.336 1022 6.59285781971 30.486 27.165 2.387 46.336 1023 6.39044766 30.441 27.172 2.3902 46.536 1024 6.39447806 30.447 27.175 2.3902 46.546 1025 6.93247802 30.445 27.175 2.3903 46.642 1026 6.93439721 30.447 27.178 2.3908 46.544 1027 6.93634763 30.445 27.181 2.3908 46.543 1028 6.93634736 30.458 27.180 2.3914 4.544 1030 6.93224434 30.464 27.191 2.3914 4.5454 1031 6.94022490 30.476 27.200 2.3924 4.551 1035 6.94215706 30.475 27.200 2.3924 4.551 1036 6.94407209 30.476 27.200 2.3924 4.551 1037 6.944087092	1020	6 027557006	30 428	27 160	23 802	-6 536	
1021 0.58291071 30.436 27.168 23.03 46.336 1022 6.53941706 30.441 27.175 23.802 46.536 1024 6.531471806 30.444 27.175 23.802 46.545 1025 6.53242206 30.449 27.175 23.803 46.642 1026 6.53342306 30.445 27.174 23.803 46.642 1027 6.93452046 30.453 27.181 23.909 46.644 1028 6.935734061 30.456 27.189 23.911 46.644 1030 6.939263944 30.463 27.189 23.924 46.545 1031 6.939263946 30.477 27.198 23.924 46.551 1033 6.94021504 30.475 27.200 23.924 46.551 1036 6.94312423 30.475 27.200 23.934 46.557 1038 6.94015091 30.484 27.192 23.934 46.557 1038 6.940517991	1020	6.029527919	20.420	27.100	23.092	-0.530	
1022 6.3904376 30.441 27.172 23.802 -6.539 1024 6.39043768 30.447 27.175 23.802 -6.645 1025 6.392447892 30.449 27.175 23.802 -6.648 1026 6.93247892 30.445 27.174 23.808 -6.639 1027 6.93634721 30.447 27.178 23.808 -6.644 1028 6.936370446 30.453 27.183 23.911 -6.643 1031 6.93624764 30.458 27.189 23.914 -6.654 1033 6.93024444 30.458 27.198 23.922 -6.646 1033 6.94022469 30.476 27.200 23.924 -6.651 1036 6.942156706 30.475 27.200 23.924 -6.651 1037 6.94018709 30.491 27.207 23.933 -6.647 1038 6.94015704 30.467 27.199 23.937 -6.551 1038 6.94015704	1021	6.020516771	20.435	27.105	23.097	-0.550	
1023 6.39147166 30.447 27.175 23.302 -6.546 1025 6.39147166 30.449 27.175 23.801 -6.546 1026 6.39342206 30.443 27.174 23.803 -6.542 1027 6.3934714 30.447 27.174 23.803 -6.542 1028 6.39357446 30.453 27.181 23.909 -6.544 1029 6.39357446 30.458 27.180 23.911 -6.545 1030 6.393714081 30.458 27.191 23.914 -6.546 1032 6.94190055 30.475 27.190 23.922 -6.543 1036 6.94190055 30.475 27.200 23.924 -6.551 1037 6.94013691 30.467 27.199 23.33 -6.647 1038 6.94012681 30.467 27.202 23.924 -6.551 1036 6.9412643 30.475 27.202 23.933 -6.547 1039 6.94015741	1022	0.929310771	30.430	27.100	23.9	-0.550	
1024 6.93244782 27.175 23.902 -6.548 1025 6.93244782 30.445 27.174 23.903 -6.548 1028 6.93337744 30.445 27.178 23.903 -6.539 1028 6.93337744 30.445 27.183 23.903 -6.543 1028 6.93354726 30.454 27.183 23.911 -6.543 1031 6.93264440 30.458 27.189 23.914 -6.549 1032 6.93264440 30.473 27.199 23.922 -6.546 1033 6.94022469 30.475 27.200 23.824 -6.551 1036 6.94312423 30.475 27.200 23.824 -6.561 1037 6.94067094 30.475 27.200 23.924 -6.561 1038 6.94051094 30.462 27.210 23.934 -6.567 1044 6.94073992 30.481 27.217 23.933 -6.561 1044 6.94087922 30.482	1023	6.930494766	30.441	27.172	23.902	-0.539	
1026 6.9324202 30.449 $Z7.176$ $Z3.903$ -6.542 1027 6.933430721 30.447 $Z7.178$ $Z3.903$ -6.544 1028 6.9335370448 30.453 $Z7.181$ $Z3.909$ -6.544 1030 6.9337314081 30.458 $Z7.183$ $Z3.913$ -6.545 1031 6.93253464 30.463 $Z7.199$ $Z3.914$ -6.546 1032 6.930253464 30.467 $Z7.199$ $Z3.924$ -6.548 1033 6.941120056 30.477 $Z7.196$ $Z3.922$ -6.561 1036 6.942156706 30.475 $Z7.200$ $Z3.924$ -6.551 1036 6.94216706 30.475 $Z7.202$ $Z3.924$ -6.551 1037 6.944087208 30.467 $Z7.190$ $Z3.333$ -6.537 1038 6.94601391 30.467 $Z7.202$ $Z3.934$ -6.557 1043 6.946987592 30.491 $Z7.213$ $Z3.937$ -6.566 1044 6.949897592 30.492 $Z7.217$ $Z3.939$ -6.5	1024	6.931471806	30.447	27.175	23.902	-6.545	
1026 6.93439721 30.445 27.174 23.906 6-6.539 1028 6.9333970446 30.453 27.181 23.906 6-6.539 1029 6.93634733 30.454 27.186 23.911 6-6.543 1031 6.936324734 30.458 27.186 23.914 6-6.549 1031 6.936224444 30.463 27.196 23.924 6-6.549 1033 6.94022469 30.477 27.106 23.922 6-561 1034 6.941190055 30.475 27.200 23.924 6-551 1036 6.942156706 30.475 27.200 23.924 6-551 1036 6.944097208 30.475 27.200 23.934 6-552 1037 6.944097208 30.475 27.207 23.933 6-547 1048 6.946071999 30.48 27.215 23.937 6-555 1044 6.946975992 30.491 27.215 23.937 6-556 1044 6.949875923 30.502 27.222 23.944 6-560<	1025	6.932447892	30.449	27.175	23.901	-6.548	
1027 6.93337044 27.181 23.909 6.534 1028 6.933570446 30.453 27.181 23.913 6.544 1030 6.93734064 30.458 27.186 23.913 6.545 1031 6.932534064 30.463 27.198 23.914 6.544 1032 6.93253464 30.476 27.106 23.922 6.542 1033 6.942156706 30.475 27.108 23.924 6.551 1033 6.942156706 30.476 27.200 23.924 6.552 1037 6.944037203 0.476 27.200 23.924 6.557 1038 6.946013991 30.48 27.213 23.333 6.547 1038 6.946073992 30.494 27.213 23.333 6.557 1041 6.94937592 30.494 27.213 23.394 6.556 1042 6.94897592 30.494 27.222 23.947 6.566 1044 6.94927224 30.344 27.223	1026	6.933423026	30.445	27.174	23.903	-6.542	
1028 6.9353270446 30.453 $Z7.183$ 23.911 6.544 1030 6.937314081 30.458 $Z7.186$ 23.914 6.543 1031 6.932623446 30.464 $Z7.196$ 23.914 6.6549 1033 6.940222469 30.47 $Z7.196$ 23.922 6.548 1034 6.941190055 30.473 $Z7.196$ 23.924 6.6561 1036 6.94212423 30.476 $Z7.200$ 23.924 6.6561 1037 6.943021203 30.475 $Z7.202$ 23.923 6.547 1038 6.940513991 30.48 $Z7.207$ 23.333 -6.547 1041 6.947937069 30.492 $Z7.217$ 23.333 -6.555 1041 6.947937069 30.492 $Z7.217$ 23.934 -6.561 1044 6.94897220 30.491 $Z7.222$ 23.944 -6.561 1044 6.949879202 30.505 $Z7.222$ 23.944 -6.561 1044 6.9498792063 30.505 $Z7.223$ 23.945 -6.550<	1027	6.93439721	30.447	27.178	23.908	-6.539	
10296.93834273630.45427.18323.911-6.54310316.93825444430.46327.18923.914-6.54910326.93825346430.46427.19123.918-6.54610336.9402246930.4727.19623.922-6.56110346.9411905530.47327.19823.922-6.56110356.94215670630.47527.20023.924-6.55110366.94312242330.47627.20023.924-6.55710376.94406720830.47727.20223.938-6.53710386.94505106430.46727.19923.933-6.55710436.94603799230.49227.21523.937-6.55510446.94697599230.49227.21523.937-6.55510446.95081476830.50227.22223.944-6.56610446.95081476830.50227.22223.944-6.56910446.95081476830.50227.22223.947-6.54910446.95081476830.50427.22223.947-6.56910446.9569266830.50427.22223.947-6.55010456.9512726630.50427.22223.947-6.56910466.956749737130.51327.22423.964-6.55010516.9564933330.5227.24223.964-6.55210536.96939851230.5227.24223.961-6.561	1028	6.935370446	30.453	27.181	23.909	-6.544	
1030 6.39324444 30.46327.18623.914 -6.545 1032 6.39325444 30.46427.19123.918 -6.546 1033 6.94022496 30.4727.19623.922 -6.546 1034 6.941190055 30.47527.20023.922 -6.551 1035 6.94212423 30.47527.20023.924 -6.551 1036 6.94312423 30.47627.10223.924 -6.552 1037 6.944067208 30.47527.20223.928 -6.547 1038 6.946013991 30.4827.20723.933 -6.547 1040 6.946979292 30.49127.21323.934 -6.565 1041 6.947937069 30.49227.21723.939 -6.5656 1042 6.948957222 30.50227.22223.941 -6.561 1044 6.956914768 30.50227.22223.944 -6.560 1044 6.95614768 30.50527.22323.944 -6.560 1044 6.956927663 30.50427.22323.944 -6.560 1046 6.95624543 30.51427.22623.947 -6.556 1046 6.95695063 30.50427.22423.944 -6.560 1047 6.95695063 30.50427.22423.944 -6.550 1054 6.95654543 30.51427.22623.957 -6.554 1054 6.95656633 30.56427.22623.964 -6.556 1054 6.956945443 <	1029	6.936342736	30.454	27.183	23.911	-6.543	
10316.38282444430.46327.18923.914 -6.549 10326.3926234630.46427.19123.918 -6.546 10336.94022346930.47327.19823.922 -6.551 10356.94315670630.47527.20023.924 -6.551 10366.94312242330.47627.20023.924 -6.552 10376.94408708930.47727.20023.933 -6.537 10386.9450150430.46727.19923.933 -6.557 10406.94607599230.49227.21523.937 -6.556 10416.94793706930.49227.21723.933 -6.556 10426.9488972233.049227.22223.941 -6.561 10436.9498645530.50227.22223.944 -6.558 10446.9502176830.50227.22323.944 -6.558 10456.9517716430.50227.22323.944 -6.558 10466.9562566630.50427.22323.944 -6.558 10476.9568454330.51427.22323.946 -6.557 10516.9564544330.51427.22623.945 -6.557 10516.9564544330.51427.22623.946 -6.559 10526.96934772930.55827.24223.946 -6.558 10536.96934772930.55827.24223.946 -6.559 10546.96034772930.55827.242 <td< td=""><td>1030</td><td>6.937314081</td><td>30.458</td><td>27.186</td><td>23.913</td><td>-6.545</td><td></td></td<>	1030	6.937314081	30.458	27.186	23.913	-6.545	
1032 6.392253946 30.4464 27.191 23.918 -6.546 1034 6.941190055 30.473 27.198 23.922 -6.551 1036 6.942156706 30.475 27.200 23.924 -6.551 1036 6.944122423 30.476 27.200 23.924 -6.551 1037 6.944067208 30.475 27.202 23.924 -6.557 1038 6.94501604 30.467 27.192 23.933 -6.547 1040 6.946979329 30.491 27.213 23.934 -6.555 1041 6.947937069 30.492 27.212 23.934 -6.561 1042 6.94869522 30.502 27.222 23.944 -6.560 1043 6.949856455 30.505 27.222 23.944 -6.560 1044 6.95614768 30.505 27.222 23.944 -6.560 1044 6.95642443 30.513 27.222 23.945 -6.550 1045 6.95642443 </td <td>1031</td> <td>6.938284484</td> <td>30.463</td> <td>27.189</td> <td>23.914</td> <td>-6.549</td> <td></td>	1031	6.938284484	30.463	27.189	23.914	-6.549	
1033 6.940222469 30.47 27.196 23.922 -6.548 1034 6.94119056 30.475 27.200 23.924 -6.551 1035 6.942156706 30.475 27.200 23.924 -6.552 1037 6.944087208 30.475 27.200 23.924 -6.552 1038 6.9440551064 30.467 27.199 23.933 -6.537 1039 6.946013991 30.48 27.271 23.933 -6.557 1041 6.946975992 30.491 27.213 23.933 -6.556 1042 6.948897222 30.495 27.212 23.934 -6.556 1043 6.949896455 30.502 27.222 23.941 -6.566 1044 6.958177164 30.502 27.222 23.944 -6.558 1046 6.9587286454 30.502 27.222 23.944 -6.556 1047 6.95828464 30.502 27.222 23.947 -6.549 1048 6.95428608 30.542 27.222 23.947 -6.551 1050 6.956546443 30.514 27.226 23.962 -6.553 1051 6.956392608 30.564 27.226 23.966 -6.552 1052 6.9522608 30.564 27.226 23.966 -6.552 1053 6.961296046 30.564 27.226 23.961 -6.603 1054 6.960247729 30.564 27.226 23.961 -6.615 1055 6.96	1032	6.939253946	30.464	27.191	23.918	-6.546	
1034 6.941190055 30.473 27.198 23.922 -6.551 1035 6.943122423 30.476 27.200 23.924 -6.552 1037 6.944087208 30.475 27.202 23.928 -6.547 1038 6.94651048 30.487 27.199 23.933 -6.537 1039 6.94651048 30.487 27.207 23.933 -6.547 1040 6.946979292 30.491 27.215 23.937 -6.555 1041 6.947937069 30.492 27.215 23.937 -6.555 1042 6.948987222 30.495 27.222 23.944 -6.558 1043 6.951772164 30.502 27.222 23.944 -6.558 1044 6.95014768 30.505 27.222 23.944 -6.558 1046 6.952728645 30.505 27.222 23.944 -6.558 1046 6.954737371 30.505 27.223 23.948 -6.557 1051 6.957497371 30.513 27.236 23.959 -6.557 1051 6.957497371 30.552 27.242 23.964 -6.556 1053 6.96394723 30.564 27.262 23.966 -6.592 1055 6.961243643 30.544 27.262 23.966 -6.656 1054 6.96347729 30.564 27.262 23.966 -6.602 1055 6.961243644 30.574 27.267 23.966 -6.613 1056 6.96	1033	6.940222469	30.47	27.196	23.922	-6.548	
1035 6.942156706 30.475 27.200 23.924 46.551 1036 6.944087708 30.476 27.200 23.928 46.552 1038 6.946087708 30.475 27.202 23.928 46.547 1038 6.946015992 30.481 27.2719 23.393 46.577 1040 6.946975992 30.491 27.213 23.933 46.557 1041 6.947937069 30.492 27.215 23.937 46.556 1042 6.948987222 30.495 27.217 23.393 46.556 1043 6.9498768455 30.502 27.222 23.944 46.560 1044 6.9581772164 30.502 27.222 23.944 46.560 1044 6.956278645 30.505 27.222 23.947 46.569 1045 6.951772164 30.504 27.222 23.947 46.550 1046 6.95278645 30.513 27.222 23.943 46.550 1050 6.96644433 30.512 27.236 23.957 46.557 1051 6.957497371 30.513 27.236 23.959 46.556 1053 6.969398512 30.52 27.242 23.964 46.556 1054 6.96024172 30.568 27.262 23.966 45.92 1055 6.961296046 30.564 27.267 23.961 46.03 1056 6.962243464 30.563 27.267 23.961 46.03 1056 6.961	1034	6.941190055	30.473	27.198	23.922	-6.551	
10366.94312242330.47627.20023.924 -6.552 10376.94408720630.47527.20223.928 -6.547 10386.9465106430.48727.19923.933 -6.537 10406.9469759230.49127.21323.393 -6.557 10416.94793706930.49227.21523.3937 -6.555 10426.9489722230.49227.21723.939 -6.556 10436.94985645530.50227.22223.944 -6.5661 10446.95081476830.50227.22223.944 -6.558 10446.95081476830.50227.22223.944 -6.558 10466.95272864530.50527.22323.944 -6.558 10466.95463886530.49827.22323.947 -6.549 10486.95463886530.49827.22323.945 -6.557 10516.95749737130.51327.23623.957 -6.557 10516.954939851230.5227.24223.964 -6.558 10536.95939851230.5227.24223.964 -6.562 10566.9612464330.56427.26523.965 -6.599 10566.96224346430.56427.26523.961 -6.602 10566.96136037630.56127.26723.961 -6.603 10576.96384398630.56327.26223.961 -6.603 10566.9669713930.57327.2767 </td <td>1035</td> <td>6.942156706</td> <td>30,475</td> <td>27.200</td> <td>23.924</td> <td>-6.551</td> <td></td>	1035	6.942156706	30,475	27.200	23.924	-6.551	
1037 6.944087208 30.475 27.202 23.928 $4.6.547$ 1038 6.94601391 30.467 27.199 23.93 $4.6.547$ 1040 6.946075992 30.491 27.213 23.933 $4.6.547$ 1041 6.946975992 30.491 27.215 23.933 $4.6.557$ 1041 6.946975992 30.492 27.217 23.933 $4.6.556$ 1042 6.948897222 30.495 27.217 23.939 $4.6.556$ 1044 6.95074768 30.502 27.222 23.944 $4.6.560$ 1044 6.950724645 30.502 27.222 23.944 $4.6.560$ 1045 6.95772645 30.502 27.222 23.944 $4.6.560$ 1046 6.95672645 30.502 27.222 23.947 $4.6.549$ 1047 6.956845121 30.496 27.222 23.947 $4.6.560$ 1049 6.9565456433 30.514 27.223 23.947 $4.6.560$ 1050 6.956454433 30.512 27.242 23.961 $4.6.564$ 1052 6.958448393 30.52 27.242 23.964 $4.6.566$ 1054 6.961296046 30.564 27.262 23.965 $4.6.562$ 1055 6.961296046 30.564 27.262 23.961 $4.6.603$ 1056 6.96224444 30.564 27.262 23.961 $4.6.603$ 1056 6.96224444 30.564 27.267 23.962 $4.6.615$ 10	1036	6,943122423	30,476	27,200	23,924	-6.552	
10386.94606106430.46727.19923.93 -6.537 10396.94601399130.4827.20723.933 -6.547 10406.9469759230.49127.21523.937 -6.557 10416.94793706930.49227.21523.939 -6.556 10426.9488072230.49527.21723.939 -6.556 10436.9498644530.50227.22223.941 -6.561 10446.95081476830.50227.22223.944 -6.561 10446.95081476830.50527.22223.944 -6.561 10446.954872864530.50527.22223.943 -6.558 10466.9572864530.50427.22223.943 -6.556 10476.95559200830.50427.22223.954 -6.550 10516.955444330.51427.23623.959 -6.554 10526.956443330.51227.24223.962 -6.556 10536.96034772930.55827.26223.961 -6.603 10546.96034772930.56427.26223.961 -6.603 10556.96129604630.56427.26223.961 -6.603 10566.96224344430.56427.26223.961 -6.603 10556.96129604630.56927.26723.962 -6.613 10566.9670302630.57127.27723.962 -6.613 10616.9669437830.58127.2742	1037	6 944087208	30 475	27 202	23 928	-6.547	
10336.94001399130.4827.20723.933 -6.557 10406.94697599230.49127.21323.934 -6.557 10416.94793706930.49227.21723.933 -6.555 10426.94889722230.49527.22123.933 -6.556 10436.94986645530.50227.22223.944 -6.560 10446.9508177216430.50227.22223.944 -6.560 10456.95177216430.50227.22223.944 -6.560 10476.95368421130.49627.22223.947 -6.549 10486.956272864530.50427.22223.943 -6.550 10506.95654544330.51427.23623.957 -6.557 10516.95749737130.51327.26623.959 -6.558 10536.95939851230.55227.24123.964 -6.558 10546.96034772930.56427.26523.966 -6.632 10556.96129604630.56427.26523.961 -6.603 10576.96613998630.56327.26223.961 -6.602 10586.966713930.57127.27723.962 -6.613 10616.96696713930.57127.26723.962 -6.613 10636.9679090730.58127.27423.966 -6.615 10636.9679090730.58127.27423.966 -6.615 10646.9697906730.58127.274 </td <td>1038</td> <td>6 945051064</td> <td>30 467</td> <td>27 199</td> <td>23.93</td> <td>-6 537</td> <td></td>	1038	6 945051064	30 467	27 199	23.93	-6 537	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	1030	6 0/6013001	30.48	27.100	23.03	-6 547	
10400.3405/03920.34127.21523.393-6.55510426.94889722230.49527.21723.939-6.55510436.94885645530.50227.22223.944-6.56010446.95081476830.50227.22223.944-6.56010456.9587264530.50227.22323.944-6.56010466.9527264530.50527.22523.945-6.56010476.95368421130.49627.22223.945-6.56010486.9527260530.50427.22923.945-6.55010506.95654543330.51427.23623.957-6.55710516.95749737130.51327.23623.959-6.55410536.95939851230.5227.24123.966-6.59210556.96129604630.56427.26523.965-6.59910566.96129604630.56427.26223.965-6.60210586.96413661230.56327.26223.961-6.60210586.96413661230.56327.26723.962-6.61310666.9609034630.56427.276723.962-6.61310616.9669034630.58127.27423.966-6.61310646.9697090730.58127.27423.966-6.61310646.96739030730.58127.27423.966-6.61310646.9673090730.58127.27423.969-6.614<	1033	6.046075002	20.401	27.207	23.333	6 557	
1041 0.34737063 30.492 27.215 23.937 -6.535 1043 6.949856455 30.502 27.222 23.941 -6.566 1044 6.950814768 30.502 27.222 23.944 -6.566 1044 6.950814768 30.502 27.223 23.944 -6.560 1046 6.951772164 30.502 27.222 23.944 -6.569 1046 6.952728645 30.505 27.222 23.944 -6.569 1047 6.95684211 30.496 27.222 23.944 -6.559 1048 6.956592608 30.504 27.223 23.948 -6.550 1050 6.95654443 30.514 27.226 23.957 -6.557 1051 6.957497371 30.513 27.236 23.962 -6.556 1052 6.958448393 30.52 27.241 23.962 -6.556 1054 6.960347729 30.558 27.262 23.964 -6.566 1055 6.961296046 30.564 27.263 23.961 -6.603 1056 6.96224464 30.564 27.265 23.961 -6.603 1058 6.966274187 30.573 27.277 23.962 -6.615 1068 6.9663718 30.571 27.277 23.962 -6.615 1068 6.96863078 30.581 27.274 23.966 -6.615 1066 6.97166605 30.591 27.284 23.977 -6.623 <td>1040</td> <td>0.940975992</td> <td>30.491</td> <td>27.213</td> <td>23.934</td> <td>-0.557</td> <td></td>	1040	0.940975992	30.491	27.213	23.934	-0.557	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	1041	0.947937069	30.492	27.213	23.937	-0.000	
1043 6.949850455 30.504 27.224 23.944 -6.560 1044 6.9507244768 30.502 27.223 23.944 -6.560 1045 6.951772164 30.502 27.223 23.944 -6.560 1047 6.95368451 30.496 27.222 23.947 -6.549 1048 6.9563864211 30.496 27.223 23.947 -6.550 1049 6.956592608 30.504 27.223 23.947 -6.550 1050 6.956545433 30.514 27.236 23.957 -6.557 1051 6.957497371 30.513 27.242 23.964 -6.556 1052 6.958448393 30.52 27.242 23.966 -6.556 1054 6.960347729 30.558 27.262 23.966 -6.592 1055 6.961296046 30.564 27.265 23.966 -6.603 1057 6.963189866 30.563 27.262 23.961 -6.603 1058 6.966024187 30.573 27.267 23.962 -6.615 1060 6.966024187 30.573 27.277 23.962 -6.615 1063 6.96880378 30.581 27.274 23.966 -6.615 1064 6.96790920 30.571 27.276 23.966 -6.615 1063 6.9678067 30.581 27.274 23.966 -6.615 1064 6.9679067 30.581 27.274 23.976 -6.625 1066 6.974	1042	0.948897222	30.495	27.217	23.939	-0.550	
1044 6.950814768 30.504 27.223 23.944 -6.568 1046 6.952728645 30.502 27.223 23.944 -6.558 1047 6.953684211 30.496 27.222 23.947 -6.560 1047 6.953684211 30.498 27.223 23.944 -6.550 1049 6.9565382608 30.504 27.229 23.948 -6.550 1050 6.95654543 30.514 27.236 23.957 -6.557 1051 6.95749731 30.513 27.236 23.959 -6.554 1052 6.958448393 30.52 27.241 23.962 -6.558 1053 6.959398512 30.558 27.262 23.966 -6.592 1055 6.961296046 30.564 27.265 23.961 -6.602 1056 6.962243464 30.564 27.262 23.961 -6.605 1058 6.964135612 30.563 27.267 23.961 -6.605 1059 6.965080346 30.569 27.267 23.962 -6.613 1060 6.966967139 30.571 27.277 23.962 -6.615 1062 6.967909202 30.5771 27.274 23.966 -6.615 1065 6.970730078 30.581 27.274 23.966 -6.615 1066 6.97168605 30.591 27.282 23.975 -6.623 1070 6.972478911 30.6 27.284 23.975 -6.623 1066 6.971	1043	6.949856455	30.502	27.222	23.941	-6.561	
1046 6.951772164 30.505 27.223 23.944 -6.558 1047 6.953684211 30.496 27.222 23.947 -6.549 1048 6.9565884211 30.496 27.222 23.944 -6.550 1049 6.955592608 30.504 27.223 23.954 -6.550 1050 6.95645443 30.514 27.226 23.957 -6.557 1051 6.957497371 30.513 27.236 23.959 -6.554 1052 6.958484333 30.52 27.241 23.962 -6.558 1053 6.959398512 30.52 27.242 23.964 -6.556 1054 6.960347729 30.564 27.263 23.966 -6.592 1055 6.961290646 30.564 27.263 23.961 -6.603 1057 6.963189986 30.564 27.262 23.961 -6.602 1058 6.9661399863162 30.569 27.267 23.961 -6.603 1060 6.966024187 30.571 27.267 23.962 -6.613 1061 6.966880376 30.581 27.274 23.966 -6.615 1062 6.967909202 30.577 27.270 23.962 -6.615 1064 6.967909202 30.571 27.276 23.969 -6.615 1064 6.967909207 30.581 27.274 23.966 -6.615 1066 6.97364302 30.591 27.274 23.969 $-$	1044	6.950814768	30.504	27.224	23.944	-6.560	
1046 6.952728645 30.505 27.225 23.945 -6.560 1044 6.953684211 30.496 27.222 23.947 -6.549 1048 6.955592608 30.504 27.229 23.954 -6.550 1050 6.956545433 30.514 27.236 23.957 -6.557 1051 6.957497371 30.513 27.236 23.959 -6.558 1052 6.958448333 30.52 27.241 23.962 -6.558 1053 6.959398512 30.52 27.242 23.964 -6.556 1054 6.960347729 30.558 27.262 23.965 -6.599 1056 6.961296046 30.564 27.265 23.965 -6.603 1057 6.963189986 30.563 27.262 23.961 -6.603 1056 6.96243464 30.564 27.267 23.961 -6.603 1056 6.964135612 30.563 27.267 23.962 -6.613 1060 6.966980347 30.571 27.277 23.962 -6.615 1062 6.967909202 30.571 27.277 23.966 -6.615 1064 6.96979067 30.581 27.274 23.966 -6.615 1065 6.970730078 30.581 27.274 23.966 -6.615 1066 6.971686055 30.591 27.282 23.977 -6.623 1066 6.97478911 30.6 27.284 23.977 -6.623 </td <td>1045</td> <td>6.951772164</td> <td>30.502</td> <td>27.223</td> <td>23.944</td> <td>-6.558</td> <td></td>	1045	6.951772164	30.502	27.223	23.944	-6.558	
1047 6.953684211 30.496 27.222 23.947 -6.549 1048 6.955692608 30.504 27.229 23.954 -6.550 1050 6.95645443 30.514 27.236 23.957 -6.557 1051 6.957497371 30.513 27.236 23.959 -6.554 1052 6.957497371 30.52 27.241 23.962 -6.558 1053 6.959398512 30.52 27.242 23.964 -6.556 1054 6.960347729 30.558 27.262 23.966 -6.592 1056 6.962243464 30.564 27.263 23.961 -6.603 1057 6.96139986 30.563 27.262 23.961 -6.602 1058 6.964135612 30.569 27.267 23.961 -6.605 1059 6.96603418 30.573 27.267 23.961 -6.605 1060 6.966924187 30.573 27.267 23.961 -6.615 1061 6.966967133 30.571 27.272 23.966 -6.615 1064 6.96799067 30.581 27.274 23.966 -6.615 1064 6.9679067 30.581 27.276 23.974 -6.620 1068 6.97073078 30.591 27.274 23.966 -6.614 1066 6.97168605 30.591 27.282 23.977 -6.623 1066 6.97168605 30.591 27.282 23.977 -6.625 <	1046	6.952728645	30.505	27.225	23.945	-6.560	
1048 6.954638865 30.498 27.223 23.948 -6.550 1049 6.95592608 30.504 27.226 23.954 -6.550 1050 6.95645443 30.514 27.236 23.957 -6.557 1051 6.957497371 30.513 27.236 23.959 -6.554 1052 6.95848393 30.52 27.241 23.962 -6.556 1053 6.959398512 30.52 27.242 23.964 -6.556 1054 6.960347729 30.558 27.262 23.966 -6.592 1056 6.962243464 30.564 27.265 23.966 -6.603 1057 6.963189986 30.563 27.262 23.961 -6.602 1058 6.960243464 30.564 27.265 23.961 -6.605 1059 6.965080346 30.569 27.267 23.962 -6.605 1060 6.966024187 30.573 27.277 23.962 -6.613 1061 6.966024187 30.577 27.270 23.962 -6.615 1062 6.9679067 30.581 27.274 23.966 -6.615 1063 6.96850378 30.581 27.274 23.966 -6.615 1064 6.9679067 30.581 27.274 23.966 -6.615 1066 6.97066251 30.594 27.284 23.974 -6.625 1066 6.974478911 30.595 27.288 23.975 -6.625 1066 6.97634807	1047	6.953684211	30.496	27.222	23.947	-6.549	
1049 6.955592608 30.504 27.229 23.954 -6.550 1050 6.95645443 30.514 27.236 23.957 -6.557 1051 6.957497371 30.513 27.236 23.959 -6.558 1052 6.958448393 30.52 27.241 23.962 -6.556 1054 6.960347729 30.558 27.262 23.964 -6.556 1055 6.961296046 30.564 27.265 23.966 -6.592 1056 6.962243464 30.564 27.262 23.961 -6.603 1057 6.96318986 30.563 27.262 23.961 -6.602 1058 6.964135612 30.565 27.262 23.961 -6.602 1059 6.965080346 30.569 27.267 23.962 -6.613 1060 6.96697139 30.571 27.277 23.962 -6.613 1061 6.96697139 30.571 27.277 23.962 -6.615 1063 6.96850378 30.581 27.274 23.966 -6.615 1064 6.967909707 30.581 27.274 23.966 -6.615 1065 6.97109078 30.591 27.288 23.972 -6.616 1066 6.97168605 30.591 27.288 23.972 -6.613 1066 6.97478911 30.692 27.288 23.975 -6.622 1070 6.97478917 30.598 27.288 23.975 -6.622 1071 6.9728134	1048	6.954638865	30.498	27.223	23.948	-6.550	
1050 6.956454343 30.514 27.236 23.957 -6.557 1051 6.957497371 30.513 27.236 23.959 -6.554 1052 6.958448393 30.52 27.241 23.964 -6.556 1054 6.960347729 30.558 27.262 23.966 -6.592 1056 6.96126046 30.564 27.265 23.966 -6.592 1056 6.962243464 30.564 27.265 23.961 -6.603 1057 6.963189986 30.563 27.262 23.961 -6.602 1058 6.964136612 30.565 27.263 23.961 -6.605 1059 6.96508346 30.569 27.267 23.96 -6.613 1060 6.966024187 30.571 27.267 23.962 -6.613 1061 6.96697139 30.571 27.274 23.966 -6.615 1063 6.968850378 30.581 27.274 23.966 -6.615 1064 6.96979067 30.581 27.274 23.966 -6.615 1066 6.97168605 30.591 27.282 23.972 -6.625 1068 6.9734302 30.591 27.284 23.975 -6.625 1069 6.974478911 30.6 27.289 23.977 -6.623 1071 6.9764307 30.598 27.288 23.976 -6.625 1069 6.974478911 30.697 27.289 23.981 -6.613 <td>1049</td> <td>6.955592608</td> <td>30.504</td> <td>27.229</td> <td>23.954</td> <td>-6.550</td> <td></td>	1049	6.955592608	30.504	27.229	23.954	-6.550	
1051 6.957497371 30.513 27.236 23.959 -6.554 1052 6.958448393 30.52 27.241 23.962 -6.556 1054 6.960347729 30.558 27.262 23.966 -6.592 1055 6.961296046 30.564 27.263 23.961 -6.603 1057 6.963189986 30.564 27.263 23.961 -6.602 1057 6.963189986 30.565 27.263 23.961 -6.602 1057 6.963189986 30.569 27.263 23.961 -6.602 1058 6.964135612 30.569 27.267 23.961 -6.608 1060 6.966924187 30.573 27.267 23.962 -6.613 1061 6.96697139 30.571 27.277 23.962 -6.615 1062 6.9679067 30.581 27.274 23.966 -6.615 1064 6.9697067 30.581 27.277 23.962 -6.615 1064 6.9697067 30.581 27.274 23.966 -6.615 1066 6.97168605 30.591 27.282 23.972 -6.619 1067 6.97354302 30.594 27.284 23.975 -6.625 1068 6.973473927 30.598 27.282 23.976 -6.625 1068 6.97354302 30.598 27.289 23.976 -6.625 1072 6.97264327 30.598 27.289 23.976 -6.622 </td <td>1050</td> <td>6.956545443</td> <td>30.514</td> <td>27.236</td> <td>23.957</td> <td>-6.557</td> <td></td>	1050	6.956545443	30.514	27.236	23.957	-6.557	
1052 6.958448393 30.52 27.241 23.962 -6.558 1053 6.959398512 30.52 27.242 23.964 -6.556 1054 6.960347729 30.558 27.262 23.966 -6.592 1055 6.961296046 30.564 27.265 23.965 -6.599 1056 6.962243464 30.564 27.262 23.961 -6.603 1057 6.963189866 30.565 27.262 23.961 -6.602 1058 6.964135612 30.565 27.262 23.961 -6.608 1059 6.965080346 30.565 27.267 23.962 -6.613 1060 6.966024187 30.571 27.267 23.962 -6.613 1061 6.966967139 30.571 27.277 23.962 -6.615 1062 6.967909202 30.577 27.277 23.966 -6.615 1063 6.968850378 30.581 27.274 23.966 -6.615 1064 6.96979067 30.581 27.274 23.966 -6.615 1066 6.97166805 30.591 27.284 23.972 -6.619 1067 6.972606251 30.598 27.288 23.975 -6.620 1068 6.97354302 30.6 27.289 23.976 -6.620 1071 6.97634807 30.598 27.289 23.982 -6.613 1072 6.97281342 30.597 27.289 23.981 -6.616 <td>1051</td> <td>6.957497371</td> <td>30.513</td> <td>27.236</td> <td>23.959</td> <td>-6.554</td> <td></td>	1051	6.957497371	30.513	27.236	23.959	-6.554	
1053 6.959398512 30.52 27.242 23.964 -6.556 1054 6.960347729 30.558 27.262 23.966 -6.592 1055 6.961296046 30.564 27.263 23.961 -6.603 1057 6.962243464 30.564 27.263 23.961 -6.603 1057 6.963189986 30.563 27.262 23.961 -6.603 1058 6.964135612 30.565 27.263 23.961 -6.603 1059 6.965080346 30.573 27.267 23.962 -6.608 1060 6.966024187 30.573 27.267 23.962 -6.613 1061 6.966967139 30.571 27.267 23.962 -6.615 1063 6.968850378 30.581 27.274 23.966 -6.615 1064 6.96979067 30.581 27.276 23.969 -6.614 1065 6.970730078 30.583 27.276 23.969 -6.614 1066 6.97168605 30.594 27.284 23.974 -6.620 1068 6.97354302 30.66 27.288 23.975 -6.623 1070 6.97634807 30.598 27.287 23.976 -6.623 1070 6.97634807 30.595 27.289 23.981 -6.613 1072 6.977281342 30.595 27.289 23.982 -6.616 1074 6.97243743 30.597 27.289 23.985 -6.616 <td>1052</td> <td>6.958448393</td> <td>30.52</td> <td>27.241</td> <td>23.962</td> <td>-6.558</td> <td></td>	1052	6.958448393	30.52	27.241	23.962	-6.558	
1054 6.960347729 30.558 27.262 23.966 -6.592 1055 6.961296046 30.564 27.265 23.961 -6.603 1057 6.962243464 30.564 27.262 23.961 -6.602 1058 6.96218986 30.565 27.262 23.961 -6.602 1058 6.964135612 30.565 27.262 23.961 -6.603 1059 6.965080346 30.569 27.265 23.961 -6.608 1060 6.966024187 30.573 27.267 23.962 -6.613 1061 6.96607139 30.571 27.277 23.962 -6.615 1062 6.967909202 30.571 27.270 23.962 -6.615 1063 6.968850378 30.581 27.274 23.966 -6.615 1064 6.96979067 30.581 27.274 23.966 -6.615 1064 6.96979067 30.581 27.272 23.972 -6.614 1066 6.971608605 30.591 27.282 23.972 -6.619 1067 6.972606251 30.594 27.284 23.974 -6.620 1076 6.97634307 30.588 27.287 23.976 -6.623 1070 6.972413927 30.595 27.289 23.976 -6.622 1071 6.97634807 30.595 27.289 23.981 -6.616 1072 6.970243743 30.595 27.292 23.985 -6.616 <	1053	6.959398512	30.52	27.242	23.964	-6.556	
1055 6.961296046 30.564 27.265 23.965 -6.599 1056 6.962243464 30.564 27.263 23.961 -6.603 1057 6.96318986 30.563 27.262 23.961 -6.602 1058 6.964135612 30.565 27.263 23.961 -6.602 1059 6.965080346 30.559 27.265 23.961 -6.608 1060 6.966024187 30.573 27.267 23.962 -6.613 1061 6.966967139 30.571 27.277 23.962 -6.615 1062 6.96790202 30.577 27.274 23.966 -6.615 1063 6.968850378 30.581 27.274 23.966 -6.615 1064 6.96979067 30.581 27.274 23.966 -6.615 1065 6.970730078 30.583 27.276 23.969 -6.614 1066 6.971668605 30.591 27.282 23.972 -6.619 1067 6.972606251 30.594 27.288 23.975 -6.620 1068 6.974478911 30.6 27.289 23.977 -6.623 1070 6.978213743 30.595 27.289 23.982 -6.613 1072 6.97030781 30.598 27.289 23.982 -6.613 1071 6.97634807 30.595 27.289 23.982 -6.613 1072 6.9707281342 30.595 27.292 23.985 -6.616 <	1054	6.960347729	30,558	27.262	23.966	-6.592	
10566.96224346430.56427.26323.961-6.60310576.96318998630.56327.26223.961-6.60210586.96413561230.56527.26323.96-6.60510596.96508034630.56927.26523.961-6.60810606.96602418730.57327.26723.962-6.61310616.9696713930.57127.26723.962-6.61510626.96790920230.57727.27023.962-6.61510636.96885037830.58127.27423.966-6.61510646.9697906730.58127.27423.966-6.61510656.97073007830.58327.27623.962-6.61910666.97166860530.59127.28223.972-6.61910666.97060625130.59427.28423.975-6.62510696.97447891130.627.28923.975-6.62310706.97541392730.59827.28723.976-6.62210716.9763480730.59827.28923.976-6.61310736.97821374330.59727.28923.981-6.61610746.97914527530.60127.29223.981-6.61610756.98007594130.59827.29423.999-6.60810766.98103674130.59827.29423.999-6.60810776.98193467730.60327.29423.999-6.608 <tr< td=""><td>1055</td><td>6.961296046</td><td>30.564</td><td>27.265</td><td>23.965</td><td>-6.599</td><td></td></tr<>	1055	6.961296046	30.564	27.265	23.965	-6.599	
1057 6.963189966 30.563 27.262 23.961 -6.602 1058 6.964135612 30.565 27.263 23.96 -6.605 1059 6.965080346 30.569 27.265 23.961 -6.608 1060 6.966024187 30.573 27.267 23.962 -6.609 1061 6.966967139 30.571 27.270 23.962 -6.613 1061 6.966967139 30.577 27.270 23.962 -6.615 1063 6.96850378 30.581 27.274 23.966 -6.615 1064 6.96979067 30.581 27.274 23.966 -6.615 1064 6.96979067 30.583 27.276 23.969 -6.614 1065 6.970730078 30.583 27.276 23.969 -6.614 1066 6.97166805 30.594 27.284 23.972 -6.619 1067 6.972606251 30.594 27.284 23.974 -6.620 1068 6.97354302 30.6 27.289 23.977 -6.623 1070 6.975413927 30.598 27.287 23.976 -6.622 1071 6.97281342 30.597 27.289 23.982 -6.613 1072 6.9707281342 30.597 27.289 23.982 -6.616 1074 6.97145275 30.601 27.292 23.988 -6.607 1075 6.980075941 30.598 27.292 23.985 -6.616 <td>1056</td> <td>6.962243464</td> <td>30.564</td> <td>27.263</td> <td>23.961</td> <td>-6.603</td> <td></td>	1056	6.962243464	30.564	27.263	23.961	-6.603	
1057 6.964136612 30.565 27.263 23.961 -6.605 1059 6.965080346 30.569 27.265 23.961 -6.608 1060 6.966024187 30.573 27.267 23.962 -6.613 1061 6.966967139 30.571 27.267 23.962 -6.609 1062 6.967909202 30.577 27.270 23.962 -6.615 1063 6.968850378 30.581 27.274 23.966 -6.615 1064 6.96979067 30.581 27.274 23.966 -6.615 1065 6.970730078 30.583 27.274 23.966 -6.615 1064 6.96979067 30.581 27.274 23.966 -6.615 1065 6.970730078 30.583 27.276 23.962 -6.614 1066 6.971668605 30.591 27.282 23.972 -6.619 1067 6.972606251 30.594 27.284 23.975 -6.620 1068 6.97354302 30.6 27.289 23.977 -6.623 1070 6.975413927 30.598 27.287 23.976 -6.620 1071 6.97634807 30.598 27.289 23.981 -6.616 1072 6.97145275 30.601 27.293 23.985 -6.616 1073 6.978213743 30.595 27.292 23.988 -6.616 1074 6.981005741 30.598 27.294 23.99 -6.608 1075 6.98007	1057	6 963189986	30 563	27 262	23 961	-6 602	
10556.96508034630.56927.26523.961-6.60810606.96602418730.57327.26723.962-6.61310616.96696713930.57127.26723.962-6.60910626.96790920230.57727.27023.962-6.61510636.96885037830.58127.27423.966-6.61510646.9697906730.58127.27423.966-6.61510656.97073007830.58327.27423.969-6.61410666.9716860530.59127.28223.972-6.61910676.97260625130.59427.28423.974-6.62010686.9735430230.627.28923.975-6.62510696.97447891130.627.28923.975-6.62210706.9763480730.59827.28723.976-6.62010716.9763480730.59827.28923.978-6.61310726.97728134230.59727.28923.982-6.61310736.97821374330.59727.28923.985-6.61610746.97914527530.60127.29323.985-6.61610756.98007594130.59827.29423.995-6.60810766.98100574130.59827.29423.995-6.60810766.98100574130.60327.29923.995-6.60810766.9810367730.60827.30423.999-6.609 <td< td=""><td>1058</td><td>6 964135612</td><td>30 565</td><td>27 263</td><td>23.96</td><td>-6 605</td><td></td></td<>	1058	6 964135612	30 565	27 263	23.96	-6 605	
1033 0.305000347 30.573 27.267 23.96 -6.613 1060 6.966024187 30.573 27.267 23.962 -6.609 1062 6.966967139 30.571 27.270 23.962 -6.615 1063 6.968850378 30.581 27.274 23.966 -6.615 1064 6.96979067 30.581 27.274 23.966 -6.615 1065 6.970730078 30.583 27.276 23.969 -6.614 1066 6.971668605 30.591 27.282 23.972 -6.619 1067 6.972606251 30.594 27.284 23.974 -6.620 1068 6.97354302 30.6 27.289 23.977 -6.623 1069 6.974478911 30.6 27.289 23.976 -6.622 1070 6.975413927 30.598 27.287 23.976 -6.622 1071 6.97634807 30.595 27.289 23.978 -6.613 1072 6.971281342 30.595 27.289 23.982 -6.613 1073 6.978213743 30.597 27.289 23.985 -6.616 1074 6.979145275 30.601 27.292 23.988 -6.607 1076 6.981005741 30.598 27.294 23.99 -6.608 1077 6.981934677 30.608 27.299 23.995 -6.608 1078 6.982862751 30.608 27.308 24.001 -6.614 <td>1050</td> <td>6.965080346</td> <td>30 569</td> <td>27.265</td> <td>23.061</td> <td>-6 608</td> <td></td>	1050	6.965080346	30 569	27.265	23.061	-6 608	
1000 0.30024407 30.571 27.207 23.962 -0.013 1061 6.966967139 30.571 27.267 23.962 -6.619 1062 6.967909202 30.577 27.270 23.962 -6.615 1063 6.968850378 30.581 27.274 23.966 -6.615 1064 6.96979067 30.581 27.274 23.966 -6.615 1065 6.970730078 30.583 27.276 23.969 -6.614 1066 6.971668605 30.591 27.282 23.972 -6.619 1067 6.972606251 30.594 27.284 23.974 -6.620 1068 6.97354302 30.6 27.288 23.975 -6.625 1069 6.974478911 30.6 27.289 23.976 -6.622 1070 6.975413927 30.598 27.287 23.976 -6.622 1071 6.97634807 30.598 27.289 23.978 -6.613 1072 6.977281342 30.597 27.289 23.982 -6.613 1073 6.978213743 30.597 27.289 23.985 -6.616 1074 6.979145275 30.601 27.292 23.988 -6.607 1076 6.981005741 30.598 27.294 23.999 -6.608 1077 6.981934677 30.603 27.299 23.995 -6.608 1078 6.982862751 30.608 27.308 24.001 -6.614 <td>1059</td> <td>6.966024187</td> <td>30.503</td> <td>27.203</td> <td>23.901</td> <td>-6.613</td> <td></td>	1059	6.966024187	30.503	27.203	23.901	-6.613	
1001 0.90907139 30.977 27.207 23.902 -0.009 1062 6.967909202 30.577 27.270 23.962 -6.615 1063 6.968850378 30.581 27.274 23.966 -6.615 1064 6.96979067 30.581 27.274 23.966 -6.615 1065 6.970730078 30.583 27.276 23.969 -6.614 1066 6.971668605 30.591 27.282 23.972 -6.619 1067 6.972606251 30.594 27.284 23.974 -6.620 1068 6.97354302 30.6 27.288 23.975 -6.625 1069 6.974478911 30.6 27.289 23.977 -6.623 1070 6.975413927 30.598 27.287 23.976 -6.622 1071 6.97634807 30.595 27.289 23.978 -6.613 1072 6.977281342 30.597 27.289 23.982 -6.613 1073 6.978213743 30.597 27.293 23.985 -6.616 1074 6.981005741 30.595 27.292 23.988 -6.607 1076 6.981005741 30.598 27.294 23.999 -6.608 1077 6.981934677 30.603 27.294 23.999 -6.608 1078 6.982862751 30.6045 27.304 23.999 -6.609 1079 6.983789965 30.615 27.308 24.001 -6.614 </td <td>1060</td> <td>6.066067120</td> <td>20.573</td> <td>27.207</td> <td>23.90</td> <td>-0.013</td> <td></td>	1060	6.066067120	20.573	27.207	23.90	-0.013	
1062 6.967909202 30.577 27.270 23.962 -6.615 1063 6.968850378 30.581 27.274 23.966 -6.615 1064 6.96979067 30.581 27.274 23.966 -6.615 1065 6.970730078 30.583 27.276 23.969 -6.614 1066 6.971668605 30.591 27.282 23.972 -6.619 1067 6.972606251 30.594 27.284 23.974 -6.620 1068 6.97354302 30.6 27.288 23.975 -6.625 1069 6.974478911 30.6 27.289 23.977 -6.623 1070 6.975413927 30.598 27.287 23.976 -6.622 1071 6.97634807 30.595 27.289 23.982 -6.613 1072 6.972813743 30.597 27.289 23.981 -6.616 1073 6.978213743 30.595 27.293 23.985 -6.616 1075 6.980075941	1001	0.900907139	30.571	27.207	23.902	-0.009	
10050.90000007 030.50127.27423.900-0.61510646.9697906730.58127.27423.966-6.61510656.97073007830.58327.27623.969-6.61410666.97166860530.59127.28223.972-6.61910676.97260625130.59427.28423.974-6.62010686.9735430230.627.28823.975-6.62510696.97447891130.627.28923.977-6.62310706.97541392730.59827.28723.976-6.62210716.9763480730.59827.28923.978-6.62010726.97728134230.59527.28923.978-6.61310736.97821374330.59727.28923.981-6.61610746.97914527530.60127.29323.985-6.61610756.98007594130.59827.29223.988-6.60710766.98100574130.59827.29423.99-6.60810766.98100574130.59827.29423.99-6.60810766.9810574130.60327.29923.995-6.60810776.98286275130.60827.30423.995-6.60810786.98286275130.60827.30423.999-6.60910796.98378996530.61527.30824.001-6.614	1002	0.907909202	30.5//	21.210	23.902	-0.015	
10646.969/906730.58127.27423.966-6.61510656.97073007830.58327.27623.969-6.61410666.97166860530.59127.28223.972-6.61910676.97260625130.59427.28423.974-6.62010686.9735430230.627.28823.975-6.62510696.97447891130.627.28923.977-6.62310706.97541392730.59827.28723.976-6.62210716.9763480730.59827.28923.978-6.62010726.97728134230.59527.28923.982-6.61310736.97821374330.59727.28923.981-6.61610746.97914527530.60127.29323.985-6.61610756.98007594130.59527.29223.988-6.60710766.98100574130.69827.29423.99-6.60810776.98193467730.60327.29923.995-6.60810786.98286275130.60827.30423.999-6.60910796.98378996530.61527.30824.001-6.614	1063	0.908850378	30.581	27.274	23.966	-0.015	
10656.97073007830.58327.27623.969-6.61410666.97166860530.59127.28223.972-6.61910676.97260625130.59427.28423.974-6.62010686.9735430230.627.28823.975-6.62510696.97447891130.627.28923.977-6.62310706.97541392730.59827.28723.976-6.62210716.9763480730.59827.28823.978-6.62010726.97728134230.59527.28923.982-6.61310736.97821374330.59727.28923.981-6.61610746.97914527530.60127.29323.985-6.61610756.98007594130.59527.29223.988-6.60710766.98100574130.59827.29423.99-6.60810776.98193467730.60327.29923.995-6.60810786.98286275130.60827.30423.999-6.60910796.98378996530.61527.30824.001-6.614	1064	0.909/906/	30.581	21.214	23.966	-0.015	
10666.97166860530.59127.28223.972-6.61910676.97260625130.59427.28423.974-6.62010686.9735430230.627.28823.975-6.62510696.97447891130.627.28923.977-6.62310706.97541392730.59827.28723.976-6.62210716.9763480730.59827.28923.978-6.62010726.97728134230.59527.28923.982-6.61310736.97821374330.59727.28923.981-6.61610746.97914527530.60127.29323.985-6.61610756.98007594130.59527.29223.988-6.60710766.98100574130.59827.29423.99-6.60810776.98193467730.60327.29923.995-6.60810786.98286275130.60827.30423.999-6.60910796.98378996530.61527.30824.001-6.614	1065	6.970730078	30.583	27.276	23.969	-6.614	
1067 6.972606251 30.594 27.284 23.974 -6.620 1068 6.97354302 30.6 27.288 23.975 -6.625 1069 6.974478911 30.6 27.289 23.977 -6.623 1070 6.975413927 30.598 27.287 23.976 -6.622 1071 6.97634807 30.598 27.289 23.978 -6.612 1072 6.977281342 30.595 27.289 23.982 -6.613 1073 6.978213743 30.597 27.289 23.981 -6.616 1074 6.979145275 30.601 27.293 23.985 -6.616 1075 6.980075941 30.595 27.292 23.988 -6.607 1076 6.981005741 30.598 27.294 23.99 -6.608 1077 6.981934677 30.603 27.299 23.995 -6.608 1078 6.982862751 30.608 27.304 23.999 -6.609 1079 6.983789965 30.615 27.308 24.001 -6.614	1066	6.971668605	30.591	27.282	23.972	-6.619	
10686.9735430230.627.28823.975-6.62510696.97447891130.627.28923.977-6.62310706.97541392730.59827.28723.976-6.62210716.9763480730.59827.28823.978-6.62010726.97728134230.59527.28923.982-6.61310736.97821374330.59727.28923.981-6.61610746.97914527530.60127.29323.985-6.61610756.98007594130.59527.29223.988-6.60710766.98100574130.59827.29423.99-6.60810776.98193467730.60327.29923.995-6.60810786.98286275130.60827.30423.999-6.60910796.98378996530.61527.30824.001-6.614	1067	6.972606251	30.594	27.284	23.974	-6.620	
10696.97447891130.627.28923.977-6.62310706.97541392730.59827.28723.976-6.62210716.9763480730.59827.28823.978-6.62010726.97728134230.59527.28923.982-6.61310736.97821374330.59727.28923.981-6.61610746.97914527530.60127.29323.985-6.61610756.98007594130.59527.29223.988-6.60710766.98100574130.59827.29423.99-6.60810776.98193467730.60327.29923.995-6.60810786.98286275130.60827.30423.999-6.60910796.98378996530.61527.30824.001-6.614	1068	6.97354302	30.6	27.288	23.975	-6.625	
10706.97541392730.59827.28723.976-6.62210716.9763480730.59827.28823.978-6.62010726.97728134230.59527.28923.982-6.61310736.97821374330.59727.28923.981-6.61610746.97914527530.60127.29323.985-6.61610756.98007594130.59527.29223.988-6.60710766.98100574130.59827.29423.99-6.60810776.98193467730.60327.29923.995-6.60810786.98286275130.60827.30423.999-6.60910796.98378996530.61527.30824.001-6.614	1069	6.974478911	30.6	27.289	23.977	-6.623	
10716.9763480730.59827.28823.978-6.62010726.97728134230.59527.28923.982-6.61310736.97821374330.59727.28923.981-6.61610746.97914527530.60127.29323.985-6.61610756.98007594130.59527.29223.988-6.60710766.98100574130.59827.29423.99-6.60810776.98193467730.60327.29923.995-6.60810786.98286275130.60827.30423.999-6.60910796.98378996530.61527.30824.001-6.614	1070	6.975413927	30.598	27.287	23.976	-6.622	
10726.97728134230.59527.28923.982-6.61310736.97821374330.59727.28923.981-6.61610746.97914527530.60127.29323.985-6.61610756.98007594130.59527.29223.988-6.60710766.98100574130.59827.29423.99-6.60810776.98193467730.60327.29923.995-6.60810786.98286275130.60827.30423.999-6.60910796.98378996530.61527.30824.001-6.614	1071	6.97634807	30.598	27.288	23.978	-6.620	
10736.97821374330.59727.28923.981-6.61610746.97914527530.60127.29323.985-6.61610756.98007594130.59527.29223.988-6.60710766.98100574130.59827.29423.99-6.60810776.98193467730.60327.29923.995-6.60810786.98286275130.60827.30423.999-6.60910796.98378996530.61527.30824.001-6.614	1072	6.977281342	30.595	27.289	23.982	-6.613	
10746.97914527530.60127.29323.985-6.61610756.98007594130.59527.29223.988-6.60710766.98100574130.59827.29423.99-6.60810776.98193467730.60327.29923.995-6.60810786.98286275130.60827.30423.999-6.60910796.98378996530.61527.30824.001-6.614	1073	6.978213743	30.597	27.289	23.981	-6.616	
10756.98007594130.59527.29223.988-6.60710766.98100574130.59827.29423.99-6.60810776.98193467730.60327.29923.995-6.60810786.98286275130.60827.30423.999-6.60910796.98378996530.61527.30824.001-6.614	1074	6.979145275	30.601	27.293	23.985	-6.616	
10766.98100574130.59827.29423.99-6.60810776.98193467730.60327.29923.995-6.60810786.98286275130.60827.30423.999-6.60910796.98378996530.61527.30824.001-6.614	1075	6.980075941	30.595	27.292	23.988	-6.607	
1077 6.981934677 30.603 27.299 23.995 -6.608 1078 6.982862751 30.608 27.304 23.999 -6.609 1079 6.983789965 30.615 27.308 24.001 -6.614	1076	6.981005741	30.598	27.294	23.99	-6.608	
1078 6.982862751 30.608 27.304 23.999 -6.609 1079 6.983789965 30.615 27.308 24.001 -6.614	1077	6.981934677	30.603	27.299	23.995	-6.608	
1079 6.983789965 30.615 27.308 24.001 -6.614	1078	6.982862751	30.608	27.304	23.999	-6.609	
	1079	6.983789965	30.615	27.308	24.001	-6.614	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
1080	6.98471632	30.623	27.313	24.003	-6.620	
1081	6.985641818	30.63	27.316	24.002	-6.628	
1082	6.986566459	30.627	27.315	24.002	-6.625	
1083	6.987490247	30.628	27.317	24.005	-6.623	
1084	6.988413182	30.629	27.317	24.005	-6.624	
1085	6.989335266	30.627	27.315	24.003	-6.624	
1086	6.9902565	30.621	27.313	24.005	-6.616	
1087	6.991176887	30.629	27.319	24.008	-6.621	
1088	6.992096427	30.628	27.319	24.009	-6.619	
1089	6.993015123	30.633	27.323	24.012	-6.621	
1090	6.993932975	30.639	27.328	24.016	-6.623	
1091	6.994849986	30.639	27.329	24.019	-6.620	
1092	6.995766156	30.644	27.333	24.021	-6.623	
1093	6.996681488	30.647	27.334	24.021	-6.626	
1094	6.997595983	30.643	27.333	24.023	-6.620	
1095	6.998509642	30.648	27.337	24.025	-6.623	
1096	6.999422468	30.64	27.333	24.026	-6.614	
1097	7.00033446	30.643	27.336	24.029	-6.614	
1098	7.001245622	30.645	27.338	24.03	-6.615	
1099	7.002155954	30.651	27.344	24.036	-6.615	
1100	7.003065459	30.648	27.343	24.038	-6.610	
1101	7.003974137	30.657	27.349	24.041	-6.616	
1102	7.00488199	30.671	27.359	24.046	-6.625	
1103	7.005789019	30.673	27.360	24.047	-6.626	
1104	7.006695227	30.675	27.363	24.051	-6.624	
1105	7.007600614	30.679	27.365	24.05	-6.629	
1106	7.008505182	30.68	27.367	24.053	-6.627	
1107	7.009408933	30.679	27.368	24.056	-6.623	
1108	7.010311867	30.677	27.368	24.058	-6.619	
1109	7.011213987	30.681	27.371	24.06	-6.621	
1110	7.012115294	30.682	27.373	24.063	-6.619	
1111	7.01301579	30.688	27.377	24.066	-6.622	
1112	7.013915475	30.69	27.380	24.07	-6.620	
1113	7.014814351	30.685	27.379	24.073	-6.612	
1114	7.01571242	30.69	27.384	24.078	-6.612	
1115	7.016609684	30.693	27.387	24.081	-6.612	
1116	7.017506143	30.696	27.390	24.084	-6.612	
1117	7.018401799	30.697	27.391	24.085	-6.612	
1118	7.019296654	30.703	27.396	24.089	-6.614	
1119	7.020190708	30.71	27.401	24.092	-6.618	
1120	7.021083964	30.714	27.404	24.094	-6.620	
1121	7.021976423	30.716	27.408	24.099	-6.617	
1122	7.022868086	30.722	27.412	24.102	-6.620	
1123	7.023758955	30.718	27.410	24.102	-6.616	
1124	7.02464903	30.719	27.412	24.105	-6.614	
1125	7.025538315	30.719	27.414	24.108	-6.611	
1126	7.026426809	30.727	27.419	24.111	-6.616	
1127	7.027314514	30.728	27.422	24.115	-6.613	
1128	7.028201432	30.732	27.425	24.117	-6.615	
1129	7.029087564	30.736	27.428	24.12	-6.616	
1130	7.029972912	30.742	27.433	24.123	-6.619	
1131	7.030857476	30.745	27.436	24.126	-6.619	
1132	7.031741259	30.746	27.437	24.127	-6.619	
1133	7 032624261	30 747	27 438	24 128	-6 619	
1134	7.033506484	30.752	27.442	24.132	-6.620	
1135	7.03438793	30.707	27.415	24.122	-6.585	
1136	7 035268599	30 466	27 437	24 407	-6 059	
1137	7.036148494	30.253	28.093	25.933	-4.320	GENERATOR FAILS
1138	7 037027615	30.033	28 830	27 626	-2 407	
1139	7.037905963	29 739	29 266	28 792	-0.947	
		0			0.011	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	O°	
1140	7 038783541	29 378	29 477	29 575	0 197	
1141	7.03966035	28 889	29 468	30.047	1 158	
1142	7.020000000	28.000	29 345	30 278	1.100	
1142	7.041411664	28.058	29.210	30 361	2 303	
1143	7.041411004	27 738	20.035	30.331	2.503	
1144	7.042200172	27.730	28.831	30.234	2.333	
1146	7.040100010	27.075	28.582	30.089	3.01/	
1140	7.044032037	26.73	28.302	29,906	3 176	
1148	7.044303117	26.79	28.052	29.300	3 3 2 4	
1140	7.046647278	26.051	27 791	29.53	3.024	
1150	7.040047270	25.729	27.531	20.00	3 603	
1150	7.047317221	25.725	27.001	29.002	3 698	
1152	7.040300403	25 165	27.053	28.120	3 776	
1152	7.040204041	24 915	26.836	28.756	3.841	
1154	7.050012202	24.515	26.607	28.562	3.041	
1155	7.051855623	24.002	26.373	28.365	3.910	
1156	7.051000020	24.00	26.175	20.303	4 056	
1150	7.052585727	23 863	25.010	20.175	4.030	
1157	7.053505727	23.003	25.919	27.975	4.112	
1150	7.054449050	23.020	25.707	27.707	4.101	
1159	7.055512045	23.407	25.514	27.02	4.213	
1161	7.050175204	23.191	25.515	27.435	4.244	
1162	7.057030962	22.970	20.110	27.23	4.274	
1102	7.057697937	22.110	24.929	27.079	4.301	
1103	7.000700100	22.303	24.740	20.911	4.320	
1104	7.009017020	22.401	24.378	20.755	4.304	
1100	7.060476366	22.234	24.420	26.606	4.372	
1100	7.001334307	22.064	24.204	20.444	4.360	
1107	7.062191632	21.879	24.073	26.267	4.388	
1168	7.063048163	21.694	23.901	26.107	4.413	
1169	7.063903961	21.52	23.744	25.967	4.447	
1170	7.064759028	21.353	23.589	25.825	4.472	
1171	7.065613364	21.181	23.432	25.683	4.502	
1172	7.06646697	21.016	23.282	25.547	4.531	
1173	7.067319849	20.868	23.151	25.434	4.566	
1174	7.068172	20.737	23.030	25.323	4.586	
11/5	7.069023427	20.608	22.910	25.212	4.604	
11/6	7.069874128	20.475	22.784	25.092	4.617	
11//	7.070724107	20.342	22.662	24.981	4.639	
11/8	7.071573364	20.224	22.553	24.881	4.657	
1179	7.072421901	20.1	22.434	24.768	4.668	
1180	7.073269717	19.981	22.323	24.665	4.684	
1181	7.074116816	19.865	22.212	24.558	4.693	
1182	7.074963198	19.75	22.103	24.455	4.705	
1183	7.075808864	19.64	22.000	24.359	4./19	
1184	7.076653815	19.54	21.904	24.267	4.727	
1185	7.077498054	19.448	21.812	24.175	4.727	
1186	7.07834158	19.358	21.722	24.086	4.728	
1187	7.079184395	19.27	21.631	23.991	4.721	
1188	7.0800265	19.18	21.538	23.896	4.716	
1189	7.080867897	19.09	21.448	23.806	4.716	
1190	7.081708586	19.004	21.365	23.725	4.721	
1191	7.082548569	18.924	21.284	23.643	4.719	
1192	7.083387848	18.84	21.205	23.569	4.729	
1193	7.084226422	18.777	21.154	23.531	4.754	
1194	7.085064294	18.717	21.079	23.44	4.723	
1195	7.085901464	18.655	20.972	23.289	4.634	
1196	7.086737935	18.593	20.857	23.121	4.528	
1197	7.087573706	18.527	20.739	22.95	4.423	
1198	7.088408779	18.478	20.621	22.763	4.285	
1199	7.089243155	18.417	20.477	22.536	4.119	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
	(•		•	
1200	7 090076836	18 341	20.319	22 297	3 956	
1200	7.090909822	18 246	20.145	22.044	3 798	
1201	7.001742115	18 146	19 966	21 786	3 640	
1202	7.007742110	18.055	19.803	21.700	3 496	
1203	7.002070710	17 966	10.000	21.335	3 360	
1204	7.093404020	17.882	19.001	21.000	3 232	
1205	7.004204040	17.801	10.400	20.888	3.087	
1200	7.095004377	17.001	10.10/	20.000	2 9/8	
1207	7.095095221	17.646	19.194	20.000	2.940	
1200	7.090721970	17.571	18.007	20.407	2.021	
1209	7.097340031	17.371	18 773	20.277	2.700	
1210	7.090373039	17.404	18.624	10.847	2.511	
1211	7.099201744	17.401	18 507	19.047	2.440	
1212	7.100027107	17.333	18.401	10.53	2.344	
1213	7.100651909	17.271	10.401	10.00	2.209	
1214	7.1010/09/2	17.210	10.303	19.369	2.173	
1210	7.102499330	17.170	10.233	19.200	2.110	
1210	7.103322063	17.146	18.180	19.225	2.079	
1217	7.104144093	17.114	18.146	19.178	2.064	
1218	7.104965448	17.072	18.103	19.134	2.062	
1219	7.105786129	17.029	18.068	19.106	2.077	
1220	7.106606138	16.986	18.037	19.088	2.102	
1221	7.107425474	16.946	18.017	19.088	2.142	
1222	7.10824414	16.913	18.004	19.094	2.181	
1223	7.109062136	16.879	17.992	19.104	2.225	
1224	7.109879463	16.841	17.977	19.112	2.271	
1225	7.110696123	16.798	17.956	19.114	2.316	
1226	7.111512116	16.749	17.925	19.1	2.351	
1227	7.112327445	16.689	17.884	19.079	2.390	
1228	7.113142109	16.627	17.844	19.061	2.434	
1229	7.11395611	16.566	17.809	19.051	2.485	
1230	7.114769448	16.508	17.778	19.047	2.539	
1231	7.115582126	16.455	17.752	19.048	2.593	
1232	7.116394144	16.678	17.659	18.64	1.962	
1233	7.117205503	16.865	17.560	18.255	1.390	
1234	7.118016204	16.778	17.532	18.285	1.507	
1235	7.118826249	16.643	17.477	18.31	1.667	
1236	7.119635638	16.497	17.418	18.339	1.842	
1237	7.120444372	16.374	17.362	18.349	1.975	
1238	7.121252453	16.268	17.306	18.343	2.075	
1239	7.122059882	16.182	17.254	18.326	2.144	
1240	7.122866659	16.103	17.206	18.308	2.205	
1241	7.123672785	16.032	17.165	18.298	2.266	
1242	7.124478262	15.968	17.130	18.292	2.324	
1243	7.125283092	15.904	17.101	18.298	2.394	
1244	7.126087273	15.852	17.082	18.311	2.459	
1245	7.126890809	15.806	17.070	18.334	2.528	
1246	7.127693699	15.764	17.062	18.36	2.596	
1247	7.128495946	15.727	17.056	18.384	2.657	
1248	7.129297549	15.692	17.051	18.409	2.717	
1249	7.13009851	15.664	17.052	18.44	2.776	
1250	7.13089883	15.638	17.053	18.468	2.830	
1251	7.13169851	15.616	17.055	18.493	2.877	
1252	7.132497552	15.596	17.056	18.516	2.920	
1253	7.133295955	15.576	17.052	18.527	2.951	
1254	7.134093721	15.552	17.043	18.533	2.981	
1255	7.134890852	15 526	17 036	18 546	3 020	
1256	7 135687347	15.5	17 032	18 564	3 064	
1257	7.136483209	15 481	17 033	18 585	3 104	
1258	7 137278437	15 467	17 037	18 607	3 140	
1259	7.138073034	15 458	17 045	18 631	3 173	
						1

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	ଂ	°C	°C.	
minutee	2.1 (1.1.10)	0	•			
1260	7 138867	15 451	17 051	18 651	3 200	
1261	7 139660336	15 448	17.058	18 668	3 220	
1262	7 140453043	15 446	17.000	18.678	3 232	
1263	7 141245122	15 444	17.066	18 687	3 243	
1200	7.141240122	15 / 30	17.000	18 603	3 254	
1265	7.142030373	15.439	17.000	18 703	3 267	
1205	7.142027401	15.435	17.070	18 711	3.207	
1200	7.143017003	15.433	17.075	19.71	3.270	
1207	7.14440710	15.44	17.000	10.72	3.200	
1200	7.145190155	15.44	17.000	19.732	3.292	
1209	7.145904400	15.44	17.095	10.745	2.305	
1270	7.140772179	15.442	17.110	10.770	3.330	
1271	7.147559271	15.443	17.140	18.830	3.393	
1272	7.148345744	15.444	17.105	18.880	3.442	
1273	7.149131599	15.444	17.187	18.929	3.485	
1274	7.149916836	15.441	17.199	18.956	3.515	
1275	7.150701458	15.444	17.214	18.983	3.539	
1276	7.151485464	15.447	17.226	19.004	3.557	
1277	7.152268856	15.452	17.234	19.016	3.564	
1278	7.153051635	15.46	17.247	19.034	3.574	
1279	7.153833802	15.466	17.256	19.045	3.579	
1280	7.154615357	15.476	17.260	19.044	3.568	
1281	7.155396302	15.479	17.250	19.021	3.542	
1282	7.156176637	15.48	17.228	18.975	3.495	
1283	7.156956365	15.476	17.190	18.903	3.427	
1284	7.157735484	15.473	17.158	18.843	3.370	
1285	7.158513997	15.479	17.150	18.82	3.341	
1286	7.159291905	15.492	17.152	18.811	3.319	
1287	7.160069208	15.51	17.153	18.796	3.286	
1288	7.160845907	15.53	17.155	18.779	3.249	
1289	7.161622003	15.55	17.154	18.758	3.208	
1290	7.162397497	15.57	17.155	18.739	3.169	
1291	7.163172391	15.598	17.159	18.719	3.121	
1292	7.163946684	15.628	17.162	18.695	3.067	
1293	7.164720379	15.661	17.163	18.665	3.004	
1294	7.165493475	15.7	17.170	18.639	2.939	
1295	7.166265974	15.74	17.174	18.607	2.867	
1296	7.167037877	15.78	17.180	18.58	2.800	
1297	7.167809184	15.829	17.197	18.564	2.735	
1298	7.168579897	15.891	17.231	18.57	2.679	
1299	7 169350017	15 959	17 267	18 574	2 615	
1300	7.170119543	16.026	17 295	18 563	2 537	
1301	7 170888479	16.020	17.200	18 562	2 468	
1302	7 171656823	16 164	17 364	18 563	2,300	
1302	7 172424577	16 233	17 305	18 556	2.000	
130/	7 1731017/2	16 301	17 497	18 552	2.020	
1304	7 17305832	16 365	17 /61	18 557	2.2.52	
1206	7 17/70/24	16.303	17.401	18 569	2.192	
1207	7 175/2071/	16 /09	17 529	18.500	2.130	
1307	7 17605/14	10.490	17.000	10.0//	2.079	
1308	1.110204032	10.302	11.5/3	10.503	2.021	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
0		19.985	19.690	19.395	-0.590	
1	0	19.999	19.699	19.398	-0.601	
2	0.693147181	20.043	19.724	19.405	-0.638	
3	1.098612289	20.071	19.713	19.354	-0.717	
4	1.386294361	17.987	17.654	17.32	-0.667	
5	1.609437912	17.057	17.009	16.96	-0.097	
6	1.791759469	17.072	16.990	16.907	-0.165	
7	1.945910149	17.074	17.013	16.951	-0.123	
8	2.079441542	17.06	16.985	16.91	-0.150	
9	2.197224577	16.952	16.866	16.779	-0.173	
10	2.302585093	16.857	16.786	16.715	-0.142	
11	2.397895273	16.85	16.776	16.702	-0.148	
12	2.48490665	16.934	16.881	16.827	-0.107	
13	2.564949357	16.943	16.858	16.772	-0.171	
14	2.63905733	16.824	16.749	16.673	-0.151	
15	2.708050201	16.776	16.702	16.627	-0.149	
16	2.772588722	16.746	16.673	16.6	-0.146	
17	2.833213344	16.722	16.648	16.573	-0.149	
18	2.890371758	16.692	16.615	16.538	-0.154	
19	2.944438979	16.657	16.581	16.505	-0.152	
20	2.995732274	16.635	16.559	16.482	-0.153	
21	3.044522438	16.626	16.552	16.477	-0.149	
22	3.091042453	16.617	16.539	16.461	-0.156	
23	3.135494216	16.591	16.512	16.433	-0.158	
24	3.17805383	16.567	16.489	16.41	-0.157	
25	3.218875825	16.542	16.466	16.389	-0.153	
26	3.258096538	16.524	16.448	16.371	-0.153	
27	3.295836866	16.505	16.428	16.35	-0.155	
28	3.33220451	16.489	16.411	16.332	-0.157	
29	3.36729583	16.471	16.393	16.314	-0.157	
30	3.401197382	16.454	16.377	16.299	-0.155	
31	3.433987204	16.44	16.362	16.284	-0.156	
32	3.465735903	16.425	16.346	16.266	-0.159	
33	3.496507561	16.41	16.331	16.252	-0.158	
34	3.526360525	16.404	16.320	16.236	-0.168	
35	3.555348061	16.39	16.305	16.22	-0.170	
36	3.583518938	16.399	16.303	16.206	-0.193	
37	3.610917913	16.392	16.291	16.19	-0.202	
38	3.63758616	16.592	16.384	16.175	-0.417	
39	3.663561646	21.666	18.913	16.16	-5.506	Heaters ON
40	3.688879454	22.948	19.551	16.153	-6.795	
41	3.713572067	22.961	19.556	16.15	-6.811	
42	3.737669618	22.958	19.552	16.146	-6.812	
43	3.761200116	22.952	19.546	16.14	-6.812	
44	3.784189634	22.932	19.532	16.132	-6.800	
45	3.80666249	22.934	19.530	16.125	-6.809	
46	3.828641396	22.923	19.521	16.119	-6.804	
47	3.850147602	22.926	19.547	16.168	-6.758	
48	3.871201011	23.336	20.018	16.699	-6.637	
49	3.891820298	23.911	20.556	17.2	-6.711	
50	3.912023005	24.193	20.819	17.444	-6.749	
51	3.931825633	24.361	20.980	17.599	-6.762	
52	3.951243719	24.489	21.102	17.715	-6.774	
53	3.970291914	24.59	21.200	17.809	-6.781	
54	3.988984047	24.677	21.282	17.886	-6.791	
55	4.007333185	24.759	21.358	17.957	-6.802	
56	4.025351691	24.819	21.421	18.022	-6.797	
57	4.043051268	24.903	21.511	18.118	-6.785	
58	4.060443011	25.039	21.650	18.261	-6.778	
59	4.077537444	25.176	21.784	18.392	-6.784	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
60	4.094344562	25.283	21.891	18.498	-6.785	
61	4.110873864	25.371	21.981	18.591	-6.780	
62	4 127134385	25 446	22.062	18 677	-6 769	
63	4 143134726	25 531	22.002	18 753	-6 778	
64	4.158883083	25.614	22.142	18 827	-6 787	
65	4.100000000	25.68	22.221	18 89/	-6 786	
66	4.17450727	25.00	22.201	19.057	6 701	
67	4.109034742	25.740	22.303	10.957	6 704	
69	4.204092019	25.619	22.422	19.025	-0.794	
00	4.219507705	25.665	22.491	19.097	-0.700	
69	4.234106505	25.945	22.554	19.163	-6.782	
70	4.248495242	26.01	22.618	19.226	-6.784	
71	4.262679877	26.069	22.678	19.286	-6.783	
72	4.276666119	26.136	22.742	19.347	-6.789	
73	4.290459441	26.207	22.807	19.407	-6.800	
74	4.304065093	26.271	22.867	19.462	-6.809	
75	4.317488114	26.326	22.919	19.511	-6.815	
76	4.33073334	26.384	22.975	19.565	-6.819	
77	4.343805422	26.425	23.020	19.615	-6.810	
78	4.356708827	26.476	23.070	19.663	-6.813	
79	4.369447852	26.523	23.118	19.713	-6.810	
80	4.382026635	26.568	23.163	19.758	-6.810	
81	4.394449155	26.618	23.211	19.804	-6.814	
82	4 406719247	26 678	23 266	19 853	-6.825	
83	4 418840608	26 733	23 315	19.896	-6.837	
84	4.410040000	26.776	23 358	10.000	-6.836	
85	4.430010733	26.818	23.330	10.082	-6.836	
86	4.442051250	20.010	23.400	19.902	-0.030	
00	4.404047290	20.000	23.439	20.024	-0.029	
<u> </u>	4.405906119	20.692	23.470	20.063	-0.029	
88	4.477330814	26.921	23.511	20.101	-0.820	
89	4.48863637	26.959	23.550	20.14	-6.819	
90	4.49980967	27	23.590	20.179	-6.821	
91	4.510859507	27.038	23.630	20.221	-6.817	
92	4.521788577	27.078	23.668	20.257	-6.821	
93	4.532599493	27.13	23.712	20.294	-6.836	
94	4.543294782	27.174	23.751	20.328	-6.846	
95	4.553876892	27.202	23.783	20.363	-6.839	
96	4.564348191	27.205	23.802	20.399	-6.806	
97	4.574710979	27.205	23.819	20.432	-6.773	
98	4.584967479	27.212	23.840	20.467	-6.745	
99	4.59511985	27.25	23.878	20.505	-6.745	
100	4.605170186	27.287	23.914	20.54	-6.747	
101	4.615120517	27.329	23.952	20.575	-6.754	
102	4.624972813	27.365	23.987	20.609	-6.756	
103	4.634728988	27.396	24.021	20.645	-6.751	
104	4.644390899	27.428	24.053	20.678	-6.750	
105	4.65396035	27.45	24.079	20,708	-6.742	
106	4 663439094	27 476	24 105	20 734	-6 742	
107	4 672828834	27 507	24 133	20.758	-6 749	
108	4 682131227	27 532	24 158	20.783	-6 749	
100	4.6013/7882	27.565	24.100	20.705	-6 755	
110	4.091347002	27.505	24.100	20.01	6 747	
110	4 700520204	27.000	24.213	20.000	-0.747	
111	4.709030201	27.000	24.230	20.007	-0.741	
112	4./ 104900/1	21.035	24.204	20.693	-0.742	
113	4.727387819	27.655	24.289	20.922	-6./33	
114	4.736198448	27.668	24.307	20.946	-6.722	
115	4./44932128	27.709	24.340	20.97	-6.739	
116	4.753590191	27.739	24.369	20.998	-6.741	
117	4.762173935	27.765	24.394	21.022	-6.743	
118	4.770684624	27.794	24.421	21.048	-6.746	
119	4.779123493	27.816	24.443	21.07	-6.746	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
120	4.787491743	27.834	24.464	21.094	-6.740	
121	4.795790546	27.859	24.488	21.117	-6.742	
122	4.804021045	27.872	24.505	21.138	-6.734	
123	4.812184355	27.894	24.527	21.159	-6.735	
124	4.820281566	27.922	24.551	21.18	-6.742	
125	4.828313737	27.948	24.575	21.201	-6.747	
126	4.836281907	27.972	24.597	21.222	-6.750	
127	4.844187086	27.998	24.621	21.244	-6.754	
128	4.852030264	28.011	24.637	21.263	-6.748	
129	4.859812404	28.022	24.653	21.284	-6.738	
130	4.86753445	28.046	24.676	21.305	-6.741	
131	4.875197323	28.057	24.691	21.325	-6.732	
132	4.882801923	28.086	24.716	21.345	-6.741	
133	4.890349128	28.106	24.736	21.366	-6.740	
134	4.8978398	28.132	24.759	21.386	-6.746	
135	4.905274778	28.149	24.777	21.404	-6.745	
136	4.912654886	28.169	24.798	21.426	-6.743	
137	4,919980926	28.179	24.813	21.446	-6.733	
138	4 927253685	28 194	24 830	21 465	-6 729	
139	4.934473933	28.205	24.843	21.481	-6.724	
140	4 941642423	28 231	24 866	21 501	-6 730	
141	4 94875989	28 245	24 883	21.52	-6 725	
142	4 955827058	28 275	24.000	21.52	-6 735	
142	4.000021000	28.29	24.000	21.6	-6 730	
143	4.0608133	28 305	24.020	21.50	-6 727	
144	4.3030133	20.303	24.942	21.570	-6.725	
145	4.970735742	28.296	24.950	21.095	-6.692	
140	4.903000022	20.290	24.950	21.004	-0.092	
147	4.990432387	20.303	24.950	21.012	-0.091	
140	4.997212274	20.319	24.971	21.023	-0.090	
149	5.003946306	20.339	24.969	21.039	-0.700	
150	5.010035294	20.303	25.020	21.007	-0.720	
151	5.017279837	28.407	25.041	21.674	-0.733	
152	5.023880521	28.439	25.067	21.694	-6.745	
153	5.030437921	28.449	25.079	21.708	-0.741	
154	5.036952602	28.457	25.090	21.722	-6.735	
155	5.043425117	28.468	25.101	21.734	-6.734	
156	5.049856007	28.473	25.110	21.747	-6.726	
157	5.056245805	28.49	25.126	21.761	-6.729	
158	5.062595033	28.508	25.143	21.778	-6.730	
159	5.068904202	28.529	25.162	21.794	-6.735	
160	5.075173815	28.541	25.176	21.81	-6.731	
161	5.081404365	28.56	25.195	21.829	-6.731	
162	5.087596335	28.575	25.209	21.842	-6.733	
163	5.093750201	28.591	25.223	21.854	-6.737	
164	5.099866428	28.604	25.237	21.87	-6.734	
165	5.105945474	28.616	25.249	21.882	-6.734	
166	5.111987788	28.633	25.265	21.896	-6.737	
167	5.117993812	28.643	25.276	21.908	-6.735	
168	5.123963979	28.659	25.293	21.926	-6.733	
169	5.129898715	28.673	25.306	21.938	-6.735	
170	5.135798437	28.683	25.317	21.951	-6.732	
171	5.141663557	28.695	25.331	21.967	-6.728	
172	5.147494477	28.706	25.342	21.978	-6.728	
173	5.153291594	28.731	25.360	21.989	-6.742	
174	5.159055299	28.753	25.377	22.001	-6.752	
175	5.164785974	28.769	25.391	22.013	-6.756	
176	5.170483995	28.778	25.402	22.026	-6.752	
177	5.176149733	28.798	25.418	22.038	-6.760	
178	5.18178355	28.804	25.427	22.049	-6.755	
179	5.187385806	28.81	25.435	22.059	-6.751	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
180	5.192956851	28.821	25.446	22.071	-6.750	
181	5.198497031	28.832	25.458	22.083	-6.749	
182	5.204006687	28.838	25.467	22.096	-6.742	
183	5.209486153	28.823	25.466	22.109	-6.714	
184	5.214935758	28.84	25.483	22.125	-6.715	
185	5.220355825	28.853	25.496	22.139	-6.714	
186	5.225746674	28.864	25.509	22.153	-6.711	
187	5.231108617	28.884	25.526	22.167	-6.717	
188	5.236441963	28.892	25.536	22.179	-6.713	
189	5.241747015	28.909	25.550	22.191	-6.718	
190	5.247024072	28.919	25.562	22.204	-6.715	
191	5.252273428	28.939	25.577	22.214	-6.725	
192	5.257495372	28.948	25.586	22.224	-6.724	
193	5.262690189	28.962	25.598	22.233	-6.729	
194	5.267858159	28.972	25.608	22.243	-6.729	
195	5.272999559	28.983	25.619	22.254	-6.729	
196	5.278114659	28.99	25.628	22.266	-6.724	
197	5.283203729	29.003	25.640	22.277	-6.726	
198	5.288267031	29.013	25.650	22.287	-6.726	
199	5.293304825	29.015	25.656	22.297	-6.718	
200	5.298317367	29.035	25.672	22.309	-6.726	
201	5.303304908	29.051	25.686	22.321	-6.730	
202	5.308267697	29.068	25.700	22.331	-6.737	
203	5.313205979	29.075	25.707	22.338	-6.737	
204	5.318119994	29.066	25.708	22.35	-6.716	
205	5 323009979	29.066	25 715	22,363	-6 703	
206	5.327876169	29.08	25.727	22.374	-6.706	
207	5 332718793	29.09	25 738	22,386	-6 704	
208	5 33753808	29.096	25 746	22 395	-6 701	
209	5 342334252	29 129	25 769	22 409	-6 720	
210	5 347107531	29 146	25 782	22.100	-6 729	
210	5 351858133	29 155	25 792	22.117	-6 726	
212	5 356586275	29 166	25 804	22.423	-6 725	
212	5 361292166	29.100	25.812	22.441	-6 727	
210	5 365976015	20.170	25.823	22.440	-6 734	
214	5 370638028	29.10	25.822	22.400	-6 738	
215	5 375278408	29.201	25.837	22.403	-6.736	
210	5 37080735/	20.200	25.007	22.405	-6 7/3	
217	5 384405063	29.222	25.001	22.473	-6 751	
210	5 38007173	29.24	25.005	22.405	-6 754	
219	5 303627546	29.234	25.077	22.5	-6.760	
220	5 209162702	29.200	25.000	22.500	6 752	
221	5.402677382	29.200	25.092	22.510	-6.751	
222	5.402077302	29.270	25.901	22.525	-6 757	
223	5.407171771	29.291	25.915	22.004	6 761	
224	5.411040052	29.303	25.925	22.042	-0.701	
225	5.410100402	29.313	25.932	22.551	6 756	
220	5.420534999	29.317	25.939	22.501	6 759	
227	5.424950017	29.327	25.940	22.309	-0.750	
220	5.429343029	29.340	25.904	22.379	-0.709	
229	5.433722004	29.305	25.976	22.307	-0.770	
230	5.436079309	29.374	25.964	22.594	-0.760	
231	5.442417711	29.301	25.992	22.602	-0.779	
232	5.446/3/3/2	29.387	25.999	22.61	-6.777	
233	5.451038454	29.397	26.008	22.619	-6.778	
234	5.455321115	29.412	26.019	22.626	-6.786	
235	5.459585514	29.429	26.031	22.632	-6.797	
236	5.463831805	29.432	26.037	22.641	-6.791	
23/	5.468060141	29.43	26.040	22.649	-6.781	
238	5.4/2270674	29.436	26.048	22.66	-6.776	
239	5.476463552	29.438	26.054	22.67	-6.768	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	ଂ	°C	°C	
minutee	2.1 (1.1.10)	0	U			
240	5 480638923	29 445	26.062	22 679	-6 766	
240	5 /8/706033	20.440	26.062	22.073	-6 764	
241	5 488037726	20.457	26.000	22.007	-6 760	
242	5.400957720	29.457	20.077	22.097	6 760	
243	5.493001443	29.400	20.000	22.700	-0.700	
244	5.497 106223	29.47	20.094	22.717	-0.753	
245	5.501258211	29.486	26.107	22.121	-0.759	
246	5.505331536	29.493	26.115	22.736	-6.757	
247	5.509388337	29.508	26.126	22.744	-6.764	
248	5.513428746	29.52	26.135	22.75	-6.770	
249	5.517452896	29.522	26.141	22.759	-6.763	
250	5.521460918	29.535	26.151	22.767	-6.768	
251	5.525452939	29.538	26.157	22.776	-6.762	
252	5.529429088	29.546	26.166	22.785	-6.761	
253	5.533389489	29.562	26.177	22.791	-6.771	
254	5.537334267	29.552		22.799	-6.753	
255	5.541263545	29.553	26.180	22.807	-6.746	
256	5.545177444	29.546	26.181	22.816	-6.730	
257	5.549076085	29.552	26,189	22.826	-6.726	
258	5.552959585	29.563	26.200	22.837	-6.726	
259	5 556828062	29.57	26 208	22 846	-6 724	
260	5 560681631	29 575	26.216	22,856	-6 719	
261	5.564520407	20.575	26.276	22.000	-6 721	
201	5 568344504	29.500	26.220	22.005	-6.721	
202	5.508544504	29.004	20.240	22.075	-0.729	
203	5.572154032	29.611	20.247	22.003	-0.720	
204	5.575949103	29.623	26.257	22.89	-0.733	
265	5.579729826	29.634	26.265	22.895	-6.739	
266	5.583496309	29.635	26.269	22.902	-6.733	
267	5.587248658	29.642	26.275	22.907	-6.735	
268	5.590986981	29.649	26.281	22.913	-6.736	
269	5.59471138	29.655	26.287	22.919	-6.736	
270	5.598421959	29.654	26.290	22.925	-6.729	
271	5.602118821	29.66	26.296	22.932	-6.728	
272	5.605802066	29.673	26.307	22.941	-6.732	
273	5.609471795	29.678	26.314	22.95	-6.728	
274	5.613128106	29.689	26.324	22.958	-6.731	
275	5.616771098	29.693	26.330	22.966	-6.727	
276	5.620400866	29.704	26.339	22.973	-6.731	
277	5.624017506	29.708	26.344	22.98	-6.728	
278	5.627621114	29.715	26.350	22.985	-6.730	
279	5.631211782	29.718	26.355	22.992	-6.726	
280	5.634789603	29.724	26.362	22,999	-6.725	
281	5 638354669	29 718	26 363	23 007	-6 711	
282	5 641907071	29 722	26,368	23 014	-6 708	
283	5 645446898	29.722	26.000	23.021	-6 716	
200	5.648074238	20.745	26.388	23.021	-6 715	
204	5 652/2012	20.754	20.000	23.03	6 717	
200	5.05240910	29.754	20.390	23.037	-0.717	
200	5.000991011	29.70	20.403	23.045	-0.715	
207	5.059462210	29.771	20.411	23.031	-0.720	
200	5.00290048	29.112	20.415	23.057	-0.715	
289	5.666426688	29.774	26.419	23.064	-6.710	
290	5.009880923	29.774	26.423	23.072	-6.702	
291	5.6/3323267	29.789	26.434	23.079	-6.710	
292	5.676753802	29.799	26.442	23.085	-6.714	
293	5.680172609	29.806	26.448	23.09	-6.716	
294	5.683579767	29.817	26.458	23.098	-6.719	
295	5.686975356	29.819	26.463	23.106	-6.713	
296	5.690359454	29.822	26.467	23.111	-6.711	
297	5.693732139	29.83	26.474	23.118	-6.712	
298	5.697093487	29.837	26.480	23.123	-6.714	
299	5.700443573	29.842	26.487	23.131	-6.711	
Time	All Data	Flow	Average	Return	Delta T	
---------	-------------	--------	---------	--------	---------	--
Minutes	Ln (Time)	°C	°C	°C	°C	
300	5.703782475	29.847	26.492	23.137	-6.710	
301	5.707110265	29.859	26.501	23.143	-6.716	
302	5.710427017	29.862	26.507	23.151	-6.711	
303	5.713732806	29.868	26.513	23.158	-6.710	
304	5.717027701	29.873	26.518	23.163	-6.710	
305	5.720311777	29.879	26.525	23.17	-6.709	
306	5.723585102	29.907	26.542	23.177	-6.730	
307	5.726847748	29.908	26.545	23.181	-6.727	
308	5.730099783	29.916	26.552	23.187	-6.729	
309	5.733341277	29.919	26.556	23.192	-6.727	
310	5.736572297	29.921	26.559	23.196	-6.725	
311	5.739792912	29.924	26.563	23.202	-6.722	
312	5.743003188	29.931	26.569	23.206	-6.725	
313	5.746203191	29.929	26.571	23.212	-6.717	
314	5.749392986	29.934	26.577	23.219	-6.715	
315	5.752572639	29.937	26.582	23.227	-6.710	
316	5.755742214	29.946	26.591	23.235	-6.711	
317	5.758901774	29.959	26.600	23.24	-6.719	
318	5.762051383	29.963	26.606	23.248	-6.715	
319	5.765191103	29.968	26.611	23.253	-6.715	
320	5.768320996	29.972	26.615	23.258	-6.714	
321	5.771441123	29.974	26.619	23.264	-6.710	
322	5.774551546	29.972	26.621	23.269	-6.703	
323	5.777652323	29.98	26.628	23.276	-6.704	
324	5.780743516	29.987	26.634	23.281	-6.706	
325	5.783825182	29.998	26.643	23.287	-6.711	
326	5.786897381	29.997	26.645	23.292	-6.705	
327	5.789960171	29.986	26.643	23.299	-6.687	
328	5.793013608	29.998	26.653	23.307	-6.691	
329	5.796057751	30.003	26.658	23.313	-6.690	
330	5,799092654	30.013	26.665	23.316	-6.697	
331	5 802118375	30 015	26 669	23 323	-6 692	
332	5 805134969	30.016	26.672	23.328	-6 688	
333	5 80814249	30 002	26.669	23,336	-6 666	
334	5 811140993	30 011	26.678	23 345	-6 666	
335	5 814130532	30 015	26.684	23,352	-6 663	
336	5 81711116	30 019	26.688	23,356	-6 663	
337	5 82008293	30.027	26.606	23 364	-6 663	
338	5 823045895	30.036	26 703	23 37	-6 666	
330	5.826000107	30.030	26.713	23 378	-6 670	
340	5 828945618	30.053	26.717	23.370	-6 672	
3/1	5.831882/77	30.061	26.725	23.388	-6 673	
3/2	5.83/810737	30.066	26.728	23.300	-6.676	
3/3	5.837730447	30.000	26.720	23.33	-6.673	
243	5.037730447	30.000	26.736	23.395	-0.073	
244	5.840041037	30.072	26.730	23.399	-0.073	
240	5.043344417	20.070	20.740	23.403	-0.073	
240	5.040430773	30.062	20.740	23.409	-0.073	
347	5.04952470	30.092	20.703	23.413	-0.079	
340	5.05220240	30.102	20.701	23.42	-0.002	
349	5.655071922	30.104	20.700	23.420	-0.070	
350	5.057933154	30.109	20.770	23.43	-0.079	
301	5.000700223	30.117	20.770	23.434	-0.003	
352	5.863631176	30.123	20.781	23.438	-0.085	
353	5.866468057	30.128	26.786	23.444	-6.684	
354	5.869296913	30.126	26.787	23.447	-6.679	
355	5.8/211//89	30.135	26.793	23.45	-6.685	
356	5.874930731	30.14	26.799	23.457	-6.683	
357	5.8///35/82	30.151	26.806	23.46	-6.691	
358	5.880532986	30.162	26.814	23.466	-6.696	
359	5.883322388	30.166	26.818	23.47	-6.696	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C.	ଂ	°C.	°C.	
Minates		0	0		<u> </u>	
360	5 88610/031	30 171	26.823	23 171	-6 607	
361	5 999977059	20 170	20.025	23.474	6 701	
262	5.000077930	20.179	20.029	23.470	6 705	
302	5.091044212	30.160	20.034	23.401	-0.705	
363	5.894402834	30.185	26.835	23.485	-6.700	
364	5.897153868	30.193	26.841	23.488	-6.705	
365	5.899897354	30.195	26.845	23.494	-6.701	
366	5.902633333	30.208	26.854	23.499	-6.709	
367	5.905361848	30.222	26.864	23.505	-6.717	
368	5.908082938	30.224	26.866	23.508	-6.716	
369	5.910796644	30.248	26.880	23.511	-6.737	
370	5.913503006	30.278	26.896	23.514	-6.764	
371	5.916202063	30.286	26.901	23.516	-6.770	
372	5.918893854	30.286	26.902	23.517	-6.769	
373	5.92157842	30.292	26.904	23.516	-6.776	
374	5.924255797	30.283	26.900	23.517	-6.766	
375	5.926926026	30.277	26.899	23.521	-6.756	
376	5 929589143	30 282	26 903	23 524	-6 758	
377	5 932245187	30 284	26,906	23 527	-6 757	
378	5 03/80/106	30.204	26.000	23.53/	-6 756	
270	5.027526205	20.29	20.912	23.534	6 755	
379	5.937530205	30.298	20.921	23.545	-0.755	
380	5.940171253	30.308	26.928	23.548	-0.760	
381	5.942799375	30.317	26.935	23.553	-6.764	
382	5.945420609	30.317	26.937	23.557	-6.760	
383	5.948034989	30.304	26.933	23.561	-6.743	
384	5.950642553	30.322	26.943	23.564	-6.758	
385	5.953243334	30.332	26.950	23.567	-6.765	
386	5.955837369	30.34	26.956	23.571	-6.769	
387	5.958424693	30.337	26.955	23.572	-6.765	
388	5.96100534	30.348	26.964	23.579	-6.769	
389	5.963579344	30.354	26.970	23.585	-6.769	
390	5.966146739	30.358	26.973	23.588	-6.770	
391	5.96870756	30,368	26.982	23.595	-6.773	
392	5.97126184	30.369	26.981	23.593	-6.776	
393	5.973809612	30.377	26.988	23.598	-6.779	
394	5 976350909	30.377	26 991	23 604	-6 773	
395	5 978885765	30.37	26.001	23,609	-6 761	
396	5 981414211	30 368	26.000	23.612	-6 756	
307	5 083036281	30 381	20.000	23.618	-6 763	
200	5.905950201	20.205	27.000	23.010	6 761	
390	5.900452005	30.365	27.005	23.024	-0.701	
399	5.900901417	30.399	27.014	23.020	-0.771	
400	5.991464547	30.401	27.017	23.632	-0.769	
401	5.993961427	30.404	27.021	23.637	-6.767	
402	5.996452089	30.407	27.025	23.642	-6.765	
403	5.998936562	30.42	27.033	23.645	-6.775	
404	6.001414878	30.41	27.030	23.649	-6.761	
405	6.003887067	30.415	27.034	23.652	-6.763	
406	6.00635316	30.422	27.040	23.658	-6.764	
407	6.008813185	30.431	27.048	23.664	-6.767	
408	6.011267174	30.433	27.050	23.667	-6.766	
409	6.013715156	30.438	27.055	23.671	-6.767	
410	6.01615716	30.443	27.061	23.678	-6.765	
411	6.018593214	30.442	27.062	23.681	-6.761	
412	6.021023349	30.452	27.070	23.688	-6.764	
413	6.023447593	30.461	27.076	23.69	-6.771	
414	6.025865974	30.463	27.079	23.694	-6.769	
415	6.02827852	30.468	27.083	23.698	-6.770	
416	6.03068526	30.469	27.086	23,703	-6.766	
417	6.033086222	30 476	27 091	23 705	-6 771	
<u>418</u>	6 035481433	30 401	27 100	23 708	-6 783	
/10	6 02787002	30 /07	27.100	23.700	-6 785	
413	0.00/0/082	50.431	L 21.100	L 20.1 12	-0.700	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
420	6.040254711	30.498	27.106	23.713	-6.785	
421	6.042632834	30.497	27.108	23.718	-6.779	
422	6.045005314	30.506	27.113	23.72	-6.786	
423	6.047372179	30.508	27.116	23.723	-6.785	
424	6.049733455	30.515	27.120	23.725	-6.790	
425	6.052089169	30.517	27.121	23.725	-6.792	
426	6.054439346	30.519	27.124	23.729	-6.790	
427	6.056784013	30.522	27.128	23.734	-6.788	
428	6.059123196	30.522	27.128	23.734	-6.788	
429	6.061456919	30.52	27.130	23.739	-6.781	
430	6.063785209	30.526	27.135	23.743	-6.783	
431	6.06610809	30.532	27.141	23.749	-6.783	
432	6.068425588	30.533	27.144	23.754	-6.779	
433	6.070737728	30.549	27.152	23.755	-6.794	
434	6.073044534	30.547	27.153	23.759	-6.788	
435	6.075346031	30.548	27.155	23.762	-6.786	
436	6.077642243	30.557	27.162	23.767	-6.790	
437	6.079933195	30.56	27.166	23.771	-6.789	
438	6.08221891	30.565	27.169	23.773	-6.792	
439	6.084499413	30.564	27.170	23.775	-6.789	
440	6.086774727	30.572	27.176	23.78	-6.792	
441	6 089044875	30 596	27 190	23 784	-6.812	
442	6.091309882	30 872	27.327	23 781	-7 091	
442	6.09356977	31 414	27 587	23 759	-7.655	
443	6.005824562	31 610	27.668	23.735	-7 903	
444	6.093024302	31.013	27.000	23.668	-7.903	
445	6 100318952	31 557	27.044	23.000	-7.032	
440	6 102558505	31.557	27.591	23.024	7 019	
447	0.102000000	21 446	27.044	23.365	-7.910	
440	6.104793232	31.440	27.490	23.549	-7.097	
449	0.107022000	31.401	27.409	23.310	-7.000	
450	0.109247505	31.373	27.427	23.401	-7.092	
451	6.11146734	31.331	27.390	23.448	-7.883	
452	6.11368218	31.208	27.319	23.43	-7.778	
453	0.115892125	31.101	27.280	23.458	-7.643	
454	6.118097198	31.154	27.334	23.514	-7.640	
455	6.120297419	31.249	27.401	23.552	-7.697	
456	6.12249281	31.294	27.434	23.574	-7.720	
457	6.124683391	31.306	27.446	23.585	-7.721	
458	6.126869184	31.284	27.437	23.59	-7.694	
459	6.12905021	31.271	27.433	23.595	-7.676	
460	6.131226489	31.294	27.447	23.6	-7.694	
461	6.133398043	31.33	27.468	23.605	-7.725	
462	6.135564891	31.279	27.440	23.601	-7.678	
463	6.137727054	31.127	27.359	23.59	-7.537	
464	6.139884552	31.011	27.302	23.593	-7.418	
465	6.142037406	31.01	27.312	23.614	-7.396	
466	6.144185634	31.11	27.373	23.636	-7.474	
467	6.146329258	31.277	27.463	23.648	-7.629	
468	6.148468296	31.418	27.535	23.651	-7.767	
469	6.150602768	31.472	27.560	23.648	-7.824	
470	6.152732695	31.528	27.587	23.645	-7.883	
471	6.154858094	31.551	27.598	23.645	-7.906	
472	6.156978986	31.52	27.579	23.638	-7.882	
473	6.159095388	31.498	27.561	23.624	-7.874	
474	6.161207322	31.498	27.547	23.596	-7.902	
475	6.163314804	31.504	27.538	23.572	-7.932	
476	6.165417854	31.485	27.522	23.558	-7.927	
477	6.167516491	31.439	27.498	23.556	-7.883	
478	6.169610732	31.425	27.498	23.57	-7.855	
479	6.171700597	31.438	27.510	23.582	-7.856	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	°C	°C	°C	
Minutes		0	0		0	
480	6 173786104	31 / 27	27 512	23 506	-7 831	
400	6 17596727	21 424	27.512	23.530	7 912	
401	6 1770//11/	21 209	27.510	23.011	7.013	
402	0.177944114	31.390	27.310	23.622	-7.770	
483	6.180016654	31.363	27.497	23.63	-7.733	
484	6.182084907	31.333	27.486	23.639	-7.694	
485	6.184148891	31.361	27.506	23.651	-7.710	
486	6.186208624	31.363	27.512	23.661	-7.702	
487	6.188264123	31.341	27.505	23.669	-7.672	
488	6.190315406	31.331	27.504	23.677	-7.654	
489	6.192362489	31.333	27.510	23.686	-7.647	
490	6.194405391	31.336	27.517	23.698	-7.638	
491	6.196444128	31.305	27.506	23.706	-7.599	
492	6.198478716	31.26	27.488	23.716	-7.544	
493	6.200509174	31.156	27.441	23.726	-7.430	
494	6.202535517	31.055	27,398	23,741	-7.314	
495	6 204557763	31 082	27 420	23 758	-7 324	
496	6 206575927	31 228	27.502	23 776	-7 452	
407	6 208500026	31.220	27.002	23.784	-7.656	
497	6.200590020	21 570	27.012	23.704	-7.000	
498	6.210600077	31.579	27.079	23.778	-7.801	
499	6.212606096	31.623	27.697	23.77	-7.853	
500	6.214608098	31.648	27.705	23.762	-7.886	
501	6.216606101	31.654	27.703	23.751	-7.903	
502	6.21860012	31.663	27.700	23.737	-7.926	
503	6.22059017	31.627	27.671	23.715	-7.912	
504	6.222576268	31.593	27.639	23.684	-7.909	
505	6.224558429	31.603	27.632	23.66	-7.943	
506	6.226536669	31.604	27.625	23.645	-7.959	
507	6.228511004	31,587	27.618	23.649	-7.938	
508	6 230481448	31 569	27 617	23 664	-7 905	
509	6 232448017	31 597	27.639	23.68	-7 917	
510	6 23//10726	31 507	27.643	23.689	-7 908	
511	6 22626050	21 527	27.043	23.003	7 926	
510	0.23030959	31.337	27.019	23.701	-7.030	
512	0.230324023	31.493	27.003	23.712	-7.701	
513	6.240275845	31.40	27.592	23.724	-7.736	
514	6.242223265	31.426	27.579	23.732	-7.694	
515	6.244166901	31.445	27.593	23.74	-7.705	
516	6.246106765	31.477	27.614	23.751	-7.726	
517	6.248042875	31.5	27.630	23.759	-7.741	
518	6.249975242	31.478	27.623	23.767	-7.711	
519	6.251903883	31.466	27.621	23.776	-7.690	
520	6.253828812	31.458	27.625	23.791	-7.667	
521	6.255750042	31.417	27.608	23.799	-7.618	
522	6.257667588	31.317	27.562	23.806	-7.511	
523	6.259581464	31.166	27.493	23.819	-7.347	
524	6.261491684	31,114	27,475	23.836	-7.278	
525	6 263398263	31 228	27 542	23 855	-7 373	
526	6 265301213	31 482	27.676	23,869	-7 613	
527	6 267200549	31 716	27.793	23.87	-7 846	
528	6 260006284	31.710	27.733	23,863	-7 017	
520	6.209090204	21 005	27.022	23.005	7.517	
529	6.070077007	31.003	21.020	20.001	-7.904	
530	0.212011001	31.804	21.022	23.84	-7.904	
531	0.2/4/62021	31.//9	27.804	23.828	-7.951	
532	6.276643489	31.755	27.783	23.811	-7.944	
533	6.278521424	31.717	27.750	23.783	-7.934	
534	6.280395839	31.719	27.734	23.748	-7.971	
535	6.282266747	31.726	27.725	23.723	-8.003	
536	6.284134161	31.7	27.710	23.719	-7.981	
537	6.285998095	31.699	27.718	23.736	-7.963	
538	6.28785856	31.689	27.724	23.758	-7.931	
539	6.289715571	31.706	27.739	23.772	-7.934	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	°C	°C	°C	
Wintates		0	0		0	
540	6 20156014	31 662	27 723	23 784	-7 878	
540	6 202/10270	21.61	27.723	23.704	7 91/	
547	6.205266001	21 562	27.703	23.790	7.014	
542	6.295200001	31.302	27.002	23.002	-7.700	
543	6.29710932	31.543	27.078	23.813	-7.730	
544	6.298949247	31.556	27.689	23.822	-7.734	
545	6.300785795	31.585	27.710	23.834	-7.751	
546	6.302618976	31.612	27.727	23.841	-7.771	
547	6.304448802	31.616	27.733	23.849	-7.767	
548	6.306275287	31.612	27.734	23.856	-7.756	
549	6.308098442	31.595	27.731	23.867	-7.728	
550	6.309918278	31.549	27.712	23.875	-7.674	
551	6.311734809	31.474	27.678	23.881	-7.593	
552	6.313548046	31.349	27.620	23.89	-7.459	
553	6.315358002	31.332	27.617	23.902	-7.430	
554	6.317164687	31,494	27,704	23.914	-7.580	
555	6.318968114	31.732	27.826	23.919	-7.813	
556	6.320768294	31 849	27 884	23 918	-7 931	
557	6 32256524	31 892	27.001	23 011	-7 981	
558	6 32/358062	31 908	27.002	23.013	-8.005	
550	6 2261 /0/72	21 995	27.900	23.905	7 000	
509	0.320149473	31.000	27.090	23.095	-7.990	
500	0.327930784	31.872	27.878	23.884	-7.988	
561	6.329720906	31.838	27.855	23.871	-7.967	
562	6.33150185	31.802	27.825	23.848	-7.954	
563	6.333279628	31.83	27.826	23.822	-8.008	
564	6.335054251	31.829	27.818	23.806	-8.023	
565	6.336825731	31.816	27.814	23.811	-8.005	
566	6.338594078	31.822	27.823	23.824	-7.998	
567	6.340359304	31.812	27.828	23.843	-7.969	
568	6.342121419	31.809	27.832	23.855	-7.954	
569	6.343880434	31.753	27.810	23.867	-7.886	
570	6.345636361	31.695	27.785	23.874	-7.821	
571	6.34738921	31.65	27.768	23.886	-7.764	
572	6.349138991	31.619	27.757	23.894	-7.725	
573	6 350885717	31 641	27 773	23 904	-7 737	
574	6 352629396	31 696	27 806	23 915	-7 781	
575	6 354370041	31 718	27.800	23.070	-7 794	
576	6 356107661	31 717	27.826	23.024	-7 782	
577	6 3578/2267	31 700	27.020	23.000	-7 768	
579	6 250572960	21.69	27.023	23.941	-7.700	
570	0.359573009	21.00	27.017	23.955	-7.727	
579	0.301302476	31.300	27.704	23.902	-7.604	
580	0.303028104	31.45	27.711	23.971	-7.479	
581	6.364/50/5/	31.447	27.713	23.979	-7.468	
582	6.366470448	31.598	27.794	23.989	-7.609	
583	6.368187186	31.756	27.873	23.989	-1.167	
584	6.369900983	31.86	27.925	23.99	-7.870	
585	6.371611847	31.882	27.936	23.989	-7.893	
586	6.37331979	31.924	27.956	23.988	-7.936	
587	6.37502482	31.939	27.962	23.984	-7.955	
588	6.376726948	31.926	27.953	23.979	-7.947	
589	6.378426184	31.893	27.929	23.964	-7.929	
590	6.380122537	31.853	27.898	23.942	-7.911	
591	6.381816017	31.851	27.885	23.918	-7.933	
592	6.383506635	31.857	27.883	23.908	-7.949	
593	6.385194399	31.845	27.879	23,913	-7.932	
594	6.386879319	31.846	27.886	23.926	-7.920	
595	6 388561406	31 829	27 883	23 936	-7 893	
596	6 300240667	31 812	27 870	23.000	-7 866	
507	6 301017112	31 772	27.013	23.040	-7 812	
500	6 302500754	31.77	27.000	23.30	-7.012	
500	0.383380734	31.72	27.040	20.9/0	-1.140 7 744	
599	0.395261598	31.695	∠1.840	23.984	-/./11	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C.	°C.	°C.	°C.	
Minates		0	0		0	
600	6 306020655	31 656	27 825	23.004	-7 662	
601	6 208504025	21.650	27.025	23.994	-7.002	
602	0.390394935	31.009	27.032	24.004	-7.000	
602	6.400257445	31.702	27.009	24.010	-7.000	
603	6.401917197	31.722	27.875	24.027	-7.695	
604	6.403574198	31.726	27.881	24.035	-7.691	
605	6.405228458	31.705	27.875	24.045	-7.660	
606	6.406879986	31.686	27.870	24.054	-7.632	
607	6.408528791	31.641	27.851	24.061	-7.580	
608	6.410174882	31.561	27.816	24.07	-7.491	
609	6.411818268	31.436	27.758	24.079	-7.357	
610	6.413458957	31.383	27.739	24.094	-7.289	
611	6.415096959	31.542	27.825	24.108	-7.434	
612	6.416732283	31.847	27.983	24.118	-7.729	
613	6.418364936	32.001	28.058	24.115	-7.886	
614	6.419994928	32.072	28.088	24.104	-7.968	
615	6.421622268	32.059	28.075	24.09	-7.969	
616	6 423246964	32 051	28.065	24 079	-7.972	
617	6 424869024	32 028	28.047	24.065	-7.963	
618	6 426488457	31 08/	28.015	24.000	-7 938	
610	6 429105272	21.026	20.013	24.040	7.930	
620	0.420103273	31.930	27.970	24.02	-7.910	
620	6.429719478	31.942	27.965	23.988	-7.954	
621	6.431331082	31.947	27.957	23.966	-7.981	
622	6.432940093	31.932	27.952	23.971	-7.961	
623	6.434546519	31.936	27.963	23.99	-7.946	
624	6.436150368	31.922	27.967	24.012	-7.910	
625	6.43775165	31.906	27.967	24.028	-7.878	
626	6.439350371	31.862	27.950	24.037	-7.825	
627	6.440946541	31.8	27.924	24.048	-7.752	
628	6.442540166	31.754	27.908	24.061	-7.693	
629	6.444131257	31.712	27.891	24.069	-7.643	
630	6.445719819	31.702	27.892	24.081	-7.621	
631	6.447305863	31,752	27.924	24.095	-7.657	
632	6.448889394	31.78	27.943	24.106	-7.674	
633	6.450470422	31.812	27.965	24.117	-7.695	
634	6 452048954	31 801	27 963	24 124	-7 677	
635	6 453624999	31 781	27.000	24.13	-7 651	
636	6 455198563	31 736	27.000	24.10	-7 596	
637	6 456760656	31.648	27.806	24.14	-7.504	
629	6 450220202	21 522	27.030	24.144	7 260	
620	0.450550205	31.323	27.039	24.154	-7.309	
639	0.409904404	31.313	27.039	24.102	-7.303	
640	0.401408170	31.753	27.962	24.171	-7.582	
641	6.463029457	31.994	28.083	24.172	-7.822	
642	6.464588304	32.078	28.123	24.16/	-7.911	
643	6.466144724	32.126	28.143	24.16	-7.966	
644	6.467698726	32.124	28.137	24.15	-7.974	
645	6.469250317	32.117	28.129	24.14	-7.977	
646	6.470799504	32.069	28.098	24.126	-7.943	
647	6.472346295	32.039	28.074	24.109	-7.930	
648	6.473890696	31.994	28.039	24.084	-7.910	
649	6.475432717	32.005	28.030	24.055	-7.950	
650	6.476972363	31.997	28.020	24.043	-7.954	
651	6.478509642	31.983	28.020	24.057	-7.926	
652	6.480044562	31.982	28.029	24.075	-7.907	
653	6.481577129	32.005	28.050	24.094	-7.911	
654	6.483107351	31.984	28.046	24.107	-7.877	
655	6,484635236	31.901	28.011	24.12	-7.781	
656	6.486160789	31.848	27,990	24.131	-7.717	
657	6 487684018	31 805	27 973	24.14	-7 665	
658	6 48020/021	31 778	27.06/	24 1/0	-7 620	
650	6 400722525	31 812	27 087	24.16	-7 653	
000	0.700120000	01.010		L 27.10	1.000	Í.

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
660	6.492239835	31.865	28.018	24.171	-7.694	
661	6.49375384	31.876	28.027	24.177	-7.699	
662	6.495265556	31.886	28.036	24.186	-7.700	
663	6.49677499	31.874	28.035	24.196	-7.678	
664	6.498282149	31.869	28.038	24.206	-7.663	
665	6.499787041	31.808	28.010	24.211	-7.597	
666	6.501289671	31.692	27.954	24.216	-7.476	
667	6.502790046	31.55	27.887	24.224	-7.326	
668	6.504288174	31.486	27.862	24.237	-7.249	
669	6.50578406	31.677	27.966	24.254	-7.423	
670	6.507277712	31.988	28.126	24.264	-7.724	
671	6.508769137	32.148	28.205	24.262	-7.886	
672	6.510258341	32.19	28.221	24.252	-7.938	
673	6.51174533	32.188	28.215	24.241	-7.947	
674	6.513230111	32.202	28.217	24.231	-7.971	
675	6.514712691	32.178	28.198	24.217	-7.961	
676	6.516193076	32.136	28.167	24.197	-7.939	
677	6.517671273	32.071	28.119	24.167	-7.904	
678	6 519147288	32 043	28.088	24 133	-7 910	
679	6 520621128	32 061	28.086	24 111	-7.950	
680	6 522092798	32 075	28.097	24 118	-7.957	
681	6 523562306	32 092	28 116	24 139	-7 953	
682	6 525029658	32 084	28 120	24.105	-7 928	
683	6 52649486	32.068	28 119	24.100	-7 898	
684	6 527057018	32.000	20.113	24.17	-7.866	
685	6 520/18838	31 047	28.068	24.170	-7.758	
686	6 530877628	31.947	28.000	24.109	-7.750	
697	6.530077020	21 942	20.039	24.201	7.622	
600	0.002004292	21 014	20.020	24.209	-7.033	
000	0.0007000000	31.014	20.015	24.210	-7.596	
600	0.000241271	31.001	20.000	24.229	-7.002	
690	0.030091090	31.922	20.002	24.241	-7.001	
691	0.538139824	31.931	28.092	24.252	-7.679	
692	6.539585956	31.931	28.099	24.266	-7.665	
693	6.541029999	31.938	28.107	24.276	-7.002	
694	6.542471961	31.916	28.100	24.284	-7.632	
695	6.543911846	31.817	28.053	24.289	-7.528	
696	6.54534966	31.677	27.984	24.291	-7.386	
697	6.546785411	31.725	28.013	24.3	-7.425	
698	6.548219103	31.976	28.138	24.3	-7.676	
699	6.549650742	32.164	28.232	24.299	-7.865	
700	6.551080335	32.226	28.259	24.291	-7.935	
701	6.552507887	32.233	28.259	24.284	-7.949	
702	6.553933404	32.269	28.272	24.274	-7.995	
703	6.555356892	32.253	28.260	24.267	-7.986	
704	6.556778356	32.206	28.232	24.257	-7.949	
705	6.558197803	32.144	28.193	24.242	-7.902	
706	6.559615237	32.108	28.163	24.217	-7.891	
707	6.561030666	32.137	28.164	24.191	-7.946	
708	6.562444094	32.129	28.157	24.185	-7.944	
709	6.563855527	32.11	28.156	24.201	-7.909	
710	6.56526497	32.1	28.161	24.221	-7.879	
711	6.56667243	32.083	28.160	24.236	-7.847	
712	6.568077911	32.109	28.180	24.25	-7.859	
713	6.56948142	32.036	28.150	24.263	-7.773	
714	6.570882962	31.966	28.121	24.276	-7.690	
715	6.572282543	31.919	28.102	24.284	-7.635	
716	6.573680167	31.899	28.096	24.292	-7.607	
717	6.575075841	31.964	28.134	24.304	-7.660	
718	6.576469569	32.008	28.160	24.312	-7.696	
719	6.577861358	32.02	28.171	24.322	-7.698	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
720	6.579251212	32.008	28.168	24.327	-7.681	
721	6.580639137	31.985	28.160	24.334	-7.651	
722	6.582025139	31.965	28.156	24.346	-7.619	
723	6.583409222	31.921	28.137	24.353	-7.568	
724	6.584791392	31.815	28.085	24.355	-7.460	
725	6.586171655	31.663	28.012	24.36	-7.303	
726	6.587550015	31.658	28.016	24.374	-7.284	
727	6.588926478	31.965	28.178	24.39	-7.575	
728	6.590301048	32.239	28.316	24.392	-7.847	
729	6.591673732	32.316	28.352	24.387	-7.929	
730	6.593044534	32.328	28.351	24.374	-7.954	
731	6.59441346	32.306	28.335	24.364	-7.942	
732	6.595780514	32.321	28.337	24.352	-7.969	
733	6.597145702	32.274	28.305	24.336	-7.938	
734	6.598509029	32.236	28.276	24.316	-7.920	
735	6.599870499	32.191	28.238	24.285	-7.906	
736	6.601230119	32.195	28.223	24.251	-7.944	
737	6.602587892	32.22	28,229	24.237	-7.983	
738	6 603943825	32 23	28 243	24 255	-7.975	
739	6 605297921	32 191	28 235	24 278	-7 913	
740	6 606650186	32 156	28 225	24 294	-7 862	
741	6 608000625	32 193	28 251	24,308	-7 885	
742	6 609349243	32 134	28 226	24.317	-7 817	
7/12	6 610696045	32.104	28.186	24.317	-7 718	
743	6 6120/1035	31 082	28.160	24.327	-7.644	
744	6.612294219	21.902	20.100	24.330	7.044	
745	6.6147256	21.950	20.100	24.340	7.010	
740	0.0147230	31.979	20.109	24.300	-7.021	
747	0.010000100	32.042	20.207	24.372	-7.070	
748	6.617402978	32.081	28.233	24.384	-7.697	
749	6.618738984	32.094	28.244	24.393	-7.701	
750	6.620073207	32.072	28.236	24.399	-7.673	
/51	6.621405652	32.049	28.228	24.406	-7.643	
752	6.622736324	32.016	28.216	24.416	-7.600	
/53	6.624065228	31.919	28.169	24.418	-7.501	
754	6.625392368	31.777	28.100	24.422	-7.355	
755	6.626717749	31.71	28.071	24.431	-7.279	
756	6.628041376	31.942	28.192	24.442	-7.500	
757	6.629363253	32.244	28.346	24.448	-7.796	
758	6.630683386	32.344	28.395	24.445	-7.899	
759	6.632001777	32.376	28.408	24.44	-7.936	
760	6.633318433	32.423	28.426	24.429	-7.994	
761	6.634633358	32.356	28.386	24.415	-7.941	
762	6.635946556	32.317	28.360	24.403	-7.914	
763	6.637258031	32.285	28.336	24.386	-7.899	
764	6.638567789	32.251	28.304	24.357	-7.894	
765	6.639875834	32.229	28.276	24.322	-7.907	
766	6.64118217	32.231	28.269	24.307	-7.924	
767	6.642486801	32.237	28.277	24.317	-7.920	
768	6.643789733	32.252	28.296	24.34	-7.912	
769	6.64509097	32.255	28.306	24.357	-7.898	
770	6.646390515	32.279	28.324	24.368	-7.911	
771	6.647688374	32.206	28.294	24.382	-7.824	
772	6.64898455	32.102	28.245	24.387	-7.715	
773	6.650279049	32.026	28.210	24.394	-7.632	
774	6.651571874	31.968	28,189	24,409	-7.559	
775	6 652863029	31 961	28 190	24 419	-7 542	
776	6 65415252	32 045	28.240	24 434	-7.611	
777	6 65544035	32 107	28.276	24.404	-7.663	
778	6 656726524	32.107	28.280	24.444	-7.669	
770	6 659011046	22.123	20.209	24.454	7.664	
113	0.000011040	JZ. 1 ZI	20.230	24.403	-1.004	1

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)		°C	°€	0°C	
IVIII IULES		0	C	C	C	
700	0.05000000			04.477		
/80	6.65929392	32.134	28.306	24.477	-7.657	
781	6.66057515	32.098	28.292	24.485	-7.613	
782	6.661854741	31.983	28.234	24.484	-7.499	
783	6.663132696	31.824	28.156	24.487	-7.337	
784	6.66440902	31.805	28.147	24.489	-7.316	
785	6.665683718	32.061	28,278	24,495	-7.566	
786	6 666956792	32 304	28 400	24 495	-7 809	
700	6 669229249	22.004	20.400	24.401	7.000	
707	0.000220240	32.401	20.440	24.491	-7.910	
788	6.66949809	32.439	28.460	24.481	-7.958	
789	6.670766321	32.451	28.463	24.474	-7.977	
790	6.672032945	32.427	28.446	24.465	-7.962	
791	6.673297968	32.389	28.423	24.457	-7.932	
792	6.674561392	32.336	28.389	24.441	-7.895	
793	6.675823222	32.283	28.347	24.411	-7.872	
794	6 677083461	32 295	28 337	24 379	-7 916	
795	6 678342115	32 294	28 330	24 365	-7 929	
706	6 670500196	22.204	20.000	24.000	7.026	
790	0.079099100	32.300	20.343	24.30	-7.920	
/9/	6.680854679	32.295	28.347	24.398	-7.897	
798	6.682108597	32.289	28.353	24.417	-7.872	
799	6.683360946	32.306	28.369	24.431	-7.875	
800	6.684611728	32.23	28.337	24.444	-7.786	
801	6.685860947	32.155	28.304	24.453	-7.702	
802	6 687108608	32 099	28 281	24 462	-7 637	
803	6 688354714	32 033	28 252	24.47	-7 563	
904	6 690500260	22.000	20.202	24.47	7.505	
004	0.009099209	32.045	20.203	24.401	-7.304	
805	6.690842277	32.131	28.313	24.494	-7.637	
806	6.692083743	32.171	28.338	24.504	-7.667	
807	6.693323668	32.183	28.348	24.513	-7.670	
808	6.694562059	32.175	28.348	24.521	-7.654	
809	6.695798917	32.18	28.356	24.532	-7.648	
810	6.697034248	32.145	28.342	24.539	-7.606	
811	6 698268054	32.05	28 295	24 539	-7 511	
812	6 60050034	31 906	28.224	24.541	-7 365	
012	6 70072111	21.900	20.224	24.541	7.303	
013	0.70073111	31.040	20.197	24.347	-7.299	
814	6.701960366	32.1	28.327	24.553	-7.547	
815	6.703188113	32.394	28.475	24.555	-7.839	
816	6.704414355	32.484	28.518	24.552	-7.932	
817	6.705639095	32.505	28.524	24.542	-7.963	
818	6.706862337	32.498	28.514	24.53	-7.968	
819	6,708084084	32.5	28.511	24.521	-7,979	
820	6 70930434	32 454	28 483	24 511	-7 943	
821	6 710523109	32 388	28.100	21.011	-7 89/	
021	6.710323103	32.300	20.441	24.434	7.034	
022	0.711740395	32.333	26.400	24.407	-7.000	
823	6.712956201	32.333	28.385	24.436	-7.897	
824	6./141/053	32.351	28.385	24.419	-7.932	
825	6.715383386	32.379	28.406	24.433	-7.946	
826	6.716594774	32.377	28.417	24.457	-7.920	
827	6.717804695	32.338	28.406	24.473	-7.865	
828	6.719013154	32.332	28,409	24.486	-7.846	
829	6 720220155	32 293	28 395	24 496	-7 797	
830	6 721/25701	32.200	28.260	24.51	_7 700	
000	6 700600705	22.21	20.000	27.01	7 6 1 6	
001	0.122029193	32.101	20.009	24.010	-7.040	
832	6.723832441	32.099	28.312	24.524	-7.575	
833	6.725033642	32.096	28.316	24.535	-7.561	
834	6.726233402	32.174	28.361	24.547	-7.627	
835	6.727431725	32.248	28.404	24.56	-7.688	
836	6.728628613	32.296	28.432	24.568	-7.728	
837	6.72982407	32.31	28.442	24.574	-7.736	
838	6 7310181	32 208	28 438	24 578	-7 720	
830	6 732210706	32 242	28 /12	24 581	-7 661	
003	0.102210100	52.272	20.712	2-1.001	1.001	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
840	6.733401892	32.145	28.363	24.58	-7.565	
841	6.73459166	31.979	28.281	24.582	-7.397	
842	6.735780014	31.897	28.242	24.587	-7.310	
843	6.736966958	32.127	28.361	24.594	-7.533	
844	6.738152495	32.41	28.503	24.596	-7.814	
845	6.739336627	32.527	28.560	24.592	-7.935	
846	6.74051936	32.603	28.595	24.586	-8.017	
847	6.741700695	32.6	28.589	24.578	-8.022	
848	6.742880636	32.567	28.569	24.57	-7.997	
849	6.744059186	32.523	28.541	24.559	-7.964	
850	6.745236349	32.467	28.505	24.542	-7.925	
851	6.746412129	32.399	28.457	24.515	-7.884	
852	6.747586527	32.396	28.440	24.483	-7.913	
853	6.748759547	32.423	28.444	24.464	-7.959	
854	6.749931194	32.425	28.449	24.473	-7.952	
855	6.751101469	32.422	28.458	24.494	-7.928	
856	6.752270376	32.409	28.462	24.514	-7.895	
857	6.753437919	32.393	28.462	24.53	-7.863	
858	6.754604099	32.402	28.472	24.541	-7.861	
859	6.755768922	32.311	28.430	24.549	-7.762	
860	6.756932389	32.223	28.391	24.559	-7.664	
861	6.758094504	32.164	28.365	24.565	-7.599	
862	6.759255271	32.163	28.368	24.572	-7.591	
863	6.760414691	32.256	28.420	24.584	-7.672	
864	6.761572769	32.32	28.459	24.597	-7.723	
865	6.762729507	32.333	28.469	24.605	-7.728	
866	6.763884909	32.344	28.478	24.612	-7.732	
867	6.765038977	32.322	28.469	24.615	-7.707	
868	6.766191715	32.282	28.454	24.625	-7.657	
869	6.767343125	32.199	28.414	24.628	-7.571	
870	6.768493212	32.068	28.348	24.628	-7.440	
871	6 769641977	31 917	28 275	24 633	-7 284	
872	6 770789424	32 034	28,339	24 643	-7.391	
873	6 771935556	32 45	28 552	24 653	-7 797	
874	6 773080376	32.65	28 650	24.65	-8 000	
875	6 774223886	32 648	28.645	24 642	-8.006	
876	6 775366091	32.605	28.619	24.632	-7 973	
877	6 776506992	32 589	28.606	24.623	-7 966	
878	6 777646594	32.56	28 587	24.623	-7 947	
879	6 778784898	32 528	28 563	24.013	-7 931	
880	6 779921907	32.020	28.526	24.537	-7 902	
881	6 781057626	32.477	20.020	24.573	-7.866	
882	6 782192056	32.400	28.480	24.542	-7.000	
883	6 783325201	32.445	20.400	24.510	-7.927	
994	6 784457063	22.445	20.403	24.52	7.323	
004	6 785587645	22.40	20.014	24.540	-7.932	
000	6 796716051	22.407	20.000	24.373	-7.914	
000	6 797944092	22.472	20.020	24.504	-7.000	
007	6 799071742	32.479	28.550	24.592	-7.007	
000	0.700971743	32.419	20.009	24.090	-7.021	
009	6.790097236	32.33	20.400	24.606	-7.724	
890	6.791221403	32.203	20.439	24.010	-7.040	
091	0.792344427	32.22	20.421	24.021	-7.599	
892	0.793400133	32.248	28.438	24.628	-7.620	
893	6.794586581	32.322	28.481	24.64	-7.682	
894	6.795705775	32.375	28.513	24.651	-7.724	
895	6.796823718	32.395	28.528	24.66	-7.735	
896	6.797940413	32.389	28.529	24.668	-7.721	
897	6.799055862	32.382	28.529	24.675	-7.707	
898	6.800170068	32.326	28.504	24.682	-7.644	
899	6.801283034	32.231	28.457	24.682	-7.549	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
900	6.802394763	32.111	28.396	24.68	-7.431	
901	6.803505258	31.977	28.333	24.688	-7.289	
902	6.80461452	32.11	28.405	24.699	-7.411	
903	6.805722553	32.453	28.582	24.71	-7.743	
904	6.80682936	32.593	28.652	24.71	-7.883	
905	6.807934944	32.652	28.677	24.702	-7.950	
906	6.809039306	32.684	28.687	24.689	-7.995	
907	6.81014245	32.67	28.677	24.683	-7.987	
908	6.811244379	32.621	28.646	24.671	-7.950	
909	6.812345094	32.577	28.616	24.654	-7.923	
910	6.8134446	32.533	28.582	24.63	-7.903	
911	6.814542897	32.468	28.533	24.598	-7.870	
912	6.81563999	32.491	28.533	24.574	-7.917	
913	6.816735881	32.509	28.543	24.577	-7.932	
914	6.817830571	32.51	28.554	24.597	-7.913	
915	6.818924065	32.498	28.556	24.614	-7.884	
916	6.820016365	32.491	28.561	24.631	-7.860	
917	6.821107472	32.504	28.574	24.644	-7.860	
918	6.822197391	32.432	28.543	24.654	-7.778	
919	6.823286122	32.34	28.502	24.663	-7.677	
920	6.82437367	32.285	28.478	24.67	-7.615	
921	6.825460036	32.242	28.461	24.679	-7.563	
922	6.826545224	32.29	28.490	24.69	-7.600	
923	6.827629235	32.343	28.523	24.702	-7.641	
924	6.828712072	32.389	28.551	24.712	-7.677	
925	6 829793738	32 412	28 566	24 72	-7 692	
926	6.830874235	32.39	28.559	24.727	-7.663	
927	6 831953566	32 375	28 556	24 737	-7 638	
928	6 833031733	32 322	28 533	24 744	-7 578	
929	6 834108739	32 212	28 478	24 743	-7 469	
930	6 835184586	32.06	28 403	24 745	-7.315	
931	6 836259277	32 015	28 387	24 758	-7 257	
932	6.837332815	32 297	28 532	24.767	-7 530	
933	6 838405201	32 584	28.678	24.707	-7 812	
034	6 839476438	32 677	28.723	24.768	-7 909	
035	6 840546529	32.673	28 717	24.760	-7 912	
936	6 841615476	32.686	28 719	24.701	-7.912	
037	6.842683282	32,662	28 702	24.731	-7 021	
038	6 8/37/00/0	32.002	28.677	24.741	-7.921	
930	6 8//815/70	32.024	28.6/1	24.73	-7.864	
939	6 8/5870875	32.575	28.603	24.709	-7.847	
0/1	6.94604214	32.520	20.003	24.075	7 972	
941	6 9/9005275	32.510	20.002	24.045	-7.073	
942	6.940066293	32.555	20.002	24.03	-7.903	
943	0.049000203	32.344	20.090	24.045	-7.099	
944	0.000120100	32.344	20.000	24.007	-7.077	
945	0.001104927	32.528	20.000	24.004	-7.044	
940	0.002242009	32.559	20.029	24.090	-7.001	
947	0.000299090	32.479	20.094	24.709	-7.770	
948	0.854354502	32.406	28.563	24.72	-7.080	
949	6.855408799	32.347	28.536	24.725	-7.622	
950	6.856461985	32.289	28.512	24.734	-7.555	
951	0.85/514063	32.286	28.515	24.744	-7.542	
952	6.858565035	32.372	28.564	24.755	-7.617	
953	6.859614904	32.449	28.607	24.765	-7.684	
954	6.860663671	32.461	28.618	24./74	-7.687	
955	6.86171134	32.467	28.625	24.782	-7.685	
956	6.862757913	32.469	28.630	24.79	-7.679	
957	6.863803391	32.412	28.603	24.794	-7.618	
958	6.864847778	32.324	28.560	24.795	-7.529	
959	6.865891075	32.156	28.476	24.795	-7.361	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	ଂ	°C	°C.	
Minutes		0	0		0	
060	6 866033284	32.003	28 117	24.8	-7 203	
900	6 967074400	32.095	20.447	24.0	7.295	
901	6 960014451	32.347	20.011	24.800	7.541	
962	0.009014451	32.364	20.095	24.605	-7.779	
963	6.870053412	32.683	28.744	24.805	-7.878	
964	6.8/1091295	32.701	28.751	24.801	-7.900	
965	6.872128101	32.683	28.739	24.794	-7.889	
966	6.873163834	32.689	28.739	24.789	-7.900	
967	6.874198495	32.648	28.715	24.781	-7.867	
968	6.875232087	32.623	28.694	24.765	-7.858	
969	6.876264612	32.565	28.653	24.741	-7.824	
970	6.877296071	32.581	28.644	24.707	-7.874	
971	6.878326468	32.567	28.630	24.693	-7.874	
972	6.879355804	32.561	28.635	24.709	-7.852	
973	6.880384082	32.594	28,662	24.73	-7.864	
974	6.881411304	32,705	28,723	24,741	-7.964	
975	6 882437471	32 591	28 669	24 746	-7 845	
976	6 883462586	32 488	28.623	24 757	-7 731	
077	6 884486652	32,400	28.506	24.766	-7.650	
977	0.004400032	32.425	20.090	24.700	-7.039	
978	0.88550967	32.381	28.579	24.777	-7.604	
979	6.886531643	32.341	28.563	24.785	-7.556	
980	6.887552572	32.364	28.579	24.794	-7.570	
981	6.88857246	32.433	28.620	24.806	-7.627	
982	6.889591308	32.46	28.636	24.811	-7.649	
983	6.89060912	32.478	28.650	24.822	-7.656	
984	6.891625897	32.571	28.706	24.84	-7.731	
985	6.892641641	32.636	28.739	24.842	-7.794	
986	6.893656355	32.643	28.738	24.832	-7.811	
987	6.894670039	32.635	28,728	24.82	-7.815	
988	6 895682698	32 613	28 709	24 804	-7 809	
989	6 896694332	32 602	28.696	24.79	-7 812	
990	6 897704943	32 607	28.694	24.78	-7.827	
001	6 808714534	32,600	20.004	24.70	-7.833	
991	0.090714554	32.009	20.093	24.770	-7.033	
992	0.099723107	32.019	20.097	24.774	-7.040	
993	0.900730004	32.622	20.097	24.772	-7.650	
994	6.901737207	32.637	28.704	24.771	-7.866	
995	6.902742737	32.69	28.733	24.776	-7.914	
996	6.903/4/258	32.679	28.729	24.779	-7.900	
997	6.90475077	32.64	28.711	24.781	-7.859	
998	6.905753276	32.585	28.684	24.783	-7.802	
999	6.906754779	32.541	28.662	24.783	-7.758	
1000	6.907755279	32.497	28.643	24.789	-7.708	
1001	6.908754779	32.411	28.605	24.799	-7.612	
1002	6.909753282	32.377	28.594	24.811	-7.566	
1003	6.910750788	32.398	28.612	24.826	-7.572	
1004	6.9117473	32,441	28.640	24.839	-7.602	
1005	6.91274282	32.505	28.680	24.854	-7.651	
1006	6 913737351	32 56	28 712	24 863	-7 697	
1007	6 914730893	32 558	28 714	24 869	-7 689	
1007	6 915723449	32 51	28 691	24.872	-7.638	
1000	6 01671502	32 //1	20.001	24.072	-7 566	
1009	6.01770561	32 250	20.000	24.070	_7 470	
1010	6.019605040	20.008	20.020	24.00	-1.413	
1011	0.910095219	32.22	20.001	24.882	-1.338	
1012	0.91968385	32.163	28.527	24.89	-1.2/3	
1013	6.920671504	32.432	28.664	24.896	-7.536	
1014	6.921658184	32.647	28.773	24.898	-7.749	
1015	6.922643891	32.729	28.813	24.896	-7.833	
1016	6.923628628	32.761	28.828	24.894	-7.867	
1017	6.924612396	32.768	28.828	24.888	-7.880	
1018	6.925595197	32.727	28.804	24.88	-7.847	
1019	6.926577033	32.706	28.787	24.868	-7.838	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	ଂମ	°C	°C.	
Mindeo		0	0		0	
1020	6 027557006	32.66	28 755	24.85	-7.810	
1020	6 029527919	22.00	20.733	24.00	7 760	
1021	0.920537010	32.393	20.709	24.024	-7.709	
1022	0.929510771	32.627	20.711	24.795	-7.032	
1023	6.930494766	32.634	28.709	24.783	-7.851	
1024	6.9314/1806	32.643	28.722	24.801	-7.842	
1025	6.932447892	32.637	28.728	24.818	-7.819	
1026	6.933423026	32.628	28.730	24.831	-7.797	
1027	6.93439721	32.625	28.734	24.842	-7.783	
1028	6.935370446	32.546	28.699	24.852	-7.694	
1029	6.936342736	32.479	28.669	24.859	-7.620	
1030	6.937314081	32.43	28.650	24.87	-7.560	
1031	6.938284484	32.389	28.633	24.876	-7.513	
1032	6.939253946	32.439	28.661	24.883	-7.556	
1033	6.940222469	32.515	28.705	24.895	-7.620	
1034	6.941190055	32.536	28.720	24.904	-7.632	
1035	6.942156706	32 548	28 730	24 911	-7 637	
1036	6 943122423	32 543	28 731	24 919	-7 624	
1037	6 944087208	32.52	28 723	24 925	-7 595	
1037	6.045051064	22.02	20.725	24.925	7 520	
1030	6.945051064	32.405	20.090	24.920	-7.539	
1039	0.940013991	32.300	20.040	24.920	-7.440	
1040	6.946975992	32.231	28.581	24.931	-7.300	
1041	6.947937069	32.29	28.614	24.937	-7.353	
1042	6.948897222	32.591	28.766	24.94	-7.651	
1043	6.949856455	32.748	28.846	24.943	-7.805	
1044	6.950814768	32.805	28.871	24.937	-7.868	
1045	6.951772164	32.811	28.870	24.929	-7.882	
1046	6.952728645	32.811	28.866	24.92	-7.891	
1047	6.953684211	32.789	28.849	24.909	-7.880	
1048	6.954638865	32.731	28.815	24.899	-7.832	
1049	6.955592608	32.691	28.785	24.878	-7.813	
1050	6.956545443	32.654	28,752	24.85	-7.804	
1051	6.957497371	32,663	28,744	24.825	-7.838	
1052	6 958448393	32 678	28 753	24 827	-7 851	
1053	6 959398512	32 674	28 761	24 847	-7 827	
1050	6 9603/7729	32 667	28.766	24.864	-7.803	
1054	6.061206046	22.007	20.700	24.004	7 706	
1055	6.062242464	32.070	20.776	24.00	7.730	
1030	0.902243404	32.002	20.770	24.09	-7.772	
1057	0.903189980	32.586	28.744	24.902	-7.084	
1058	6.964135612	32.524	28.717	24.909	-7.615	
1059	6.965080346	32.47	28.693	24.916	-7.554	
1060	6.966024187	32.441	28.683	24.924	-7.517	
1061	6.966967139	32.5	28.718	24.936	-7.564	
1062	6.967909202	32.576	28.761	24.946	-7.630	
1063	6.968850378	32.601	28.777	24.952	-7.649	
1064	6.96979067	32.584	28.771	24.957	-7.627	
1065	6.970730078	32.593	28.780	24.966	-7.627	
1066	6.971668605	32.58	28.778	24.975	-7.605	
1067	6.972606251	32.526	28.750	24.974	-7.552	
1068	6.97354302	32.411	28.693	24.975	-7.436	
1069	6.974478911	32.389	28.683	24.977	-7.412	
1070	6.975413927	32.596	28.787	24.977	-7.619	
1071	6.97634807	32.754	28.864	24.973	-7.781	
1072	6.977281342	32 804	28 887	24 969	-7 835	
1072	6 9782127/2	32 8/12	28 906	24 968	-7 875	
1073	6 9701/6776	32.0+3	20.000	24.000	-7 87/	
1074	6.080075044	22.000	20.030	24.303	-7.074	
1073	6.0010073941	22.031	20.032	24.902	-1.019	
10/0	0.901005741	32.8U3	20.0/5	24.940	-7.000	
10//	0.9019346//	32.112	28.853	24.934	-7.838	
1078	6.982862751	32.727	28.822	24.91/	-7.810	
1079	6.983789965	32.736	28.816	24.895	-7.841	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	ଂମ	°C.	°C.	
minucoo	(Ū	0		
1080	6 98471632	32 768	28.830	24 891	-7 877	
1080	6 985641818	32 775	28.839	24.001	-7 873	
1082	6 986566459	32 752	28 835	24 917	-7 835	
1083	6 987490247	32 741	28 834	24 926	-7 815	
1084	6 988413182	32 729	28 833	24 937	-7 792	
1085	6 989335266	32.68	28.813	24.946	-7 734	
1086	6 9902565	32.60	28 783	24 955	-7 655	
1087	6 991176887	32 573	28 768	24.962	-7 611	
1088	6 992096427	32 527	28 749	24.002	-7.557	
1089	6 993015123	32 536	28 758	24.07	-7 557	
1000	6 993932975	32 628	28.811	24.070	-7 634	
1000	6 994849986	32.673	28.840	25.006	-7 667	
1092	6 995766156	32.687	28.850	25.000	-7 674	
1093	6 996681488	32.68	28,850	25.019	-7 661	
1094	6 997595983	32 654	28.838	25.013	-7.632	
1094	6 998509642	32.004	28.818	25.022	-7 582	
1000	6 999422468	32 535	28.783	25.027	-7 505	
1000	7.00033446	32.000	28.736	25.00	-7 /1/	
1097	7.001245622	32.445	28.679	25.029	-7.282	
1090	7.001245022	32.52	28.079	25.030	-7.442	
1100	7.002155954	32.491	20.770	25.049	-7 732	
1100	7.003003439	32.709	20.923	25.057	-7.834	
1101	7.003974137	32.09	20.973	25.050	-7.801	
1102	7.00400199	32.942	20.997	25.001	7.091	
1103	7.005789019	32.940	20.990	25.044	-7.904	
1104	7.000095227	32.94	20.907	25.033	-7.907	
1105	7.007600614	22.92	20.970	25.02	-7.900	
1100	7.006303162	32.007	20.933	23.002	-7.000	
1107	7.009406933	32.609	20.090	24.901	-7.020	
1100	7.010311007	32.779	20.007	24.955	-7.024	
1109	7.011213967	32.794	20.004	24.934	-7.000	
1110	7.012115294	32.040	20.097	24.940	-7.902	
1111	7.01301579	32.849	28.907	24.965	-7.884	
1112	7.013915475	32.843	28.911	24.979	-7.864	
1113	7.014814351	32.876	28.935	24.993	-7.883	
1114	7.01571242	32.781	28.892	25.003	-7.778	
1115	7.016609684	32.69	28.851	25.012	-7.678	
1116	7.017506143	32.636	28.830	25.024	-7.612	
1117	7.018401799	32.603	28.817	25.031	-7.572	
1118	7.019296654	32.585	28.813	25.041	-7.544	
1119	7.020190708	32.647	28.850	25.052	-7.595	
1120	7.021083964	32.736	28.899	25.062	-7.674	
1121	7.021976423	32.78	28.928	25.075	-7.705	
1122	7.022868086	32.806	28.945	25.083	-7.723	
1123	7.023758955	32.796	28.943	25.089	-7.707	
1124	7.02464903	32.747	28.920	25.093	-7.654	
1125	7.025538315	32.644	28.868	25.091	-7.553	
1126	7.026426809	32.534	28.813	25.091	-7.443	
1127	7.027314514	32.427	28.761	25.095	-7.332	
1128	7.028201432	32.465	28.785	25.105	-7.360	
1129	7.029087564	32.792	28.953	25.114	-7.678	
1130	7.029972912	32.975	29.047	25.118	-7.857	
1131	7.030857476	33.029	29.073	25.116	-7.913	
1132	7.031741259	33.033	29.073	25.113	-7.920	
1133	7.032624261	33.03	29.069	25.107	-7.923	
1134	7.033506484	33.021	29.060	25.098	-7.923	
1135	7.03438793	32.943	29.012	25.081	-7.862	
1136	7.035268599	32.895	28.976	25.056	-7.839	
1137	7.036148494	32.844	28.937	25.029	-7.815	
1138	7.037027615	32.848	28.926	25.004	-7.844	
1139	7.037905963	32.863	28.935	25.007	-7.856	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
1140	7.038783541	32,902	28,966	25.03	-7.872	
1141	7.03966035	32.929	28.990	25.05	-7.879	
1142	7.04053639	32,909	28.986	25.062	-7.847	
1143	7 041411664	32.91	28 991	25.071	-7 839	
1144	7 042286172	32 831	28 955	25 079	-7 752	
1145	7.043159916	32 74	28.912	25.084	-7 656	
1146	7.044032897	32 671	28.882	25.001	-7 579	
1147	7.044002007	32 644	28.873	25 101	-7 543	
1148	7.044300117	32 676	28.892	25 108	-7 568	
1140	7.046647278	32 766	28.002	25 119	-7 647	
1150	7.047517221	32 826	28.979	25 132	-7 694	
1151	7.048386409	32 853	28.998	25 143	-7 710	
1152	7.040000400	32 842	28,996	25 149	-7 693	
1153	7.05012252	32 833	28.995	25 157	-7.676	
1154	7.050989447	32 785	28.000	25 158	-7 627	
1155	7.051855623	32.7	28.928	25 155	-7 545	
1156	7.052721049	32.61	28.882	25 153	-7 457	
1157	7.053585727	32.01	28.822	25.155	-7 336	
1158	7.053303727	32.43	20.022	25.164	-7 336	
1150	7.054449030	32.304	20.030	25.100	-7.556	
1160	7.056175284	33.055	29.012	25.104	-7.867	
1161	7.057036082	33 133	29.122	25.100	-7.007	
1162	7.057897937	33 111	29.139	25.105	-7.940	
1163	7.057591937	33.11	29.144	25.177	-7.934	
1164	7.050730133	22 107	29.139	25.107	7 052	
1104	7.059017020	33.107	29.131	25.135	-7.952	
1100	7.000470300	33.044	29.092	25.139	-7.905	
1167	7.001334307	32.979	29.047	25.115	-7.004	
1107	7.002191032	32.93	29.009	25.060	-7.042	
1100	7.003040103	32.904	20.903	25.001	-7.043	
1109	7.003903901	32.934	20.997	25.00	-7.074	
1170	7.064739026	32.993	29.037	25.061	-7.912	
11/1	7.065613364	33.009	29.057	25.105	-7.904	
1172	7.06646697	32.995	29.057	25.118	-7.877	
1173	7.067319849	32.992	29.060	25.128	-7.804	
1174	7.068172	32.966	29.051	25.135	-7.831	
1175	7.069023427	32.824	28.984	25.143	-7.681	
1176	7.069874128	32.734	28.942	25.149	-7.585	
1177	7.070724107	32.708	28.934	25.159	-7.549	
1178	7.071573364	32.711	28.940	25.169	-7.542	
1179	7.072421901	32.79	28.984	25.178	-7.612	
1180	7.073269717	32.881	29.037	25.192	-7.689	
1181	7.074116816	32.924	29.064	25.203	-7.721	
1182	7.074963198	32.94	29.076	25.211	-7.729	
1183	7.075808864	32.928	29.073	25.218	-7.710	
1184	7.076653815	32.896	29.060	25.223	-7.673	
1185	7.077498054	32.804	29.012	25.219	-7.585	
1186	7.07834158	32.676	28.945	25.213	-7.463	
1187	7.079184395	32.537	28.876	25.215	-7.322	
1188	7.0800265	32.63	28.927	25.223	-7.407	
1189	7.080867897	32.969	29.101	25.233	-7.736	
1190	7.081708586	33.113	29.174	25.234	-7.879	
1191	7.082548569	33.185	29.209	25.233	-7.952	
1192	7.083387848	33.19	29.208	25.226	-7.964	
1193	7.084226422	33.161	29.192	25.222	-7.939	
1194	7.085064294	33.142	29.177	25.212	-7.930	
1195	7.085901464	33.099	29.149	25.199	-7.900	
1196	7.086737935	33.032	29.104	25.176	-7.856	
1197	7.087573706	32.979	29.063	25.146	-7.833	
1198	7.088408779	32.978	29.050	25.122	-7.856	
1199	7.089243155	33.026	29.075	25.124	-7.902	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	С°	°C	°C	°C	
1200	7.090076836	33.036	29.092	25.147	-7.889	
1201	7.090909822	33.034	29.101	25.168	-7.866	
1202	7.091742115	33.043	29.114	25.185	-7.858	
1203	7.092573716	33.089	29.141	25.192	-7.897	
1204	7.093404626	32.988	29.094	25.199	-7.789	
1205	7.094234846	32.879	29.043	25.207	-7.672	
1206	7.095064377	32.815	29.013	25.211	-7.604	
1207	7.095893221	32.777	28.998	25.218	-7.559	
1208	7.096721378	32.809	29.017	25.225	-7.584	
1209	7.097548851	32.892	29.066	25.24	-7.652	
1210	7.098375639	32.961	29.106	25.25	-7.711	
1211	7.099201744	32.981	29.119	25.257	-7.724	
1212	7.100027167	32.992	29.129	25.265	-7.727	
1213	7.100851909	32.979	29.126	25.273	-7.706	
1214	7.101675972	32.945	29.112	25.279	-7.666	
1215	7.102499356	32.868	29.070	25.272	-7.596	
1216	7.103322063	32.776	29.021	25.266	-7.510	
1217	7.104144093	32.61	28.939	25.267	-7.343	
1218	7.104965448	32.649	28.963	25.276	-7.373	
1219	7.105786129	32.999	29.144	25.289	-7.710	
1220	7.106606138	33.195	29.244	25.293	-7.902	
1221	7.107425474	33.235	29.262	25.289	-7.946	
1222	7.10824414	33.244	29.262	25.28	-7.964	
1223	7.109062136	33.233	29.254	25.274	-7.959	
1224	7.109879463	33.222	29.243	25.263	-7.959	
1225	7 110696123	33 186	29 217	25 248	-7.938	
1226	7.111512116	33.114	29.170	25.226	-7.888	
1227	7 112327445	33 056	29 127	25 197	-7 859	
1228	7 113142109	33 042	29 106	25 169	-7 873	
1229	7 11395611	33 091	29 129	25 167	-7.924	
1230	7 114769448	33 127	29 159	25 191	-7 936	
1231	7 115582126	33 138	29 174	25.21	-7 928	
1232	7.116394144	33 121	29.174	25.22	-7 901	
1232	7.110004144	33 132	29 182	25 231	-7 901	
1234	7.118016204	33.058	20.102	25 237	-7.821	
1235	7.118826249	32 948	20.140	25.207	-7 700	
1235	7.110626249	32.888	29.030	25.240	-7.631	
1230	7.110000000	32.000	20.073	25.201	-7 583	
1238	7.120444372	32,862	29.000	25.201	-7 503	
1230	7.121252455	32.002	29.000	25.209	-7.665	
1239	7.122039002	33 025	29.112	25.219	-7.735	
1240	7.122000000	22 047	29.130	25.29	7.746	
1241	7.123072703	22.06	29.174	25.301	7 752	
1242	7.124470202	22.051	29.104	25.307	7 726	
1243	7.125265092	22.001	29.103	25.315	7.730	
1244	7.120007273	33.020	29.173	25.310	-7.710	
1240	7.120090009	32.929	29.122	25.314	-7.010	
1240	7.127093099	32.622	29.065	25.300	-7.314	
1247	7.126495946	32.691	29.001	20.31	-7.301	
1240	7.129297549	32.041	20.900	25.319	-1.322	
1249	7.13009851	32.81	29.073	25.335	-7.475	
1250	7.13089883	33.148	29.249	25.349	-7.799	
1251	7.13169851	33.298	29.324	25.349	-7.949	
1252	7.132497552	33.358	29.350	25.341	-8.017	
1253	7.133295955	33.333	29.331	25.329	-8.004	
1254	7.134093721	33.288	29.304	25.319	-7.969	
1255	/.134890852	33.256	29.280	25.304	-7.952	
1256	7.135687347	33.222	29.252	25.281	-7.941	
1257	/.136483209	33.152	29.202	25.251	-7.901	
1258	7.137278437	33.103	29.163	25.222	-7.881	
1259	7.138073034	33.063	29.133	25.202	-7.861	

				_		1
Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
1000	7 400007	22 4 24	20 171	25.24	7 0 2 4	
1200	7.130007	33.131	29.171	20.21	-7.921	
1261	7.139660336	33.193	29.216	25.239	-7.954	
1262	7.140453043	33.222	29.239	25.255	-7.967	
1263	7.141245122	33.192	29.232	25.271	-7.921	
1264	7 142036575	33 137	29 208	25 278	-7 859	
1265	7.142000070	22.11	20.200	25.270	7.000	
1200	7.142627401	33.11	29.196	25.265	-7.625	
1266	7.143617603	32.982	29.138	25.293	-7.689	
1267	7.14440718	32.895	29.096	25.296	-7.599	
1268	7.145196135	32.895	29.098	25.301	-7.594	
1269	7 145984468	32 939	29 121	25 303	-7 636	
1200	7.146772170	22.000	20.121	25.000	7.000	
1270	7.140772179	33.027	29.171	25.514	-7.713	
1271	7.147559271	33.113	29.219	25.324	-7.789	
1272	7.148345744	33.162	29.249	25.335	-7.827	
1273	7.149131599	33.167	29.254	25.341	-7.826	
1274	7 149916836	33 141	29 243	25 344	-7 797	
1274	7.140310000	22.004	20.240	25.044	7 752	
1273	7.150701456	33.094	29.210	23.342	-7.752	
1276	7.151485464	33.033	29.185	25.337	-7.696	
1277	7.152268856	32.959	29.142	25.325	-7.634	
1278	7.153051635	32.919	29.120	25.321	-7.598	
1279	7 153833802	32 927	29 125	25 322	-7 605	
1275	7.100000002	02.021	20.120	20.022	7.000	
1280	7.154615357	32.981	29.156	25.33	-7.001	
1281	7.155396302	33.059	29.202	25.344	-7.715	
1282	7.156176637	33.123	29.239	25.355	-7.768	
1283	7,156956365	33.13	29.247	25.364	-7,766	
128/	7 157735/8/	33.008	20.233	25 367	-7 731	
1204	7.137733404	33.090	29.200	25.507	-7.731	
1285	7.158513997	33.046	29.206	25.365	-7.681	
1286	7.159291905	33.003	29.184	25.364	-7.639	
1287	7.160069208	32.922	29.140	25.358	-7.564	
1288	7 160845907	32 849	29 105	25.36	-7 489	
1200	7.161622002	22.010	20.100	25.00	7.100	
1209	7.101022003	32.011	29.007	25.502	-7.449	
1290	7.162397497	32.879	29.127	25.374	-7.505	
1291	7.163172391	33.023	29.205	25.387	-7.636	
1292	7.163946684	33.096	29.248	25.4	-7.696	
1293	7 164720379	33 116	29 261	25 405	-7 711	
1200	7.165402475	22 107	20.201	25.100	7 700	
1294	7.100490470	33.107	29.207	25.407	-7.700	
1295	7.166265974	33.083	29.244	25.404	-7.679	
1296	7.167037877	33.029	29.215	25.4	-7.629	
1297	7.167809184	32.954	29.175	25.395	-7.559	
1298	7 168579897	32 895	29 141	25 387	-7 508	
1200	7.160250017	22.000	20.170	25.001	7.000	
1299	7.109350017	32.070	29.129	20.001	-7.495	
1300	7.170119543	32.901	29.141	25.38	-7.521	
1301	7.170888479	32.982	29.189	25.396	-7.586	
1302	7.171656823	33.068	29.237	25.406	-7.662	
1303	7,172424577	33,101	29,259	25.417	-7.684	
1304	7 1731017/2	33 107	20.264	25 / 21	-7.686	
1304	7.175191742	33.107	29.204	25.421	-7.000	
1305	7.17395832	33.09	29.257	25.423	-7.667	
1306	7.17472431	33.02	29.220	25.419	-7.601	
1307	7.175489714	32.973	29.193	25.413	-7.560	
1308	7,176254532	32,912	29,159	25,406	-7,506	
1300	7 177018766	32 000	20.156	25 403	-7 506	
1309	7.177010700	32.909	29.130	25.405	-7.500	
1310	1.1//82416	32.931	29.170	20.403	-1.534	
1311	7.178545484	33	29.205	25.409	-7.591	
1312	7.17930797	33.071	29.245	25.419	-7.652	
1313	7,180069874	33.142	29,284	25.425	-7.717	
131/	7 180831100	33 138	20 283	25 428	-7 710	
4045	7.100001133	20.100	20.200	20.420	7.710	
1315	1.101591945	33.132	29.281	25.43	-1.102	
1316	7.182352112	33.08	29.253	25.426	-7.654	
1317	7.183111702	33.035	29.227	25.418	-7.617	
1318	7.183870715	32,985	29,197	25,409	-7.576	
1310	7 184620153	32 076	20 100	25 403	-7 573	
1018	1.107023100	52.370	20.100	20.700	1.515	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	ଂମ	°C	°C.	
Mindeo	En (Time)	0	0		0	
1320	7 185387016	32.086	20 105	25 403	-7 583	
1221	7.105307010	32.900	29.195	25.403	7.505	
1321	7.100144303	22.051	29.211	25.400	-7.000	
1322	7.10090102	33.051	29.235	25.410	-7.033	
1323	7.187657164	33.103	29.266	25.428	-7.675	
1324	7.188412736	33.089	29.262	25.434	-7.655	
1325	7.189167738	33.07	29.255	25.439	-7.631	
1326	7.189922171	33.04	29.240	25.439	-7.601	
1327	7.190676034	33.001	29.220	25.439	-7.562	
1328	7.19142933	32.974	29.206	25.438	-7.536	
1329	7.192182059	32.98	29.208	25.435	-7.545	
1330	7.192934221	33.011	29.224	25.437	-7.574	
1331	7.193685818	33.045	29.244	25.442	-7.603	
1332	7.194436851	33.073	29.260	25.446	-7.627	
1333	7.19518732	33.108	29.279	25.45	-7.658	
1334	7,195937226	33.121	29.287	25,452	-7.669	
1335	7 196686571	33 107	29 280	25 453	-7 654	
1336	7 107435354	33.062	20.200	25.451	-7 611	
1337	7 108183577	33.044	20.246	25.401	-7 507	
1007	7.190103377	22.026	29.240	25.447	7 5 9 2	
1330	7.190931241	33.020	29.235	25.445	-7.303	
1339	7.199678346	33.01	29.226	25.441	-7.569	
1340	7.200424893	33.015	29.229	25.443	-7.572	
1341	7.2011/0883	33.041	29.244	25.447	-7.594	
1342	7.201916318	33.061	29.258	25.454	-7.607	
1343	7.202661197	33.091	29.277	25.463	-7.628	
1344	7.203405521	33.101	29.285	25.468	-7.633	
1345	7.204149292	33.102	29.285	25.468	-7.634	
1346	7.20489251	33.068	29.268	25.467	-7.601	
1347	7.205635176	33.029	29.248	25.467	-7.562	
1348	7.206377291	33.012	29.239	25.466	-7.546	
1349	7.207118856	33.014	29.241	25.468	-7.546	
1350	7.207859871	33.014	29.241	25.468	-7.546	
1351	7.208600338	33.032	29.252	25.472	-7.560	
1352	7 209340257	33.06	29 269	25 478	-7.582	
1353	7 210079628	33 084	29 284	25 484	-7 600	
1354	7.210818453	33 11	20.204	25.489	-7.621	
1255	7.210010433	22.005	29.000	25.403	7.604	
1355	7.211330733	33.095	29.293	25.491	7 592	
1330	7.212294409	33.073	29.202	20.49	-7.303	
1357	7.21303166	33.054	29.271	25.487	-7.507	
1358	7.213768308	33.045	29.266	25.486	-7.559	
1359	7.214504414	33.054	29.270	25.485	-7.569	
1360	7.215239979	33.036	29.260	25.483	-7.553	
1361	7.215975003	33.043	29.265	25.486	-7.557	
1362	7.216709487	33.061	29.276	25.491	-7.570	
1363	7.217443432	33.086	29.291	25.496	-7.590	
1364	7.218176838	33.097	29.300	25.502	-7.595	
1365	7.218909708	33.08	29.292	25.503	-7.577	
1366	7.21964204	33.069	29.287	25.505	-7.564	
1367	7.220373837	33.064	29.285	25.506	-7.558	
1368	7.221105098	33.058	29.282	25.506	-7.552	
1369	7.221835825	33.052	29.281	25.509	-7.543	
1370	7.222566019	33.05	29.280	25.51	-7.540	
1371	7,22329568	33.055	29.284	25.512	-7.543	
1372	7.224024808	33 066	29 290	25 513	-7 553	
1372	7 224753406	33 083	20.200	25 515	-7 568	
137/	7 225481472	33 08/	20.200	25.510	-7 565	
1275	7 22620001	33 070	20.002	25.513	-7 5/0	
1070	7.0000040	22.072	23.230	20.020	7 549	
13/0	7.220930010	33.U/Z	29.290	20.023	-1.349	
13//	7.22/002499	33.076	29.300	20.524	-1.552	
1378	1.228388452	33.08	29.304	25.527	-7.553	
1379	7.229113878	33.088	29.308	25.528	-7.560	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)		°C	°C	0 0	
WIITULES		0	U	U	U	
4000	7 00000770	22.005	00.044	05 507	7 500	
1380	7.229838778	33.095	29.311	25.527	-7.508	
1381	7.230563153	33.101	29.313	25.525	-7.576	
1382	7.231287004	33.111	29.319	25.526	-7.585	
1383	7.232010332	33.117	29.323	25.529	-7.588	
1384	7.232733136	33.106	29.318	25.529	-7.577	
1385	7.233455419	33.098	29.315	25.532	-7.566	
1386	7.23417718	33.097	29.314	25.53	-7.567	
1387	7.23489842	33.081	29.307	25.532	-7.549	
1388	7.235619141	33.074	29.305	25.535	-7.539	
1389	7,236339343	33.075	29.307	25.539	-7.536	
1390	7 237059026	33 087	29.312	25 537	-7.550	
1301	7 237778192	33 081	20.012	25.54	-7 541	
1302	7.238/068/1	33.004	20.011	25.545	-7 5/19	
1202	7.230430041	22,000	29.320	25.545	7 551	
1393	7.239214974	33.099	29.324	25.540	-7.551	
1394	7.239932591	33.096	29.322	25.548	-7.548	
1395	7.240649694	33.097	29.323	25.549	-7.548	
1396	7.241366283	33.108	29.330	25.552	-7.556	
1397	7.242082359	33.081	29.317	25.552	-7.529	
1398	7.242797923	33.071	29.311	25.551	-7.520	
1399	7.243512975	33.078	29.316	25.553	-7.525	
1400	7.244227516	33.08	29.317	25.554	-7.526	
1401	7.244941546	33.074	29.316	25.558	-7.516	
1402	7.245655068	33.078	29.320	25.561	-7.517	
1403	7 24636808	33 123	29 343	25 563	-7 560	
1404	7 247080585	33 115	29 340	25 565	-7 550	
1405	7.247000505	33 128	20.346	25.563	-7.564	
1405	7.247792302	22 110	29.340	25.504	-7.504	
1400	7.240304072	33.110	29.343	25.500	-7.550	
1407	7.249215057	33.119	29.342	25.564	-7.555	
1408	7.249925537	33.114	29.337	25.56	-7.554	
1409	7.250635512	33.11	29.336	25.561	-7.549	
1410	7.251344983	33.113	29.336	25.559	-7.554	
1411	7.252053952	33.095	29.328	25.561	-7.534	
1412	7.252762418	33.086	29.323	25.56	-7.526	
1413	7.253470383	33.091	29.328	25.565	-7.526	
1414	7.254177846	33.107	29.338	25.569	-7.538	
1415	7.25488481	33.123	29.347	25.571	-7.552	
1416	7.255591274	33.106	29.339	25.571	-7.535	
1417	7 25629724	33 099	29.336	25 573	-7.526	
1/18	7 257002707	33.1	20.000	25.576	-7 524	
1410	7.257002101	22 105	29.000	25.570	7 5 2 7	
1419	7.201101011	33.105	29.342	20.070	-7.327	
1420	7.230412131	33.090	29.340	20.001	-7.517	
1421	7.259116128	33.098	29.340	25.582	-7.516	
1422	7.25981961	33.114	29.348	25.582	-7.532	
1423	7.260522598	33.123	29.351	25.579	-7.544	
1424	7.261225092	33.134	29.356	25.578	-7.556	
1425	7.261927093	33.144	29.363	25.581	-7.563	
1426	7.262628601	33.164	29.374	25.584	-7.580	
1427	7.263329617	33.157	29.369	25.581	-7.576	
1428	7.264030143	33.146	29.363	25.58	-7.566	
1429	7.264730178	33.14	29.361	25.581	-7.559	
1430	7,265429723	33.129	29.355	25.581	-7.548	
1431	7.26612878	33.149	29.364	25.579	-7.570	
1/132	7 2668273/12	33 158	20.004	25 581	-7 577	
1402	7 267525420	22 165	23.370	20.001	-1.511 7 E04	
1433	7.207525428	33.105	29.3/3	20.001	-7.504	
1434	7.208223021	33.164	29.3/3	25.582	-7.582	
1435	7.268920128	33.155	29.370	25.584	-7.571	
1436	7.26961675	33.164	29.376	25.587	-7.577	
1437	7.270312886	33.167	29.378	25.588	-7.579	
1438	7.271008538	33.158	29.373	25.588	-7.570	
1439	7.271703707	33.151	29.370	25.589	-7.562	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C.	°C.	°C.	°C.	
Miniates		0	0		<u> </u>	
1440	7 272308303	33 152	20 360	25 585	-7 567	
1440	7.272002506	22 159	29.309	25.505	7.507	
1441	7.273092390	22 171	29.373	25.566	-7.570	
1442	7.273700310	33.171	29.301	25.591	-7.560	
1443	7.274479559	33.174	29.383	25.592	-7.582	
1444	7.275172319	33.192	29.393	25.593	-7.599	
1445	7.275864601	33.18	29.388	25.595	-7.585	
1446	7.276556403	33.186	29.392	25.597	-7.589	
1447	7.277247727	33.181	29.390	25.598	-7.583	
1448	7.277938573	33.172	29.385	25.598	-7.574	
1449	7.278628942	33.171	29.384	25.596	-7.575	
1450	7.279318835	33.159	29.378	25.597	-7.562	
1451	7.280008253	33.15	29.374	25.597	-7.553	
1452	7.280697195	33.166	29.383	25.599	-7.567	
1453	7.281385664	33.178	29.390	25.602	-7.576	
1454	7.282073658	33,192	29,400	25.607	-7.585	
1455	7 28276118	33 196	29 404	25 611	-7.585	
1456	7 283448229	33 186	29 399	25.611	-7 575	
1400	7 28/13/806	33 100	20.000	25.613	-7 586	
1457	7.204134000	22 1 92	29.400	25.015	7.500	
1400	7.204020913	33.102	29.390	25.014	-7.300	
1459	7.26000000000000000000000000000000000000	33.107	29.391	25.014	-7.553	
1460	7.286191715	33.162	29.388	25.613	-7.549	
1461	7.286876412	33.182	29.398	25.614	-7.568	
1462	7.28756064	33.181	29.396	25.61	-7.571	
1463	7.288244401	33.174	29.394	25.613	-7.561	
1464	7.288927695	33.187	29.402	25.617	-7.570	
1465	7.289610521	33.202	29.411	25.619	-7.583	
1466	7.290292882	33.201	29.412	25.622	-7.579	
1467	7.290974778	33.208	29.416	25.623	-7.585	
1468	7.291656209	33.203	29.412	25.62	-7.583	
1469	7.292337176	33.193	29.406	25.618	-7.575	
1470	7.29301768	33.184	29,401	25.618	-7.566	
1471	7.293697721	33,179	29,400	25.621	-7.558	
1472	7 294377299	33 193	29 409	25 625	-7 568	
1473	7 295056416	33 205	29 415	25.625	-7.580	
1474	7 295735073	33 206	20.110	25.625	-7 581	
1475	7 206/13260	33.2	20.410	25.025	-7 573	
1475	7.230413203	33 201	29.414	25.027	-7.573	
1470	7.297091003	22 207	29.415	25.020	7.575	
1477	7.297700203	33.207	29.419	25.031	-7.570	
1470	7.296445102	33.210	29.424	25.632	-7.364	
1479	7.299121463	33.199	29.415	25.63	-7.569	
1480	7.299797367	33.173	29.401	25.628	-7.545	
1481	7.300472814	33.157	29.389	25.621	-7.536	
1482	7.301147806	33.188	29.408	25.627	-7.561	
1483	7.301822342	33.199	29.417	25.634	-7.565	
1484	7.302496424	33.217	29.426	25.635	-7.582	
1485	7.303170051	33.213	29.425	25.637	-7.576	
1486	7.303843225	33.221	29.430	25.639	-7.582	
1487	7.304515946	33.223	29.433	25.643	-7.580	
1488	7.305188215	33.221	29.433	25.645	-7.576	
1489	7.305860033	33.229	29.438	25.646	-7.583	
1490	7.306531399	33.22	29.432	25.644	-7.576	
1491	7.307202315	33.209	29.426	25.643	-7.566	
1492	7,307872781	33.224	29.434	25.644	-7.580	
1493	7 308542798	33 227	29 436	25 644	-7 583	
1494	7 309212366	33 241	29 444	25.646	-7 595	
1405	7 300881/86	33 233	20.444	25.645	-7 588	
1/06	7 3105501400	32 224	20.700	25.040	-7 501	
1430	7 31101020/	22 227	23.434	25.045	-7.501	
1437	7 211006464	22 225	23.403	20.04	7 500	
1498	7.311000104	JJ.∠JJ	29.430	20.030	-7.599	
1499	1.312553498	JJ.245	29.442	25.638	-7.607	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C.	ଂ	°C.	°C.	
Minates		0	0		0	
1500	7 313220387	33.24	20 110	25 630	-7 601	
1500	7.313220307	22.24	29.440	25.039	7.502	
1501	7.313000032	22.23	29.434	25.037	-7.595	
1502	7.314002032	33.235	29.430	25.030	-7.599	
1503	7.31521839	33.241	29.439	25.637	-7.604	
1504	7.315883505	33.243	29.442	25.64	-7.603	
1505	7.316548177	33.244	29.442	25.639	-7.605	
1506	7.317212408	33.253	29.446	25.639	-7.614	
1507	7.317876199	33.239	29.438	25.637	-7.602	
1508	7.318539549	33.232	29.436	25.64	-7.592	
1509	7.319202459	33.237	29.441	25.644	-7.593	
1510	7.31986493	33.236	29.440	25.644	-7.592	
1511	7.320526962	33.25	29.448	25.646	-7.604	
1512	7.321188557	33.251	29,448	25.644	-7.607	
1513	7 321849714	33 231	29 439	25 646	-7 585	
1514	7 322510434	33 233	29 442	25.65	-7 583	
1515	7 323170718	33 237	29.442	25.654	-7 583	
1516	7 323830566	33 230	20.440	25.004	-7 581	
1510	7.323030300	33.239	29.449	25.050	-7.501	
1517	7.324489979	33.235	29.447	25.659	-7.576	
1518	7.325148958	33.236	29.448	25.659	-7.577	
1519	7.325807503	33.236	29.449	25.662	-7.574	
1520	7.326465614	33.237	29.451	25.665	-7.572	
1521	7.327123292	33.247	29.457	25.667	-7.580	
1522	7.327780538	33.246	29.459	25.671	-7.575	
1523	7.328437353	33.248	29.459	25.67	-7.578	
1524	7.329093736	33.254	29.463	25.672	-7.582	
1525	7.329749689	33,239	29,456	25.673	-7.566	
1526	7.330405212	33.233	29.454	25.675	-7.558	
1527	7 331060305	33 231	29 454	25 676	-7 555	
1528	7 33171497	33 227	29 454	25 681	-7 546	
1520	7 332360206	33.243	20.404	25.001	-7 562	
1520	7 333023014	33 242	20.402	25.001	-7 558	
1530	7.333023014	22 246	29.405	25.004	7.530	
1531	7.333070390	33.240	29.400	23.065	-7.301	
1532	7.33432935	33.240	29.467	25.687	-7.559	
1533	7.334981879	33.247	29.468	25.689	-7.558	
1534	7.335633982	33.249	29.470	25.691	-7.558	
1535	7.33628566	33.245	29.469	25.692	-7.553	
1536	7.336936914	33.244	29.469	25.694	-7.550	
1537	7.337587744	33.243	29.467	25.691	-7.552	
1538	7.33823815	33.239	29.466	25.693	-7.546	
1539	7.338888134	33.242	29.469	25.696	-7.546	
1540	7.339537695	33.231	29.464	25.697	-7.534	
1541	7.340186835	33.241	29.469	25.697	-7.544	
1542	7.340835554	33.247	29.474	25.7	-7.547	
1543	7.341483852	33.239	29.470	25.701	-7.538	
1544	7.342131731	33.254	29.479	25.704	-7.550	
1545	7 342779189	33 257	29 482	25 707	-7 550	
1546	7 343426229	33 259	20.102	25 707	-7 552	
1540	7 344072851	33.26	20.484	25.707	-7 552	
1547	7.344072031	22.250	29.404	25.700	7 551	
1040	7.044719004	20.209	29.404	20.708	-7.331	
1549	1.34530484	JJ.201	29.483	20.709	-1.548	
1550	7.34601021	33.25/	29.483	25.709	-7.548	
1551	7.346655163	33.252	29.480	25.707	-7.545	
1552	7.347299701	33.247	29.479	25.71	-7.537	
1553	7.347943823	33.251	29.481	25.711	-7.540	
1554	7.348587531	33.249	29.482	25.715	-7.534	
1555	7.349230825	33.251	29.485	25.718	-7.533	
1556	7.349873705	33.266	29.492	25.718	-7.548	
1557	7.350516172	33.264	29.492	25.719	-7.545	
1558	7.351158226	33.254	29.487	25.719	-7.535	
1559	7.351799869	33.261	29.491	25.72	-7.541	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)		°C	°€	0°C	
WIITULES		0	C	C	C	
4500	7.0504444	22.050	00.400	05 704	7 505	
1560	7.3524411	33.256	29.489	25.721	-7.535	
1561	7.353081921	33.255	29.489	25.723	-7.532	
1562	7.35372233	33.264	29.494	25.723	-7.541	
1563	7.35436233	33.273	29.500	25.726	-7.547	
1564	7.355001921	33.268	29.497	25.726	-7.542	
1565	7.355641103	33.277	29.501	25.725	-7.552	
1566	7.356279877	33.281	29.505	25.728	-7.553	
1567	7.356918242	33.273	29.501	25.729	-7.544	
1568	7.357556201	33.271	29.501	25.731	-7.540	
1569	7.358193753	33,285	29.508	25.73	-7.555	
1570	7 358830898	33 279	29 505	25.73	-7 549	
1571	7 350/67638	33 283	20.000	25.73	-7 553	
1572	7 360103073	33 288	29.507	25.73	-7.550	
1572	7.300103973	33.200	29.309	25.729	-7.559	
1573	7.360739903	33.204	29.497	25.729	-7.535	
1574	7.361375429	33.285	29.508	25.73	-7.555	
1575	7.362010551	33.3	29.516	25.732	-7.568	
1576	7.36264527	33.302	29.517	25.731	-7.571	
1577	7.363279587	33.287	29.509	25.731	-7.556	
1578	7.363913501	33.301	29.517	25.732	-7.569	
1579	7.364547014	33.278	29.506	25.733	-7.545	
1580	7.365180126	33.277	29.506	25.735	-7.542	
1581	7.365812837	33.277	29.507	25.737	-7.540	
1582	7 366445148	33.28	29 510	25 739	-7 541	
1583	7 36707706	33 268	29 504	25 739	-7 529	
1584	7 367708572	33.284	20.004	25.705	-7.543	
1504	7.307700372	22 200	29.010	25.741	7.543	
1505	7.300339000	33.299	29.021	25.742	-7.537	
1580	7.368970402	33.289	29.518	25.746	-7.543	
1587	7.369600721	33.283	29.516	25.748	-7.535	
1588	7.370230642	33.29	29.520	25.75	-7.540	
1589	7.370860167	33.288	29.519	25.75	-7.538	
1590	7.371489295	33.285	29.518	25.751	-7.534	
1591	7.372118028	33.281	29.515	25.748	-7.533	
1592	7.372746366	33.295	29.521	25.746	-7.549	
1593	7.37337431	33.291	29.519	25.746	-7.545	
1594	7.374001859	33.28	29.514	25.748	-7.532	
1595	7.374629015	33.269	29.511	25.752	-7.517	
1596	7.375255778	33.292	29.522	25.751	-7.541	
1597	7 375882148	33 287	29 521	25 755	-7 532	
1508	7.376508126	33 280	20.021	25.754	-7.535	
1500	7.370300120	22 276	29.522	25.754	7 521	
1599	7.377133713	33.270	29.010	25.755	-7.321	
1000	7.377736906	33.274	29.010	25.750	-7.310	
1601	7.378383713	33.278	29.518	25.757	-7.521	
1602	7.379008128	33.285	29.521	25.757	-7.528	
1603	7.379632153	33.281	29.520	25.758	-7.523	
1604	7.380255788	33.292	29.525	25.757	-7.535	
1605	7.380879036	33.29	29.523	25.756	-7.534	
1606	7.381501895	33.282	29.520	25.757	-7.525	
1607	7.382124366	33.286	29.522	25.758	-7.528	
1608	7.38274645	33.276	29.517	25.757	-7.519	
1609	7.383368147	33,291	29.524	25,757	-7.534	
1610	7.383989458	33 291	29 524	25 756	-7 535	
1611	7 384610383	33 205	29 525	25 754	-7 541	
1612	7 385220022	33 301	20.020	25.752	_7 5/9	
1012	7.000200923	33.301	29.021	20.100	-1.040	
1613	1.385851078	33.295	29.525	25.754	-7.541	
1614	1.3864/0849	33.281	29.51/	25.753	-1.528	
1615	7.387090236	33.287	29.522	25.756	-7.531	
1616	7.387709239	33.28	29.518	25.755	-7.525	
1617	7.38832786	33.283	29.518	25.753	-7.530	
1618	7.388946098	33.285	29.520	25.754	-7.531	
1619	7.389563954	33.28	29.518	25.755	-7.525	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	ଂମ	°C	°C.	
Mindeo		0	0	U	<u> </u>	
1620	7 300181/28	33 203	20 525	25 757	-7 536	
1620	7.390101420	22 290	29.525	25.757	7.530	
1622	7.390790322	22 206	29.525	25.757	-7.532	
1022	7.391415235	33.290	29.527	25.756	-7.536	
1623	7.392031568	33.286	29.521	25.755	-7.531	
1624	7.392647521	33.29	29.522	25.754	-7.536	
1625	7.393263095	33.29	29.521	25.752	-7.538	
1626	7.39387829	33.284	29.518	25.751	-7.533	
1627	7.394493107	33.28	29.518	25.755	-7.525	
1628	7.395107547	33.264	29.510	25.755	-7.509	
1629	7.395721609	33.263	29.510	25.757	-7.506	
1630	7.396335294	33.272	29.515	25.757	-7.515	
1631	7.396948603	33.278	29.519	25.759	-7.519	
1632	7.397561536	33.295	29.528	25.76	-7.535	
1633	7.398174093	33.28	29.520	25.759	-7.521	
1634	7.398786275	33.279	29.519	25,758	-7.521	
1635	7 399398083	33 286	29.523	25.76	-7.526	
1636	7.0000000000000000000000000000000000000	33 279	29.520	25.76	-7 519	
1637	7.400620577	33 278	20.518	25.758	-7.520	
1620	7.400020377	33.270	29.010	25.750	-7.520	
1038	7.401231264	33.280	29.522	25.758	-7.528	
1639	7.401841579	33.289	29.524	25.759	-7.530	
1640	7.402451521	33.3	29.530	25.759	-7.541	
1641	7.403061091	33.298	29.529	25.759	-7.539	
1642	7.40367029	33.294	29.526	25.757	-7.537	
1643	7.404279118	33.281	29.521	25.76	-7.521	
1644	7.404887576	33.293	29.526	25.759	-7.534	
1645	7.405495663	33.287	29.523	25.759	-7.528	
1646	7.406103381	33.291	29.525	25.759	-7.532	
1647	7,40671073	33,289	29.524	25,759	-7.530	
1648	7 40731771	33 281	29 521	25.76	-7 521	
1649	7 407924323	33 284	29 523	25 761	-7 523	
1650	7.407524626	33 203	20.020	25 765	-7 528	
1651	7.400136444	22 205	29.525	25.765	7.520	
1001	7.409130444	33.305	29.000	25.765	-7.540	
1002	7.409741954	33.290	29.530	25.764	-7.332	
1653	7.410347098	33.281	29.523	25.765	-7.516	
1654	7.410951876	33.295	29.530	25.764	-7.531	
1655	7.411556288	33.286	29.527	25.767	-7.519	
1656	7.412160335	33.298	29.533	25.767	-7.531	
1657	7.412764017	33.297	29.533	25.768	-7.529	
1658	7.413367336	33.292	29.530	25.767	-7.525	
1659	7.41397029	33.292	29.530	25.768	-7.524	
1660	7.414572881	33.303	29.536	25.769	-7.534	
1661	7.41517511	33.301	29.536	25.771	-7.530	
1662	7.415776975	33.297	29.534	25.77	-7.527	
1663	7.416378479	33.278	29.525	25.772	-7.506	
1664	7,416979621	33,296	29.533	25.77	-7.526	
1665	7 417580402	33 302	29 537	25 771	-7 531	
1666	7 418180823	33 305	29 539	25 773	-7 532	
1667	7.418780883	33 307	20.000	25.773	-7.534	
1668	7.410380583	33 31	20.540	25.773	-7 537	
1000	7.419300303	22.21	29.042	25.775	-7.537	
1009	7 400570005	22.292	29.002	20.112	-1.320	
10/0	1.420318905	JJ.293	29.030	20.110	-1.51/	
16/1	7.421177529	33.316	29.547	25.///	-7.539	
16/2	1.421/15794	33.308	29.543	25.777	-7.531	
1673	7.422373701	33.308	29.542	25.776	-7.532	
1674	7.422971251	33.297	29.537	25.777	-7.520	
1675	7.423568444	33.303	29.542	25.78	-7.523	
1676	7.424165281	33.32	29.551	25.781	-7.539	
1677	7.424761762	33.31	29.545	25.78	-7.530	
1678	7.425357887	33.308	29.545	25.782	-7.526	
1679	7.425953657	33.318	29.550	25.781	-7.537	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	°C	°C	°C	
minucoo	2.1 (1.1.10)	0	•		0	
1680	7 426549072	33 316	29 549	25 781	-7 535	
1681	7.420343072	33 314	29.549	25.701	-7 533	
1682	7.427144133	33 318	29.540	25.701	-7.534	
1002	7.427730041	33.310	29.001	23.764	-7.004	
1083	7.428333194	33.324	29.554	25.783	-7.541	
1684	7.428927195	33.317	29.551	25.784	-7.533	
1685	7.429520843	33.309	29.546	25.783	-7.526	
1686	7.430114139	33.325	29.555	25.785	-7.540	
1687	7.430707083	33.331	29.559	25.786	-7.545	
1688	7.431299675	33.332	29.559	25.785	-7.547	
1689	7.431891917	33.31	29.548	25.785	-7.525	
1690	7.432483808	33.298	29.542	25.786	-7.512	
1691	7.433075349	33.301	29.544	25.787	-7.514	
1692	7.43366654	33.298	29.543	25.788	-7.510	
1693	7,434257382	33,303	29.547	25.79	-7.513	
1694	7 434847875	33 309	29 551	25 792	-7.517	
1695	7 43543802	33 311	29.551	25 791	-7 520	
1606	7 436027816	33 310	20.556	25.701	-7 526	
1090	7.430027010	33.319	29.000	25.795	-7.520	
1697	7.430017205	33.337	29.566	25.795	-7.542	
1698	7.437206367	33.342	29.571	25.799	-7.543	
1699	7.437795122	33.331	29.564	25.796	-7.535	
1700	7.43838353	33.318	29.556	25.794	-7.524	
1701	7.438971592	33.316	29.555	25.794	-7.522	
1702	7.439559309	33.317	29.555	25.793	-7.524	
1703	7.440146681	33.313	29.554	25.794	-7.519	
1704	7.440733707	33.329	29.562	25.794	-7.535	
1705	7.44132039	33.325	29.560	25.794	-7.531	
1706	7.441906728	33.314	29.554	25.794	-7.520	
1707	7 442492723	33 326	29.562	25 798	-7.528	
1708	7 443078374	33 329	29.566	25.802	-7 527	
1700	7.443663683	33 318	29.560	25.802	-7 516	
1709	7.443003003	22 205	29.500	25.002	7.510	
1710	7.444240049	33.305	29.000	25.601	-7.504	
1711	7.444833274	33.32	29.562	25.804	-7.516	
1712	7.445417557	33.32	29.562	25.803	-7.517	
1/13	7.446001498	33.331	29.567	25.803	-7.528	
1714	7.446585099	33.307	29.556	25.805	-7.502	
1715	7.44716836	33.323	29.565	25.807	-7.516	
1716	7.44775128	33.335	29.572	25.809	-7.526	
1717	7.448333861	33.332	29.572	25.811	-7.521	
1718	7.448916103	33.336	29.573	25.809	-7.527	
1719	7.449498005	33.344	29.577	25.81	-7.534	
1720	7.45007957	33.327	29.567	25.807	-7.520	
1721	7 450660796	33 316	29 563	25 809	-7 507	
1722	7 451241685	33 321	29 566	25.81	-7 511	
1722	7.451822237	33 316	20.500	25.813	-7 503	
1723	7.452402451	22 211	29.505	25.013	7 400	
1724	7.452402451	33.311	29.302	20.012	-7.499	
1725	7.452982329	33.309	29.560	25.811	-7.498	
1726	7.453561872	33.324	29.570	25.815	-7.509	
1727	7.454141078	33.334	29.575	25.816	-7.518	
1728	7.454719949	33.334	29.575	25.816	-7.518	
1729	7.455298486	33.326	29.573	25.82	-7.506	
1730	7.455876687	33.344	29.582	25.82	-7.524	
1731	7.456454555	33.331	29.576	25.821	-7.510	
1732	7.457032089	33.338	29.579	25.819	-7.519	
1733	7 45760929	33 334	29 577	25.82	-7 514	
1734	7 458186157	33 348	29 585	25 821	-7 527	
1735	7.100100107	33 335	20.000	25.818	-7 517	
1736	7 450332805	22 2/1	20.517	25.010	-7 500	
1730	7 45001 4766	22 250	29.000	20.022	-7.524	
1/3/	7.409914700	00.000	29.091	20.024	-7.004	
1/38	7.460490306	33.30	29.592	25.823	-1.531	
1739	/.461065514	33.349	29.586	25.822	-7.527	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	0°	°C	°C	°C	
minutee	2.1 (1.1.10)	•	U			
1740	7 461640392	33 345	29 583	25.821	-7 524	
1740	7.46721/0/	33 345	20.500	25.021	-7 522	
1741	7.40221454	33 342	20.583	25.025	-7 518	
1742	7.402709137	22 252	29.505	25.024	7.510	
1743	7.403303040	33.355	29.590	25.020	-7.527	
1744	7.403930004	33.35	29.369	20.027	-7.523	
1745	7.464509835	33.349	29.588	25.827	-7.522	
1746	7.465082736	33.346	29.587	25.828	-7.518	
1/4/	7.46565531	33.36	29.595	25.83	-7.530	
1/48	7.466227556	33.359	29.597	25.834	-7.525	
1749	7.466799475	33.365	29.599	25.832	-7.533	
1750	7.467371067	33.373	29.604	25.834	-7.539	
1751	7.467942332	33.363	29.598	25.832	-7.531	
1752	7.468513271	33.372	29.601	25.83	-7.542	
1753	7.469083885	33.375	29.603	25.831	-7.544	
1754	7.469654173	33.373	29.602	25.831	-7.542	
1755	7.470224136	33.365	29.598	25.831	-7.534	
1756	7.470793774	33.383	29.607	25.83	-7.553	
1757	7.471363088	33.377	29.605	25.833	-7.544	
1758	7.471932078	33.373	29.602	25.831	-7.542	
1759	7 472500745	33 362	29 597	25 832	-7 530	
1760	7.473069088	33 374	29.605	25.835	-7 539	
1760	7.473637108	33 360	20.000	25.000	-7 535	
1762	7.473037100	33 372	29.002	25.004	-7.535	
1702	7.474204000	22 270	29.005	25.037	-7.535	
1703	7.474772102	33.370	29.000	25.634	-7.344	
1764	7.475339237	33.369	29.603	25.837	-7.532	
1765	7.475905969	33.366	29.602	25.837	-7.529	
1/66	7.476472381	33.386	29.614	25.841	-7.545	
1/6/	7.477038472	33.377	29.610	25.842	-7.535	
1768	7.477604243	33.373	29.607	25.841	-7.532	
1769	7.478169694	33.372	29.607	25.842	-7.530	
1770	7.478734826	33.362	29.603	25.844	-7.518	
1771	7.479299638	33.373	29.609	25.845	-7.528	
1772	7.479864131	33.372	29.609	25.846	-7.526	
1773	7.480428306	33.401	29.624	25.847	-7.554	
1774	7.480992163	33.394	29.621	25.848	-7.546	
1775	7.481555702	33.386	29.617	25.848	-7.538	
1776	7.482118924	33.393	29.621	25.849	-7.544	
1777	7.482681828	33.39	29.620	25.85	-7.540	
1778	7.483244416	33.393	29.621	25.849	-7.544	
1779	7.483806688	33.378	29.615	25.852	-7.526	
1780	7,484368643	33.391	29.621	25.85	-7.541	
1781	7 484930283	33 403	29.627	25.85	-7 553	
1782	7 485491608	33 402	29.625	25.848	-7 554	
1783	7.486052618	33 304	20.020	25.852	-7 542	
1784	7.486613313	33 382	20.020	25.002	-7 526	
1704	7.400013313	22 292	20.610	25.000	7 526	
1705	7.407173094	33.302	29.019	25.050	-7.520	
1700	7.407733701	33.400	29.032	20.007	-7.549	
1/0/	7.400293313	33.433	29.045	20.007	-7.570	
1/88	7.400002956	33.43	29.644	25.85/	-1.5/3	
1789	7.489412084	33.429	29.642	25.855	-1.5/4	
1/90	7.489970899	33.447	29.650	25.852	-7.595	
1791	7.490529402	33.441	29.647	25.853	-7.588	
1792	7.491087594	33.437	29.645	25.853	-7.584	
1793	7.491645474	33.431	29.642	25.852	-7.579	
1794	7.492203043	33.434	29.642	25.85	-7.584	
1795	7.492760301	33.425	29.637	25.848	-7.577	
1796	7.493317249	33.436	29.642	25.848	-7.588	
1797	7.493873887	33.433	29.642	25.851	-7.582	
1798	7.494430215	33.434	29.645	25.855	-7.579	
1799	7.494986234	33.438	29.647	25.855	-7.583	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	С°	°C	°C	°C	
1800	7.495541944	33.452	29.655	25.858	-7.594	
1801	7.496097345	33.452	29.655	25.858	-7.594	
1802	7.496652438	33.447	29.653	25.858	-7.589	
1803	7.497207223	33.451	29.655	25.858	-7.593	
1804	7.497761701	33.448	29.653	25.857	-7.591	
1805	7.498315871	33.437	29.647	25.856	-7.581	
1806	7.498869734	33.456	29.657	25.858	-7.598	
1807	7.499423291	33.454	29.656	25.858	-7.596	
1808	7.499976541	33.452	29.656	25.859	-7.593	
1809	7.500529485	33.455	29.657	25.859	-7.596	
1810	7.501082124	33.451	29.656	25.86	-7.591	
1811	7.501634458	33.453	29.657	25.861	-7.592	
1812	7.502186487	33.437	29.651	25.865	-7.572	
1813	7.502738211	33.448	29.657	25.865	-7.583	
1814	7.503289631	33.449	29.658	25.867	-7.582	
1815	7.503840747	33.463	29.665	25.867	-7.596	
1816	7.504391559	33.476	29.672	25.868	-7.608	
1817	7.504942068	33.473	29.672	25.87	-7.603	
1818	7.505492275	33.472	29.671	25.869	-7.603	
1819	7.506042179	33.459	29.664	25.869	-7.590	
1820	7,50659178	33.465	29.669	25.873	-7.592	
1821	7.50714108	33.468	29.671	25.873	-7.595	
1822	7.507690078	33.466	29.669	25.872	-7.594	
1823	7.508238775	33.456	29.664	25.871	-7.585	
1824	7.508787171	33.466	29.669	25.871	-7.595	
1825	7 509335266	33 468	29 671	25 874	-7 594	
1826	7.509883061	33.474	29.675	25.876	-7.598	
1827	7 510430556	33 481	29.680	25 878	-7 603	
1828	7 510977752	33 475	29 677	25 879	-7 596	
1829	7 511524648	33 478	29.678	25 877	-7 601	
1830	7 512071246	33 489	29.684	25.879	-7.610	
1831	7 512617545	33 464	29.672	25.88	-7 584	
1832	7 513163545	33 448	29.665	25.881	-7 567	
1833	7.513709248	33 454	29.669	25.884	-7 570	
1834	7.514254653	33 464	29.674	25.883	-7 581	
1835	7.514204000	33 473	29.678	25.883	-7 590	
1836	7 515344571	33 481	29.684	25.886	-7 595	
1837	7.515880085	33 /80	20.004	25.888	-7.601	
1838	7.515003003	33 405	29.009	25.000	-7.606	
1830	7.516077225	33 /01	29.092	25.009	-7.603	
1840	7.517520851	33 / 88	29.090	25.000	-7.508	
1940	7.517520051	22 402	29.009	25.09	7.590	
1941	7.518004181	22 470	29.091	25.009	-7.004	
1042	7.510007217	22 472	29.003	25.007	-7.592	
1043	7.519149956	22 477	29.000	25.000	-7.504	
1044	7.519092404	33.477	29.003	25.009	-7.300	
1040	7.520234556	33.475	29.003	25.69	-7.303	
1040	7.520776415	33.40	29.007	25.693	-7.307	
1047	7.52131790	33.493	29.695	25.690	-7.597	
1040	7.521659252	33.494	29.090	25.697	-7.597	
1849	7.522400231	33.482	29.691	25.899	-7.583	
1850	7.522940918	33.485	29.693	25.901	-7.584	
1851	7.523481313	33.48	29.692	25.903	-7.577	
1852	7.524021415	33.503	29.702	25.901	-7.602	
1853	7.524561226	33.497	29.698	25.899	-7.598	
1854	7.525100746	33.502	29.701	25.899	-7.603	
1855	1.525639975	33.492	29.696	25.899	-7.593	
1856	7.526178913	33.487	29.694	25.901	-7.586	
1857	1.526/1/561	33.488	29.696	25.903	-7.585	
1858	1.527255919	33.482	29.693	25.904	-7.578	
1859	7.527793988	33.478	29.692	25.905	-7.573	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)		°C	°€	0°C	
WIITULES		0	C	C	0	
4000	7 500004707	22,400	00.000	05.000	7 500	
1860	7.528331767	33.489	29.698	25.906	-7.583	
1861	7.528869257	33.486	29.696	25.906	-7.580	
1862	7.529406458	33.474	29.692	25.909	-7.565	
1863	7.529943371	33.479	29.695	25.911	-7.568	
1864	7.530479995	33.469	29.691	25.913	-7.556	
1865	7.531016332	33.468	29.692	25.916	-7.552	
1866	7.531552381	33.466	29.692	25.917	-7.549	
1867	7.532088144	33.458	29.689	25.919	-7.539	
1868	7.532623619	33.453	29.686	25.919	-7.534	
1869	7,533158807	33,456	29.688	25.92	-7.536	
1870	7 53369371	33 455	29.687	25 919	-7 536	
1870	7 534228326	33 441	29.680	25.018	-7 523	
1872	7.534762657	33 /33	20.000	25.018	-7 515	
1072	7.534702037	22 420	29.070	25.910	7.510	
1073	7.555290702	33.429	29.073	20.917	-7.512	
1874	7.535830463	33.423	29.672	25.92	-7.503	
1875	7.536363938	33.409	29.664	25.919	-7.490	
1876	7.53689713	33.395	29.658	25.921	-7.474	
1877	7.537430037	33.389	29.658	25.926	-7.463	
1878	7.53796266	33.383	29.654	25.925	-7.458	
1879	7.538494999	33.388	29.658	25.927	-7.461	
1880	7.539027056	33.391	29.660	25.929	-7.462	
1881	7.539558829	33.41	29.670	25.93	-7.480	
1882	7.54009032	33.423	29.676	25.929	-7.494	
1883	7 540621529	33 434	29.681	25 928	-7 506	
1884	7 541152455	33 408	29.668	25 927	-7 481	
1885	7.5416831	33 408	20.000	25.027	-7.484	
1005	7.5410031	22 417	29.000	25.924	-7.404	
1000	7.342213403	33.417	29.071	25.925	-7.492	
1887	7.542743545	33.436	29.678	25.919	-7.517	
1888	7.543273347	33.423	29.669	25.915	-7.508	
1889	7.543802868	33.43	29.670	25.91	-7.520	
1890	7.544332108	33.44	29.675	25.909	-7.531	
1891	7.544861069	33.458	29.684	25.91	-7.548	
1892	7.54538975	33.455	29.682	25.909	-7.546	
1893	7.545918151	33.455	29.683	25.91	-7.545	
1894	7.546446274	33.46	29.685	25.909	-7.551	
1895	7.546974118	33.463	29.686	25.908	-7.555	
1896	7.547501683	33.467	29.687	25.906	-7.561	
1897	7 54802897	33 462	29.683	25 904	-7 558	
1808	7 5/8555979	33 457	20.000	25.001	-7 554	
1800	7.540092711	22 466	29.000	25.903	7 562	
1099	7.549062711	33.400	29.000	25.903	-7.303	
1900	7.549009105	33.475	29.000	25.901	-7.374	
1901	7.550135342	33.452	29.678	25.904	-7.548	
1902	7.550661243	33.446	29.676	25.905	-7.541	
1903	7.551186867	33.468	29.688	25.907	-7.561	
1904	7.551712215	33.455	29.682	25.909	-7.546	
1905	7.552237288	33.456	29.684	25.912	-7.544	
1906	7.552762084	33.472	29.693	25.913	-7.559	
1907	7.553286606	33.467	29.691	25.914	-7.553	
1908	7.553810852	33.472	29.693	25.914	-7.558	
1909	7.554334824	33.487	29.701	25.915	-7.572	
1910	7,554858521	33.489	29.704	25.918	-7.571	
1911	7.555381944	33.484	29.701	25.917	-7.567	
1012	7 55500500/	33 466	20.601	25 915	-7 551	
1012	7 556407060	22 470	20.001	25.315	-7 561	
1913	7.550427909	33.479	29.099	20.910	-7.501	
1914	1.000900572	33.479	29.698	25.917	-7.562	
1915	1.55/4/2902	33.485	29.702	25.919	-7.566	
1916	7.557994959	33.475	29.698	25.92	-7.555	
1917	7.558516743	33.494	29.708	25.921	-7.573	
1918	7.559038255	33.489	29.706	25.922	-7.567	
1919	7.559559496	33.489	29.707	25.924	-7.565	

		- 1.	Δ	Deter		
lime	All Data	FIOW	Average	Return	Deita I	
Minutes	Ln (Time)	°C	°C	°C	°C	
1920	7.560080465	33.502	29.715	25.927	-7.575	
1921	7 560601163	33 507	29 718	25 928	-7 579	
1021	7.600001100	22,409	20.710	20.020	7.073	
1922	7.50112159	33.490	29.711	25.924	-7.574	
1923	7.561641746	33.506	29.716	25.926	-7.580	
1924	7.562161631	33.509	29.718	25.926	-7.583	
1925	7.562681247	33.518	29.723	25.928	-7.590	
1926	7 563200592	33 507	29 717	25 926	-7 581	
1020	7.562710669	22 526	20.717	25.020	7.501	
1927	7.505719000	33.520	29.727	25.920	-7.590	
1928	7.564238475	33.528	29.729	25.929	-7.599	
1929	7.564757013	33.526	29.728	25.93	-7.596	
1930	7.565275282	33.526	29.729	25.931	-7.595	
1931	7.565793282	33.529	29.731	25.933	-7.596	
1932	7 566311015	33 516	29 724	25 932	-7 584	
1022	7 566929470	22 525	20.720	25.022	7 502	
1955	7.500020479	33.323	29.729	25.952	-7.595	
1934	7.567345676	33.526	29.729	25.932	-7.594	
1935	7.567862605	33.525	29.729	25.933	-7.592	
1936	7.568379268	33.505	29.720	25.935	-7.570	
1937	7.568895663	33.492	29.715	25.937	-7.555	
1938	7 569411792	33 509	29 725	25 941	-7 568	
1020	7.505411752	22 526	20.726	25.045	7.500	
1939	7.509927055	33.520	29.730	25.945	-7.301	
1940	7.570443252	33.529	29.736	25.943	-7.586	
1941	7.570958583	33.521	29.733	25.945	-7.576	
1942	7.571473649	33.522	29.733	25.944	-7.578	
1943	7 571988449	33 514	29 729	25 944	-7 570	
1014	7 572502085	33 524	20.734	25.043	-7 581	
1944	7.572502905	00.500	29.734	25.945	-7.501	
1945	7.573017256	33.523	29.735	25.946	-7.577	
1946	7.573531263	33.529	29.738	25.946	-7.583	
1947	7.574045005	33.524	29.734	25.943	-7.581	
1948	7.574558484	33.543	29.744	25.945	-7.598	
1949	7 5750717	33 531	29 738	25 945	-7 586	
1050	7.575594652	22 52	20.700	20.040	7.000	
1950	7.575564052	33.03	29.739	25.947	-7.303	
1951	7.576097341	33.535	29.743	25.95	-7.585	
1952	7.576609767	33.533	29.741	25.948	-7.585	
1953	7.577121931	33.537	29.743	25.948	-7.589	
1954	7.577633833	33.53	29,740	25,949	-7.581	
1955	7 578145472	33 53	29 740	25 949	-7 581	
1056	7.570145472	22.52	20.740	25.545	7.501	
1950	7.576050651	33.03	29.740	25.95	-7.560	
1957	7.579167967	33.533	29.742	25.951	-7.582	
1958	7.579678823	33.537	29.744	25.951	-7.586	
1959	7.580189418	33.545	29.749	25.953	-7.592	
1960	7,580699752	33,548	29,751	25,953	-7,595	
1961	7 581209826	33 559	29 757	25 954	-7 605	
1062	7.501205020	22 5 4 4	20.740	25.554	7.000	
1962	7.56171904	33.344	29.749	25.954	-7.590	
1963	7.582229194	33.537	29.747	25.956	-7.581	
1964	7.582738489	33.535	29.745	25.955	-7.580	
1965	7.583247524	33.526	29.740	25.954	-7.572	
1966	7.583756301	33.541	29.750	25.958	-7.583	
1967	7 584264818	33 544	29 750	25 956	-7 588	
1069	7.59/772079	22 556	20.757	25.059	7.500	
1900	7.504775070	33.330	29.757	23.930	-7.590	
1969	1.585281079	33.553	29.757	25.96	-7.593	
1970	7.585788822	33.555	29.758	25.96	-7.595	
1971	7.586296307	33.555	29.758	25.961	-7.594	
1972	7.586803535	33.552	29.757	25.961	-7.591	
1973	7 587310506	33 552	29 757	25 962	-7 590	
1073	7 50701700	22 520	20.751	20.002	7 530	
1974	1.00/01/22	33.339	29.701	20.902	-7.577	
1975	7.588323677	33.536	29.749	25.962	-1.5/4	
1976	7.588829878	33.552	29.758	25.964	-7.588	
1977	7.589335823	33.577	29.772	25.966	-7.611	
1978	7.589841512	33.586	29.776	25.965	-7.621	
1070	7 500346046	33 587	20 777	25.067	-7 620	
1010	1.0000-00-00	00.007		20.001	1.020	Í.

Time	All Data	Flow	Average	Return	Delta T	
Minutoc		°C	o ∾	°C	0 0	
Willinutes		0	0	U U	0	
4000	7 500050404	00 507	00 777	05.007	7 000	
1980	7.590852124	33.587	29.777	25.967	-7.620	
1981	7.591357047	33.581	29.774	25.967	-7.614	
1982	7.591861715	33.569	29.768	25.967	-7.602	
1983	7.592366129	33.57	29.768	25.966	-7.604	
1984	7.592870288	33.566	29.767	25.968	-7.598	
1985	7.593374193	33.565	29.765	25.965	-7.600	
1986	7.593877845	33,559	29.761	25.963	-7.596	
1987	7,594381243	33,582	29.774	25.966	-7.616	
1988	7 594884387	33 616	29 793	25 969	-7 647	
1000	7 505387270	33.646	20.700	25.000	-7.678	
1000	7.5050001210	22 626	20.801	25.000	7.670	
1990	7.595009910	22 624	29.001	25.905	7.071	
1991	7.590592304	22 629	29.790	25.902	-7.072	
1992	7.590694436	33.020	29.795	25.901	-7.007	
1993	7.59739632	33.030	29.797	25.958	-7.078	
1994	7.597897951	33.613	29.786	25.958	-7.655	
1995	7.598399329	33.599	29.778	25.957	-7.642	
1996	7.598900457	33.604	29.781	25.957	-7.647	
1997	7.599401333	33.603	29.780	25.957	-7.646	
1998	7.599901959	33.612	29.787	25.962	-7.650	
1999	7.600402335	33.616	29.793	25.97	-7.646	
2000	7.60090246	33.631	29.800	25.969	-7.662	
2001	7.601402335	33.631	29.802	25.972	-7.659	
2002	7.60190196	33.618	29.795	25.972	-7.646	
2003	7.602401336	33,619	29,797	25,975	-7.644	
2004	7 602900462	33 619	29 798	25.976	-7 643	
2004	7.60330034	33.61	20.703	25.076	-7.634	
2005	7.00339934	22 604	29.795	25.970	7.034	
2000	7.003697909	33.004	29.790	25.970	-7.020	
2007	7.604396349	33.018	29.797	25.975	-7.643	
2008	7.604894481	33.625	29.802	25.978	-7.647	
2009	7.605392365	33.631	29.805	25.978	-7.653	
2010	7.605890001	33.618	29.799	25.98	-7.638	
2011	7.60638739	33.617	29.800	25.982	-7.635	
2012	7.606884531	33.632	29.808	25.983	-7.649	
2013	7.607381426	33.623	29.802	25.981	-7.642	
2014	7.607878073	33.607	29.795	25.982	-7.625	
2015	7.608374474	33.609	29.797	25.984	-7.625	
2016	7.608870629	33.627	29.806	25.984	-7.643	
2017	7.609366538	33.627	29.807	25.987	-7.640	
2018	7 609862201	33 617	29 804	25.99	-7 627	
2019	7 610357618	33 618	29 804	25 989	-7 629	
2013	7.61085270	33.624	20.004	25.000	-7.632	
2020	7.6112/7717	22 629	29.000	25.332	7.629	
2021	7.011347717	22 621	29.009	25.99	-7.030	
2022	7.0110424	33.031	29.013	25.994	-7.037	
2023	7.012330037	33.042	29.010	25.994	-7.040	
2024	7.61283103	33.627	29.810	25.993	-7.634	
2025	7.61332498	33.618	29.807	25.996	-7.622	
2026	7.613818685	33.631	29.815	25.998	-7.633	
2027	7.614312146	33.627	29.813	25.998	-7.629	
2028	7.614805365	33.637	29.819	26	-7.637	
2029	7.61529834	33.637	29.818	25.998	-7.639	
2030	7.615791072	33.643	29.821	25.998	-7.645	
2031	7.616283562	33.622	29.811	25.999	-7.623	
2032	7.616775809	33.629	29.816	26.002	-7.627	
2033	7.617267814	33.648	29.827	26.005	-7.643	
2034	7.617759577	33.653	29.830	26.006	-7.647	
2035	7,618251098	33.652	29.829	26.006	-7.646	
2036	7.618742378	33.646	29.827	26.007	-7.639	
2037	7 619233416	33 652	29 830	26.008	-7 644	
2007	7 61072/21/	33.61	20.000	26.008	-7 632	
2000	7 62021/771	22 6/7	20.024	26.000	-7 630	
2039	1.020214//1	55.047	∠9.0Z0	20.000	-1.039	

Time	All Data	Flow	Δνοτοσο	Return	Delta T	
Minutes		11000	Average			
winutes	Ln (Time)	C	U		C	
2040	7.620705087	33.66	29.835	26.009	-7.651	
2041	7.621195163	33.664	29.836	26.008	-7.656	
2042	7.621684999	33.657	29.831	26.005	-7.652	
2043	7.622174595	33,636	29.822	26.008	-7.628	
2014	7 622663051	33 661	20.836	26.01	-7 651	
2044	7.622000001	22 667	20.840	26.012	7.655	
2045	7.023155000	33.007	29.040	20.012	-7.000	
2046	7.623641947	33.058	29.835	26.012	-7.646	
2047	7.624130586	33.669	29.841	26.013	-7.656	
2048	7.624618986	33.676	29.845	26.013	-7.663	
2049	7.625107148	33.688	29.851	26.013	-7.675	
2050	7.625595072	33.676	29.845	26.014	-7.662	
2051	7 626082758	33 668	29 841	26.014	-7 654	
2052	7.626570206	33 661	20.836	26.011	-7.650	
2052	7.020370200	33.001	29.000	20.011	-7.030	
2053	7.027057417	33.000	29.034	20.011	-7.045	
2054	7.62754439	33.672	29.842	26.011	-7.661	
2055	7.628031127	33.672	29.843	26.013	-7.659	
2056	7.628517627	33.672	29.843	26.014	-7.658	
2057	7.62900389	33.672	29.844	26.015	-7.657	
2058	7,629489916	33.676	29.848	26.019	-7.657	
2059	7 620975707	33 688	29.853	26.018	-7 670	
2000	7.023373707	22.67	29.000	20.010	-7.070	
2060	7.030401202	33.07	29.645	20.02	-7.050	
2061	7.630946581	33.679	29.849	26.019	-7.660	
2062	7.631431665	33.673	29.847	26.02	-7.653	
2063	7.631916513	33.671	29.844	26.017	-7.654	
2064	7.632401127	33.666	29.842	26.018	-7.648	
2065	7 632885505	33 673	29 845	26 017	-7 656	
2066	7 63336965	33 676	20.847	26.018	-7 658	
2000	7.00000000	22.69	20.047	26.010	7.000	
2007	7.03303300	33.00	29.049	20.010	-7.002	
2068	7.634337236	33.673	29.844	26.014	-7.659	
2069	7.634820678	33.654	29.835	26.016	-7.638	
2070	7.635303886	33.659	29.837	26.015	-7.644	
2071	7.635786861	33.649	29.832	26.014	-7.635	
2072	7.636269603	33.642	29.828	26.014	-7.628	
2073	7 636752112	33 645	29 832	26.018	-7 627	
2074	7 63723/389	33 650	20.840	26.02	-7 639	
2074	7.007204000	22.000	20.040	20.02	-7.033	
2075	7.037710433	33.07	29.640	20.021	-7.049	
2076	7.638198244	33.673	29.846	26.019	-7.654	
2077	7.638679824	33.664	29.844	26.023	-7.641	
2078	7.639161172	33.669	29.846	26.022	-7.647	
2079	7.639642288	33.685	29.853	26.02	-7.665	
2080	7.640123173	33.673	29.846	26.019	-7.654	
2081	7 640603826	33 663	29 842	26.02	-7 643	
2082	7 6/108/2/9	33 654	20.836	26.018	-7.636	
2002	7.041004243	22 662	23.000	26.016	7.646	
2003	7.041304441	33.002	29.039	20.010	-7.040	
2084	7.642044403	33.676	29.846	26.016	-7.660	
2085	7.642524134	33.685	29.851	26.016	-7.669	
2086	7.643003636	33.678	29.849	26.019	-7.659	
2087	7.643482907	33.672	29.846	26.02	-7.652	
2088	7.643961949	33.667	29.843	26.019	-7.648	
2089	7 644440762	33 655	29 837	26.019	-7 636	
2000	7 64/0103/5	33 658	20.820	26.010	-7 630	
2030	7 645207600	22 656	23.003	20.013	7 640	
2091	1.04009/099	33.000	29.030	20.014	-1.042	
2092	1.645875825	33.655	29.834	26.013	-7.642	
2093	7.646353722	33.66	29.837	26.014	-7.646	
2094	7.646831391	33.656	29.836	26.016	-7.640	
2095	7.647308832	33.666	29.843	26.019	-7.647	
2096	7.647786045	33.669	29.845	26.02	-7.649	
2000	7 648263031	33 671	29.846	26.021	-7 650	
2007	7 6/0720700	32 660	20.040	26.021	_7 6/0	
2090	1.040139109	33.009	29.040	20.021	-7.040	
2099	7.64921632	33.662	29.843	26.023	-7.639	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)		°C	°C	0 0	
WIITULES		0	C	U	U	
0100	7.040000004	00.07	00.040	00.000	7.040	
2100	7.649692624	33.67	29.846	26.022	-7.648	
2101	7.650168701	33.65	29.837	26.023	-7.627	
2102	7.650644551	33.664	29.843	26.022	-7.642	
2103	7.651120176	33.674	29.848	26.021	-7.653	
2104	7.651595574	33.668	29.846	26.023	-7.645	
2105	7.652070746	33.669	29.846	26.023	-7.646	
2106	7.652545693	33.675	29.850	26.025	-7.650	
2107	7 653020414	33 667	29 847	26.026	-7 641	
2108	7 65349491	33 666	29.846	26.026	-7 640	
2100	7 65396918	33.676	20.010	26.026	-7.650	
2100	7.654442226	22 657	20.001	26.020	7.000	
2110	7.034443220	33.057	29.042	20.020	-7.031	
2111	7.654917048	33.644	29.835	26.025	-7.619	
2112	7.655390645	33.644	29.837	26.029	-7.615	
2113	7.655864018	33.668	29.851	26.034	-7.634	
2114	7.656337166	33.659	29.848	26.036	-7.623	
2115	7.656810091	33.655	29.846	26.036	-7.619	
2116	7.657282793	33.666	29.852	26.038	-7.628	
2117	7.657755271	33.668	29.855	26.041	-7.627	
2118	7.658227526	33.669	29.857	26.044	-7.625	
2119	7.658699558	33.676	29.861	26.046	-7.630	
2120	7 659171368	33 681	29 863	26 045	-7 636	
2121	7 659642955	33 668	29.856	26.044	-7 624	
2121	7.660114310	33,665	20.855	26.044	-7.624	
2122	7.000114319	22.679	29.000	20.044	7.021	
2123	7.000303402	33.078	29.003	20.047	-7.031	
2124	7.001000302	33.070	29.004	26.049	-7.029	
2125	7.661527081	33.686	29.867	26.048	-7.638	
2126	7.661997559	33.674	29.861	26.048	-7.626	
2127	7.662467815	33.676	29.864	26.052	-7.624	
2128	7.66293785	33.673	29.863	26.052	-7.621	
2129	7.663407665	33.679	29.866	26.053	-7.626	
2130	7.663877259	33.674	29.864	26.053	-7.621	
2131	7.664346632	33.663	29.859	26.054	-7.609	
2132	7.664815785	33.685	29.870	26.055	-7.630	
2133	7.665284718	33.687	29.873	26.058	-7.629	
2134	7.665753432	33.679	29.869	26.059	-7.620	
2135	7.666221926	33.688	29.873	26.058	-7.630	
2136	7.6666902	33.693	29.877	26.061	-7.632	
2137	7.667158255	33.692	29.877	26.062	-7.630	
2138	7.667626092	33.676	29.869	26.062	-7.614	
2139	7.668093709	33.67	29.867	26.064	-7.606	
2140	7 668561108	33 681	29 873	26.064	-7 617	
2141	7 669028289	33.7	29.882	26.063	-7 637	
2142	7.669495251	33.68	20.002	26.063	-7.617	
2142	7.660061005	33.682	20.072	26.005	-7.617	
2140	7.670429522	22.69	20.074	26.005	7.615	
2144	7.070420322	22.609	29.075	20.003	7.013	
2145	7.070094031	33.090	29.000	20.071	-7.027	
2140	7.071300923	33.000	29.000	20.073	-7.013	
2147	7.071820798	33.008	29.871	26.073	-7.595	
2148	7.672292456	33.68	29.878	26.075	-7.605	
2149	1.6/2/5/897	33.679	29.878	26.076	-7.603	
2150	7.673223121	33.692	29.885	26.078	-7.614	
2151	7.673688129	33.688	29.884	26.08	-7.608	
2152	7.674152921	33.678	29.878	26.077	-7.601	
2153	7.674617497	33.681	29.880	26.078	-7.603	
2154	7.675081858	33.689	29.884	26.079	-7.610	
2155	7.675546003	33.695	29.888	26.08	-7.615	
2156	7.676009932	33.695	29.889	26.083	-7.612	
2157	7.676473646	33.702	29.891	26.08	-7.622	
2158	7.676937146	33.713	29.897	26.081	-7.632	
2159	7.677400431	33.702	29.892	26.082	-7.620	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	°C	°€	0°C	
WIITULES		0	C	C	C	
0100	7.077000504		00.007	00.00	7.040	
2160	7.677863501	33.693	29.887	26.08	-7.613	
2161	7.678326357	33.696	29.888	26.08	-7.616	
2162	7.678788998	33.705	29.892	26.079	-7.626	
2163	7.679251426	33.7	29.889	26.077	-7.623	
2164	7.67971364	33.709	29.893	26.077	-7.632	
2165	7.68017564	33.705	29.892	26.079	-7.626	
2166	7.680637428	33.716	29.897	26.078	-7.638	
2167	7.681099002	33.721	29.903	26.084	-7.637	
2168	7.681560363	33.709	29.899	26.088	-7.621	
2169	7.682021511	33.715	29.902	26.088	-7.627	
2170	7 682482447	33 702	29 895	26.087	-7 615	
2171	7 68294317	33 699	29 894	26.088	-7 611	
2172	7 683403681	33 689	29.889	26.088	-7 601	
2172	7 68386308	33 684	20.000	26.000	-7 501	
2173	7 694224069	22 694	29.009	26.093	7 501	
2174	7.694722000	22 602	29.009	20.095	7 509	
2175	7.004703944	33.093	29.094	20.095	-7.596	
2176	7.085243008	33.701	29.901	20.1	-7.601	
2177	7.685703061	33.714	29.908	26.101	-7.613	
2178	7.686162303	33.711	29.905	26.099	-7.612	
2179	7.686621335	33.704	29.902	26.1	-7.604	
2180	7.687080156	33.699	29.901	26.102	-7.597	
2181	7.687538766	33.698	29.900	26.102	-7.596	
2182	7.687997166	33.693	29.896	26.099	-7.594	
2183	7.688455357	33.7	29.901	26.102	-7.598	
2184	7.688913337	33.708	29.905	26.101	-7.607	
2185	7.689371108	33.718	29.910	26.102	-7.616	
2186	7.689828669	33.728	29.915	26.102	-7.626	
2187	7.690286021	33.73	29,917	26,104	-7.626	
2188	7 690743164	33 728	29.918	26 107	-7 621	
2189	7 691200098	33 726	29.915	26 104	-7 622	
2100	7.601656823	33 732	20.010	26.104	-7.626	
2130	7.031030023	22 717	20.011	26.100	7.612	
2191	7.09211334	33.717	29.911	20.105	-7.012	
2192	7.092309040	33.713	29.910	20.100	-7.007	
2193	7.093025746	33.707	29.906	26.105	-7.002	
2194	7.693481641	33.72	29.914	26.107	-7.613	
2195	7.693937326	33.726	29.918	26.109	-7.617	
2196	7.694392803	33.717	29.915	26.113	-7.604	
2197	7.694848072	33.729	29.922	26.114	-7.615	
2198	7.695303135	33.748	29.932	26.116	-7.632	
2199	7.695757991	33.743	29.931	26.118	-7.625	
2200	7.696212639	33.738	29.928	26.117	-7.621	
2201	7.696667082	33.736	29.927	26.118	-7.618	
2202	7.697121317	33.724	29.922	26.119	-7.605	
2203	7.697575347	33.727	29.923	26.118	-7.609	
2204	7.69802917	33.74	29.931	26.121	-7.619	
2205	7.698482788	33.736	29.927	26.117	-7.619	
2206	7.6989362	33.738	29.927	26.116	-7.622	
2207	7.699389406	33.733	29.925	26.117	-7.616	
2208	7 699842407	33 733	29 927	26.12	-7 613	
2200	7 700295203	33 736	20.027	26.122	-7 614	
2210	7.700200200	33.74	20.020	26.122	-7.617	
2210	7 701200191	33 720	20.002	26.125	-7 61/	
2211	7 701650262	22 700	29.902	20.120	-7.014	
2212	7 70040404	20.740	29.920	20.123	-7.000	
2213	7.70210434	33.748	29.936	20.123	-7.625	
2214	7.702556113	33.745	29.935	26.124	-7.621	
2215	1.703007682	33.751	29.938	26.125	-7.626	
2216	7.703459048	33.736	29.931	26.126	-7.610	
2217	7.70391021	33.733	29.929	26.125	-7.608	
2218	7.704361168	33.746	29.937	26.128	-7.618	
2219	7.704811923	33.736	29.932	26.128	-7.608	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)	°C	ଂମ	°C	°C.	
Minates	En (Time)	0	0	U	0	
2220	7 705262475	33 747	20.030	26 131	-7.616	
2220	7.705202473	22 754	29.939	20.131	7.010	
2221	7.705712024	22 727	29.943	20.132	-7.022	
2222	7.70010297	33.737	29.934	20.131	-7.000	
2223	7.706612914	33.746	29.940	26.133	-7.613	
2224	7.707062655	33.758	29.947	26.136	-7.622	
2225	7.707512195	33.752	29.944	26.135	-7.617	
2226	7.707961532	33.76	29.947	26.134	-7.626	
2227	7.708410667	33.76	29.948	26.135	-7.625	
2228	7.708859601	33.753	29.945	26.136	-7.617	
2229	7.709308333	33.757	29.946	26.135	-7.622	
2230	7.709756864	33.747	29.942	26.136	-7.611	
2231	7.710205194	33.759	29.948	26.137	-7.622	
2232	7.710653324	33,762	29.948	26.134	-7.628	
2233	7.711101252	33.768	29.952	26.136	-7.632	
2234	7 71154898	33 758	29 949	26 139	-7 619	
2235	7 711996507	33 751	29.947	26.100	-7 609	
2200	7 7124/383/	33 758	20.052	26.142	-7.613	
2230	7.712443034	22.75	29.952	20.145	7.013	
2237	7.712890961	33.75	29.946	26.142	-7.608	
2238	7.713337889	33.768	29.956	26.144	-7.624	
2239	7.713784617	33.771	29.957	26.143	-7.628	
2240	7.714231145	33.764	29.953	26.142	-7.622	
2241	7.714677474	33.777	29.961	26.145	-7.632	
2242	7.715123604	33.783	29.963	26.143	-7.640	
2243	7.715569535	33.776	29.961	26.146	-7.630	
2244	7.716015267	33.77	29.958	26.146	-7.624	
2245	7.7164608	33.772	29.960	26.147	-7.625	
2246	7.716906135	33.767	29.957	26.146	-7.621	
2247	7,717351272	33,747	29.947	26,146	-7.601	
2248	7 717796211	33 75	29 950	26 15	-7 600	
2249	7 718240952	33 733	29.943	26 152	-7 581	
2250	7 718685495	33 734	20.010	26.162	-7 581	
2250	7 7101208/1	33 751	20.054	26.155	-7 50/	
2201	7.719129041	22 750	29.954	20.157	-7.594	
2202	7.719573969	33.750	29.957	20.100	-7.596	
2203	7.72001794	33.750	29.960	20.102	-7.596	
2254	7.720461695	33.75	29.957	26.163	-7.587	
2255	7.720905252	33.752	29.958	26.163	-7.589	
2256	7.721348613	33.758	29.961	26.163	-7.595	
2257	7.721791777	33.753	29.959	26.165	-7.588	
2258	7.722234745	33.757	29.962	26.167	-7.590	
2259	7.722677516	33.754	29.959	26.164	-7.590	
2260	7.723120092	33.754	29.958	26.162	-7.592	
2261	7.723562472	33.755	29.960	26.165	-7.590	
2262	7.724004657	33.768	29.967	26.166	-7.602	
2263	7.724446646	33.787	29.977	26.167	-7.620	
2264	7.724888439	33,789	29.980	26.17	-7.619	
2265	7.725330038	33.794	29.982	26.17	-7.624	
2266	7 725771442	33 792	29 981	26 169	-7 623	
2267	7 726212651	33 783	29 975	26 166	-7 617	
2268	7 726653665	33 794	20.070	26.165	-7 629	
2200	7 727004485	33 780	20.076	26.163	-7.626	
2203	7 70752514	32 700	29.910	20.103	-7.020	
2210	7 707075540	22 700	23.310	20.101	7 605	
22/1	1.121910042	33.190	29.979	20.101	-7.035	
22/2	1.12841578	33.785	29.973	20.161	-7.624	
2273	1.128855824	33.791	29.976	26.161	-7.630	
2274	7.729295674	33.786	29.976	26.165	-7.621	
2275	7.729735331	33.795	29.980	26.164	-7.631	
2276	7.730174795	33.785	29.976	26.166	-7.619	
2277	7.730614066	33.796	29.981	26.165	-7.631	
2278	7.731053144	33.803	29.985	26.167	-7.636	
2279	7.731492029	33.786	29.977	26.168	-7.618	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)		°C	°C	0 0	
IVIII IULES		U	0	U U	0	
	7 704000700		00.070	00.407	7 00 1	
2280	7.731930722	33.788	29.978	26.167	-7.621	
2281	7.732369222	33.797	29.984	26.17	-7.627	
2282	7.73280753	33.789	29.981	26.172	-7.617	
2283	7.733245647	33.785	29.978	26.171	-7.614	
2284	7.733683571	33,791	29.982	26.172	-7.619	
2285	7,734121303	33,809	29,990	26,171	-7.638	
2286	7 734558844	33,806	29 990	26 173	-7 633	
2200	7 724006104	22 701	20.002	26.175	7.616	
2207	7.734990194	33.791	29.903	20.175	-7.010	
2288	7.735433352	33.789	29.983	26.177	-7.612	
2289	7.73587032	33.799	29.988	26.177	-7.622	
2290	7.736307097	33.8	29.988	26.175	-7.625	
2291	7.736743682	33.793	29.983	26.173	-7.620	
2292	7.737180078	33.809	29.992	26.174	-7.635	
2293	7.737616283	33.798	29.985	26.171	-7.627	
2294	7 738052298	33 802	29 986	26 17	-7 632	
2295	7 738488122	33.8	29 986	26 171	-7 629	
2200	7 728022757	22.915	20.000	26.172	7.642	
2290	7.730923737	33.015	29.994	20.173	-7.042	
2297	7.739359203	33.798	29.985	26.172	-7.626	
2298	7.739794458	33.797	29.984	26.171	-7.626	
2299	7.740229525	33.784	29.977	26.17	-7.614	
2300	7.740664402	33.801	29.986	26.171	-7.630	
2301	7.74109909	33.798	29.984	26.169	-7.629	
2302	7,741533589	33,795	29,984	26,172	-7.623	
2303	7 7419679	33 804	20.001	26.172	-7.632	
2000	7 742402022	22 007	20.000	26.172	7.635	
2304	7.742402022	33.007	29.990	20.172	-7.035	
2305	7.742835955	33.827	29.999	26.171	-7.656	
2306	7.743269701	33.811	29.991	26.17	-7.641	
2307	7.743703258	33.81	29.990	26.17	-7.640	
2308	7.744136628	33.819	29.994	26.169	-7.650	
2309	7.744569809	33.811	29.990	26.169	-7.642	
2310	7.745002804	33.817	29.993	26.168	-7.649	
2311	7 74543561	33,809	29 989	26 168	-7 641	
2312	7 7/586823	33,816	20.000	26.100	-7.646	
2012	7.74500025	22 010	29.995	20.17	-7.040	
2313	7.740300002	33.010	29.994	20.17	-7.040	
2314	7.746732908	33.806	29.991	26.175	-7.631	
2315	7.747164967	33.816	29.997	26.177	-7.639	
2316	7.747596839	33.832	30.005	26.178	-7.654	
2317	7.748028524	33.832	30.004	26.176	-7.656	
2318	7.748460024	33.812	29.997	26.181	-7.631	
2319	7,748891337	33.81	29,994	26,178	-7.632	
2320	7 749322465	33 825	30.003	26.18	-7 645	
2321	7 7/0753/06	33,832	30.007	26.182	-7.650	
2021	7 750104160	22 042	20.012	20.102	7.000	
2322	7.750104102	33.043	30.013	20.102	-7.001	
2323	7.750614733	33.845	30.014	26.182	-7.663	
2324	7.751045118	33.841	30.012	26.182	-7.659	
2325	7.751475318	33.839	30.010	26.181	-7.658	
2326	7.751905333	33.834	30.009	26.184	-7.650	
2327	7.752335163	33.831	30.009	26.186	-7.645	
2328	7.752764809	33.826	30.006	26.185	-7.641	
2329	7,75319427	33.81	29 999	26 187	-7 623	
2330	7 753623547	33 827	30.007	26.186	-7.6/1	
2000	7 754052620	32 920	30.000	26 190	-7 640	
2331	7.754052659	33.629	30.009	20.109	-7.040	
2332	1.15448154/	33.846	30.020	26.194	-7.652	
2333	7.754910272	33.837	30.017	26.196	-7.641	
2334	7.755338813	33.856	30.027	26.198	-7.658	
2335	7.75576717	33.862	30.030	26.198	-7.664	
2336	7.756195344	33.853	30.026	26.198	-7.655	
2337	7.756623335	33.834	30.017	26.199	-7.635	
2338	7 757051142	33 837	30.017	26 197	-7 640	
2330	7 757/79767	33 831	30.015	26 100	-7 632	
2008	1.101710101	00.001	00.010	20.133	1.002	

			-	_		1
Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
2240	7 757006000	22.045	20.022	26.2	7 6 4 5	
2340	7.757906206	33.045	30.023	20.2	-7.043	
2341	7.758333467	33.847	30.025	26.203	-7.644	
2342	7.758760544	33.873	30.039	26.204	-7.669	
2343	7.759187439	33.88	30.042	26.204	-7.676	
2344	7 759614151	33.87	30.038	26 205	-7 665	
2044	7.760040691	22.051	20.000	26.200	7.000	
2345	7.760040661	33.651	30.029	20.200	-7.045	
2346	7.760467029	33.849	30.028	26.207	-7.642	
2347	7.760893196	33.858	30.033	26.208	-7.650	
2348	7.761319181	33.842	30.025	26.208	-7.634	
2349	7 761744985	33 839	30.024	26 209	-7 630	
2010	7.762170607	22.000	20.020	26.200	7,600	
2350	7.702170007	33.040	30.029	20.209	-7.039	
2351	7.762596049	33.856	30.033	26.21	-7.646	
2352	7.763021309	33.858	30.036	26.214	-7.644	
2353	7.763446389	33.875	30.046	26.217	-7.658	
2354	7 763871288	33 874	30 047	26.22	-7 654	
2355	7 764206006	33.867	30.044	26.221	-7.646	
2333	7.704290000	33.007	30.044	20.221	-7.040	
2350	7.764720545	33.863	30.042	26.221	-7.642	
2357	7.765144903	33.874	30.048	26.221	-7.653	
2358	7.765569081	33.875	30.048	26.22	-7.655	
2359	7 765993079	33 877	30 048	26 218	-7 659	
2260	7 766/16909	22.976	20.049	26.210	7.656	
2300	7.700410090	33.070	30.046	20.22	-7.030	
2361	7.766840537	33.868	30.045	26.221	-7.647	
2362	7.767263997	33.866	30.043	26.22	-7.646	
2363	7.767687277	33.864	30.043	26.221	-7.643	
2364	7 768110379	33 876	30 050	26 224	-7 652	
2265	7 769522201	22.974	20.049	26.222	7.652	
2305	7.700555501	33.074	30.040	20.222	-7.032	
2366	7.768956045	33.862	30.042	26.221	-7.641	
2367	7.76937861	33.877	30.050	26.223	-7.654	
2368	7.769800996	33.874	30.051	26.227	-7.647	
2369	7 770223204	33 872	30 049	26 225	-7 647	
2270	7 770645224	22.962	20.044	26.225	7 627	
2370	7.770045254	33.002	30.044	20.225	-7.037	
2371	7.771067086	33.864	30.045	26.226	-7.638	
2372	7.77148876	33.873	30.050	26.226	-7.647	
2373	7.771910256	33.875	30.050	26.224	-7.651	
2374	7 772331575	33 875	30 052	26 228	-7 647	
2275	7 772752716	22 971	20.051	26.22	7.6/1	
2373	7.77247200	22.071	20.057	20.23	-7.041	
2376	1.//31/368	33.885	30.057	26.229	-7.656	
2377	7.773594467	33.886	30.059	26.231	-7.655	
2378	7.774015077	33.877	30.051	26.224	-7.653	
2379	7,77443551	33,864	30.046	26.227	-7.637	
2380	7 77/855767	33,860	30.049	26.228	-7.6/1	
2000	7 775075040	22 070	20.0-13	20.220	7.071	
2301	1.115215846	33.8/3	30.051	20.229	-1.044	
2382	7.77569575	33.885	30.057	26.228	-7.657	
2383	7.776115477	33.885	30.056	26.226	-7.659	
2384	7.776535028	33.891	30.061	26.231	-7.660	
2385	7 776954403	33.89	30.060	26.23	-7 660	
2000	7.770004400	22.000	20.050	20.20	7.000	
2300	7.777373003	33.000	30.059	20.229	-7.009	
2387	1.111192626	33.878	30.053	26.227	-7.651	
2388	7.778211475	33.877	30.051	26.225	-7.652	
2389	7.778630147	33.88	30.053	26.226	-7.654	
2390	7 779048645	33 876	30 051	26 226	-7 650	
2200	7 770466067	22.00	30.054	26.220	_7 650	
2391	1.119400907	33.00	30.034	20.220	-7.052	
2392	1.119885115	33.874	30.053	26.231	-7.643	
2393	7.780303088	33.865	30.048	26.231	-7.634	
2394	7.780720886	33.871	30.052	26.233	-7.638	
2395	7 78113851	33 877	30.056	26 235	-7 642	
22000	7 781555050	32 002	30.060	26.200	_7 650	
2390	7.701000909	33.092	30.003	20.234	-7.000	
2397	7.781973234	33.884	30.059	26.234	-7.650	
2398	7.782390336	33.875	30.054	26.233	-7.642	
2399	7.782807263	33.882	30.058	26.234	-7.648	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	°C	
2400	7.783224016	33.886	30.060	26.234	-7.652	
2401	7.783640596	33.891	30.063	26.234	-7.657	
2402	7.784057003	33.9	30.067	26.234	-7.666	
2403	7.784473236	33.885	30.060	26.235	-7.650	
2404	7.784889296	33.887	30.059	26.231	-7.656	
2405	7.785305183	33.886	30.059	26.232	-7.654	
2406	7.785720897	33.89	30.063	26.235	-7.655	
2407	7.786136438	33.888	30.062	26.235	-7.653	
2408	7.786551806	33.888	30.063	26.238	-7.650	
2409	7.786967003	33.89	30.066	26.241	-7.649	
2410	7.787382026	33.885	30.063	26.24	-7.645	
2411	7.787796878	33.879	30.059	26.239	-7.640	
2412	7.788211558	33.872	30.056	26.24	-7.632	
2413	7,788626066	33.884	30.064	26.244	-7.640	
2414	7.789040402	33.895	30.070	26.245	-7.650	
2415	7.789454566	33.9	30.073	26.246	-7.654	
2416	7 789868559	33,903	30 074	26 244	-7 659	
2417	7 790282381	33 905	30 075	26 245	-7 660	
2418	7 790696031	33 905	30.075	26 245	-7.660	
2419	7 791109511	33 892	30.070	26 248	-7 644	
2420	7 791522819	33,899	30.074	26 249	-7.650	
2420	7 701022010	33 884	30.068	26.245	-7.633	
2421	7 792348924	33 892	30.072	26.251	-7 641	
2422	7.792761721	33.896	30.072	26.257	-7 644	
2423	7.70217/12/	33,906	30.081	26.252	-7 651	
2424	7 703586803	33 907	30.082	26.255	-7.651	
2425	7 70300000	33,906	30.082	26.250	-7.649	
2420	7 794411206	33,903	30.002	26.257	-7.644	
2421	7 70/823152	33 905	30.083	26.255	-7.644	
2420	7 70523/020	33.905	30.003	26.201	-7.044	
2429	7.795646536	33 008	30.086	26.203	-7.031	
2430	7.795040550	22 909	30.000	20.204	7.044	
2431	7.790037974	22 909	30.001	20.203	-7.035	
2432	7.790409243	33.090	30.062	20.200	-7.033	
2433	7.790000343	33.904	30.065	20.205	-7.039	
2434	7.797291274	22.92	30.093	20.200	-7.000	
2435	7.797702030	<u> </u>	30.100	26.269	-7.001	
2430	7.790112029	33.920	30.099	20.209	-7.009	
2437	7.796523054	33.909	30.090	20.27	-7.039	
2438	7.79893331	33.921	30.096	26.271	-7.650	
2439	7.799343398	33.924	30.099	26.274	-7.650	
2440	7.799753318	33.927	30.102	26.277	-7.650	
2441	7.80016307	33.921	30.099	26.276	-7.645	
2442	7.800572655	33.922	30.099	26.276	-7.646	
2443	7.800982071	33.932	30.103	26.274	-7.658	
2444	7.80139132	33.932	30.104	26.275	-7.657	
2445	7.801800402	33.924	30.100	26.276	-7.648	
2446	7.802209316	33.925	30.103	26.281	-7.644	
2447	7.802618063	33.929	30.105	26.281	-7.648	
2448	7.803026644	33.942	30.112	26.281	-7.661	
2449	7.803435057	33.93	30.106	26.282	-7.648	
2450	7.803843304	33.938	30.112	26.285	-7.653	
2451	7.804251384	33.941	30.113	26.284	-7.657	
2452	7.804659297	33.936	30.111	26.286	-7.650	
2453	7.805067044	33.938	30.112	26.286	-7.652	
2454	7.805474625	33.947	30.117	26.286	-7.661	
2455	7.80588204	33.952	30.118	26.284	-7.668	
2456	7.806289289	33.943	30.114	26.285	-7.658	
2457	7.806696373	33.934	30.110	26.285	-7.649	
2458	7.80710329	33.939	30.113	26.287	-7.652	
2459	7.807510042	33.935	30.111	26.287	-7.648	
Time	All Data	Flow	Average	Return	Delta T	
------------	--------------	--------	---------	--------	---------	--
Minutes	In (Time)		°C	°€	°€	
Willinutes		0	U		0	
0.400	7 007040000		00.440	00.007	7 000	
2460	7.807916629	33.949	30.118	26.287	-7.662	
2461	7.80832305	33.972	30.129	26.286	-7.686	
2462	7.808729307	33.98	30.134	26.287	-7.693	
2463	7.809135398	33.978	30.131	26.284	-7.694	
2464	7.809541325	33.984	30.134	26.284	-7.700	
2465	7.809947086	33.98	30,131	26,281	-7.699	
2466	7 810352684	33 965	30 124	26 282	-7 683	
2400	7.010002004	22.056	20.124	26.202	7.000	
2407	7.010700117	33.900	30.110	20.279	-7.077	
2468	7.811163385	33.932	30.107	26.281	-7.051	
2469	7.811568489	33.926	30.104	26.282	-7.644	
2470	7.81197343	33.935	30.110	26.284	-7.651	
2471	7.812378206	33.952	30.121	26.29	-7.662	
2472	7.812782819	33.963	30.129	26.294	-7.669	
2473	7.813187268	33.962	30.129	26.295	-7.667	
2474	7 813591553	33 97	30 133	26 296	-7 674	
2475	7 813995675	33 966	30 133	26 299	-7 667	
2475	7.010000070	22.004	20.142	26.200	7.007	
2470	7.014399034	33.904	30.142	20.299	-7.000	
2477	7.814803429	33.987	30.143	26.298	-7.689	
2478	7.815207062	33.979	30.137	26.295	-7.684	
2479	7.815610532	33.967	30.131	26.295	-7.672	
2480	7.816013839	33.96	30.127	26.294	-7.666	
2481	7.816416984	33.988	30,142	26.296	-7.692	
2482	7 816819966	33 999	30 149	26 298	-7 701	
2/83	7.817222786	33 001	30 1/5	26.200	-7 692	
2403	7.017222700	22.095	20.140	20.299	-7.092	
2404	7.017023443	33.965	30.140	20.295	-7.690	
2485	7.818027939	33.988	30.142	26.296	-7.692	
2486	7.818430272	33.992	30.145	26.297	-7.695	
2487	7.818832444	33.97	30.134	26.298	-7.672	
2488	7.819234454	33.976	30.139	26.302	-7.674	
2489	7.819636302	33.964	30.132	26.3	-7.664	
2490	7.820037989	33,961	30,130	26,299	-7.662	
2401	7 820439515	33 926	30 113	26.3	-7 626	
2402	7 92094099	22 029	20.119	20.0	7.620	
2492	7.02004000	33.920	20.117	20.300	-7.020	
2493	7.821242084	33.924	30.117	26.31	-7.614	
2494	7.821643126	33.928	30.120	26.312	-7.616	
2495	7.822044008	33.929	30.122	26.315	-7.614	
2496	7.822444729	33.939	30.131	26.322	-7.617	
2497	7.82284529	33.946	30.135	26.323	-7.623	
2498	7.823245691	33.944	30.136	26.327	-7.617	
2499	7 823645931	33 961	30 145	26.328	-7 633	
2500	7.824046011	33 053	30 1/0	26.327	-7.626	
2500	7.024040011	22.052	20 120	26.327	7.620	
2501	7.024443931	33.955	30.139	20.324	-7.029	
2502	7.824845691	33.955	30.139	26.323	-7.632	
2503	7.825245291	33.963	30.143	26.322	-7.641	
2504	7.825644732	33.94	30.131	26.322	-7.618	
2505	7.826044014	33.962	30.144	26.325	-7.637	
2506	7.826443135	33.967	30.145	26.322	-7.645	
2507	7.826842098	33.96	30.142	26.323	-7.637	
2508	7.827240902	33,949	30,137	26.325	-7.624	
2509	7 827639546	33 954	30 141	26 327	-7 627	
2510	7.828038032	33 072	30 150	26.327	-7.645	
2010	7 000 400050	22.050	20.130	20.021	7 604	
2511	7.828436359	33.959	30.144	26.328	-7.631	
2512	1.828834528	33.956	30.142	26.327	-7.629	
2513	7.829232538	33.959	30.145	26.33	-7.629	
2514	7.829630389	33.957	30.143	26.328	-7.629	
2515	7.830028083	33.968	30.151	26.333	-7.635	
2516	7.830425618	33.97	30.154	26.337	-7.633	
2517	7.830822995	33 961	30 150	26.338	-7 623	
2518	7 83122002	33 058	30 1/12	26.338	_7 620	
2510	7 921617070	22 052	20.140	20.000	7 61 4	
2019	1.03101/2/0	JJ.90∠	30.145	∠0.33ŏ	-7.014	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)		°C	°€	0°C	
IVIII IULES		C	U		0	
0500	7 00004 44 04	00.070	00 457	00.04	7 000	
2520	7.832014181	33.973	30.157	26.34	-7.633	
2521	7.832410927	33.983	30.164	26.344	-7.639	
2522	7.832807517	33.988	30.167	26.345	-7.643	
2523	7.833203949	33.985	30.166	26.346	-7.639	
2524	7.833600224	33.979	30.162	26.344	-7.635	
2525	7.833996342	33.996	30.171	26.346	-7.650	
2526	7.834392303	34.009	30.178	26.346	-7.663	
2527	7 834788107	34 005	30 176	26 346	-7 659	
2528	7 835183755	33 988	30 166	26.344	-7 644	
2520	7.835570247	33.084	30 164	26.344	-7.640	
2520	7 925074592	22.095	20 164	26.342	7.642	
2530	7.000974002	33.900	20.104	20.343	-7.042	
2531	7.836369761	33.993	30.169	26.344	-7.649	
2532	7.836764783	33.994	30.170	26.346	-7.648	
2533	7.83715965	34.002	30.174	26.345	-7.657	
2534	7.837554361	33.998	30.172	26.346	-7.652	
2535	7.837948916	33.995	30.171	26.346	-7.649	
2536	7.838343316	34.001	30.175	26.349	-7.652	
2537	7.83873756	34	30.176	26.352	-7.648	
2538	7.839131648	33.985	30.169	26.352	-7.633	
2539	7.839525582	33.998	30,175	26.352	-7.646	
2540	7 83991936	33 995	30 175	26.354	-7 641	
2541	7 8/0312083	34.006	30 181	26.355	-7 651	
2541	7.040312903	24.000	20.101	20.335	7.001	
2542	7.040700452	34.021	30.100	20.355	-7.000	
2543	7.841099765	34	30.179	26.357	-7.643	
2544	7.841492924	33.998	30.178	26.357	-7.641	
2545	7.841885929	34.015	30.186	26.357	-7.658	
2546	7.842278779	34.025	30.192	26.358	-7.667	
2547	7.842671475	34.029	30.194	26.358	-7.671	
2548	7.843064017	34.033	30.194	26.355	-7.678	
2549	7.843456404	34.024	30.189	26.353	-7.671	
2550	7.843848638	34.025	30.189	26.353	-7.672	
2551	7.844240718	34.023	30.188	26.352	-7.671	
2552	7.844632644	34.015	30.184	26.353	-7.662	
2553	7.845024417	34.011	30.183	26.354	-7.657	
2554	7.845416037	34.01	30.181	26.352	-7.658	
2555	7.845807503	34.009	30.182	26.355	-7.654	
2556	7.846198815	34.031	30.194	26.356	-7.675	
2557	7.846589975	34.034	30,196	26.358	-7.676	
2558	7.846980982	34.024	30,193	26.361	-7.663	
2559	7 847371836	34 018	30 189	26 359	-7 659	
2560	7 847762537	34 017	30 190	26,362	-7 655	
2561	7 848153086	34 028	30 197	26 365	-7 663	
2562	7.848543482	34.018	30 101	26.000	-7.655	
2562	7.848033726	34.028	30 105	26.362	-7.666	
2505	7.040900720	24.020	20,195	20.302	-7.000	
2504	7.049323010	34.023	30.193	20.303	-7.000	
2000	7.849713758	34.023	30.193	26.362	-7.001	
2566	7.850103545	34.024	30.194	26.364	-7.660	
2567	7.850493181	34.034	30.199	26.364	-7.670	
2568	7.850882665	34.033	30.200	26.366	-7.667	
2569	7.851271997	34.033	30.200	26.366	-7.667	
2570	7.851661178	34.028	30.197	26.366	-7.662	
2571	7.852050207	34.011	30.189	26.366	-7.645	
2572	7.852439085	34.03	30.200	26.37	-7.660	
2573	7.852827812	34.033	30.202	26.371	-7.662	
2574	7.853216388	34.031	30.201	26.371	-7.660	
2575	7.853604813	34.033	30.204	26.374	-7.659	
2576	7.853993087	34.036	30.206	26.375	-7.661	
2577	7.854381211	34.035	30.205	26.375	-7.660	
2578	7.854769183	34.057	30.218	26.379	-7.678	
2579	7.855157006	34.045	30.212	26.379	-7.666	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	In (Time)		°C	°C	0 0	
WIITULES		C	C	C	U	
0500	7 0555 4 4070	04.000	00.000	00.00	7 050	
2580	7.855544678	34.032	30.206	26.38	-7.652	
2581	7.8559322	34.023	30.200	26.376	-7.647	
2582	7.856319571	34.037	30.209	26.38	-7.657	
2583	7.856706793	34.054	30.218	26.381	-7.673	
2584	7.857093865	34.052	30.217	26.382	-7.670	
2585	7.857480787	34.036	30.207	26.378	-7.658	
2586	7.857867559	34.036	30.209	26.381	-7.655	
2587	7.858254182	34,041	30.212	26.383	-7.658	
2588	7 858640656	34.05	30 217	26,383	-7 667	
2580	7 85002608	34 042	30.21/	26.385	-7.657	
2500	7 950/12155	24.026	20.214	20.000	7.651	
2590	7.003410100	24.030	20.211	20.303	7.001	
2591	7.009799101	24.044	20.214	20.304	-7.000	
2592	7.000103037	34.049	30.217	20.365	-7.004	
2593	7.860570786	34.045	30.217	20.388	-7.057	
2594	7.860956365	34.061	30.226	26.391	-7.670	
2595	7.861341796	34.062	30.227	26.391	-7.671	
2596	7.861727078	34.053	30.222	26.391	-7.662	
2597	7.862112212	34.06	30.226	26.392	-7.668	
2598	7.862497197	34.06	30.227	26.393	-7.667	
2599	7.862882035	34.066	30.229	26.392	-7.674	
2600	7.863266724	34.052	30.222	26.391	-7.661	
2601	7.863651265	34.036	30.215	26.393	-7.643	
2602	7.864035659	34.041	30.218	26.394	-7.647	
2603	7.864419905	34,036	30,216	26.396	-7.640	
2604	7 864804003	34 047	30 222	26 397	-7 650	
2605	7.865187054	34.046	30.224	26.001	-7.645	
2005	7.865571759	24.040	20.224	20.401	7.652	
2000	7.000071700	34.034	30.220	20.402	-7.032	
2607	7.865955414	34.046	30.225	26.403	-7.643	
2608	7.866338923	34.056	30.230	26.404	-7.652	
2609	7.866722285	34.058	30.233	26.407	-7.651	
2610	7.8671055	34.059	30.233	26.406	-7.653	
2611	7.867488569	34.034	30.220	26.406	-7.628	
2612	7.86787149	34.019	30.213	26.407	-7.612	
2613	7.868254266	34.027	30.219	26.411	-7.616	
2614	7.868636894	34.042	30.228	26.413	-7.629	
2615	7.869019376	34.049	30.231	26.413	-7.636	
2616	7.869401713	34.051	30.233	26.415	-7.636	
2617	7.869783903	34,036	30,226	26.415	-7.621	
2618	7 870165946	34 04	30 231	26 421	-7 619	
2610	7.870547845	34.05	30,236	26.421	-7 629	
2620	7 870020507	34.06	30.242	26.421	-7.636	
2620	7.070323337	24 020	20.242	20.424	7.000	
2021	7 871602664	31 039	30.230	20.421	-7.010	
2022	7.071092004	34.030	30.220	20.410	-7.020	
2023	7.07207390	34.047	30.234	20.42	-7.027	
2624	7.87245515	34.044	30.234	26.423	-7.621	
2625	7.872836175	34.058	30.242	26.425	-7.633	
2626	7.873217055	34.061	30.243	26.424	-7.637	
2627	7.87359779	34.05	30.239	26.427	-7.623	
2628	7.87397838	34.062	30.245	26.428	-7.634	
2629	7.874358825	34.067	30.248	26.429	-7.638	
2630	7.874739125	34.086	30.257	26.427	-7.659	
2631	7.875119281	34.08	30.254	26.427	-7.653	
2632	7.875499292	34.067	30.247	26.426	-7.641	
2633	7.875879159	34.054	30.241	26.427	-7.627	
2634	7.876258882	34.047	30.236	26.424	-7.623	
2635	7.876638461	34.065	30.247	26.428	-7.637	
2636	7.877017896	34.082	30.257	26.431	-7.651	
2637	7.877397186	34.077	30.253	26.429	-7.648	
2638	7 877776333	34 064	30 247	26.43	-7 634	
2639	7 878155337	34 075	30 254	26 432	-7 643	
2000	1.010100007	01.010	20.207	-0.102	1.0.10	

Time	All Data	Flow	Average	Return	Delta T	
Minutes	Ln (Time)	°C	°C	°C	S°	
2640	7.878534196	34.1	30.266	26.432	-7.668	
2641	7.878912912	34.08	30.257	26.434	-7.646	
2642	7.879291485	34.079	30.258	26.437	-7.642	
2643	7.879669915	34.076	30.255	26.433	-7.643	
2644	7.880048201	34.075	30.253	26.431	-7.644	
2645	7.880426344	34.073	30.254	26.434	-7.639	
2646	7.880804345	34.079	30.259	26.438	-7.641	
2647	7.881182202	34.089	30.264	26.438	-7.651	
2648	7.881559917	34.093	30.265	26.436	-7.657	
2649	7.881937489	34.094	30.267	26.439	-7.655	