National Oceanography Centre

FROM COAST TO DEEP OCEAN – MAKING SENSE OF CHANGING SEAS

MECHANICAL & ELECTRICAL ENGINEERING SERVICES SPECIFICATION

for the

AQUARIUM SEAWATER CIRCULATION SYSTEM MODIFICATIONS

at

NATIONAL OCEANOGRAPHY CENTRE, SOUTHAMPTON

CLIENT
National Oceanography Centre, Southampton - Estates
University of Southampton Waterfront Campus
European Way
Southampton
SO14 3ZH

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Appendices

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APPENDIX A

SCHEDULE OF DRAWINGS

APPENDIX A

SCHEDULE OF DRAWINGS

MECHANICAL ENGINEERING SERVICES

Drawing No	Drawing Title
J2180202 M1(00)101	Mechanical Legend
J2180202 M7(BA)711	Basement Level O – Plantroom – Aquarium Seawater Installation Modifications
J2180202 M7(GF)712	Ground Floor (Level 1) Modifications

APPENDIX B

SCHEDULES OF TECHNICAL REQUIREMENTS

B1	**Aquarium Pump Motors**
B2	**Laboratory Seawater Pumps**
B3	**External Seawater Fill Point**

APPENDIX B

SCHEDULE OF TECHNICAL REQUIREMENTS

B1 AQUARIUM PUMP MOTORS

Manufacturer: Michael Smith Engineers Limited
Unit E
Scotswood Park
Forsythe Road
Sheerwater
Woking
GU21 5SU

Telephone: 01483771871
Contact: Adrian Turner
Email: a.turner@michael-smith-engineers.co.uk

Quote Ref: 15318

2No Brooke Compton
4.0 kW 112 Frame 2 pole motors
400V/3Ph/50 Hz IP55 B34 IE3
Painted in accordance with 3.3 coating
Finish colour RAL 5010 (Blue)

APPENDIX B

SCHEDULE OF TECHNICAL REQUIREMENTS

B2 LABORATORY SEAWATER PUMPS

Supplier: Grundfos Pumps Limited
Grovebury Road
Leighton Buzzard
Bedfordshire
LU7 8TL

Telephone: 01525 850000
Contact: Alexander Phelps
Website: www.grundfos.co.uk

No Off	2
Model	CRT-4-5 A-P-A-E-AUUE
Type	Vertical, non-self-priming, multistage, in-line centrifugal pump for installation in pipe systems
Electrical Supply	380 – 415V/3Ph/50 Hz
Motor	1.1 kW
Rated Current	2.50 A
Starting Current	450 – 500%
Rated Flow	6 m^3/h
Rated Head	30.6 m
Pump Speed	2900 rpm

Notes:
1. Pumps selected as like for like replacement of existing but with titanium components for protection against seawater corrosion.

APPENDIX B

SCHEDULE OF TECHNICAL REQUIREMENTS

B3 EXTERNAL SEAWATER FILL POINT

Existing fill point was originally supplied by Landon Kingsway and is marketed as an Oil Fill Point.

Dimensions: 650 W x 580 H x 300 D

Contractor to provide a bespoke GRP enclosure of similar dimensions c/w openable/lockable lid and housing suitable plastic isolation valve and hose connector.

The Contractor is able to offer as an option a similar Landon Kingsway replacement product but constructed from stainless steel for corrosion resistance.

APPENDIX C

HANDOVER DOCUMENTATION AND PROCEDURES

C1	**Introduction**
C2	**Scope and Definitions**
C3	**General Requirements**
C4	**Content, Structure and Layout**
C5	**Drawing Records Generally**
C6	**Mechanical Records**
C7	**Electrical Records**
C8	**Communication Systems Records**

C1 INTRODUCTION

The Client shall maintain, as part of its Health & Safety File and Operation & Maintenance Manuals, an up-to-date series of Record Drawings showing building outlines, partitions and Engineering Services, which may take the form of schematics.

All such information is the property of the Client and as such will not be conveyed to any third party without the express written consent of a duly authorised officer of the Client.

The primary legislation in the UK associated with the operation and maintenance of Building Services is the Health and Safety at Work Act 1974.

Under Sections 3 and 6 of this Act, as amended by the Consumer Protection Act 1987, Designers, Manufacturers and Importers or Suppliers of plant and systems have a duty to provide adequate operating information for the User to ensure that the plant or system will be safe and without risk to health when in use. This should include details of any maintenance required for continued safe operation.

Sections 2 and 6 of the Health and Safety at Work Act imply that building owners must possess adequate operating information for the operation and maintenance of Building Services. The primary items of legislation that apply are:

- Construction (Design and Management) Regulations 2015 (CDM)
- Control of Substances Hazardous to Health Regulations 2002 (COSHH)
- Electricity at Work Regulations 1989
- Environmental Protection Act 1990
- Factories Act 1961
- Regulatory Reform (Fire Safety) Order 2005
- Management of Health and Safety at Work Regulations 1999
- Offices, Shops and Railways Premises Act 1963
- Pressure Systems and Transportable Gas Containers Regulations 1989
- Provision and Use of Works Equipment Regulations 1998
- Workplace Health, Safety and Welfare Regulations 1992
- Disability Discrimination Act 2005
- The Notification of Cooling Towers and Evaporative Condenser Regulations 1992
- The Control of Noise at Work Regulations 2005

It is the Client's intention that, through implementation of its' procedure, all CAD/CAFM drawings supplied to the Client will be compatible with existing drawings.

Where the project affects existing buildings for which records exist, the As-Fitted drawings shall use the existing Record Drawings as their basis; and these shall be requested from the Project Manager before commencing work.

C2 SCOPE AND DEFINITIONS

This Specification details the type and content of technical documentation required to provide for the safe and efficient operation and maintenance of Engineering Services, including As-Fitted and other drawings. The Engineering Services covered by this Specification shall include (as appropriate):

- Mechanical
- Electrical
- Public Health
- Fire Protection
- Security
- Control
- Communication Systems

C2 SCOPE AND DEFINITIONS - contd

For the purpose of this Specification, maintenance terms defined in BS 3811: 1993 have been used as far as practicable. The British Standard Glossary of Refrigeration, Heating, Ventilation and Air Conditioning Terms (BS 5643: 1984) shall be used as guidance for defining terms in the technical documentation.

The following definitions of terms will apply:

Equipment: Any engineering plant, machine or component

System: A basic concept of equipment or appliances, connected, associated, or independent so as to form a complex unity

Installation: A specific system placed in position and set up for use

Supplier of Technical Manuals (called the **Supplier**): The organisation made responsible for providing the correct documentation (even though the organisation employs an Author to supply this, or to carry out associated work)

Author: The person or organisation that writes, collates and presents the information and produces the final Operating and Maintenance Manual (this could be the Supplier but may be either an independent organisation offering this service or in-house staff of the Installation Contractor or Consulting Engineer)

Client: The purchaser of the installation or installations, or an assignee

Enquiry Specification: The Specification for the technical documentation which is prepared by the Client's professional Advisor and against which selected Authors are invited to Tender

Contract Specification: The Specification as modified by a post-Tender discussion to form the basis of a Contract to cover the technical documentation. It may form part of the Specification for an Engineering Installation.

C3 GENERAL REQUIREMENTS

C3.1 Preparation of the Manual

To ensure that the Operating and Maintenance Manual is available when required, unless otherwise agreed, the information shall be issued in accordance with the programme detailed in Section C3.8.

Responsibility for production of the As-Fitted documentation shall be the responsibility of the primary Mechanical and Electrical Sub-Contractor, who shall nominate an individual within his Company or other organisation to prepare the documentation. The individual or firm appointed to prepare the Operating and Maintenance Manual (subsequently called the Author) shall write, assemble and complete the Manual in accordance with the requirements of this Specification.

In the event of the project being a refurbishment or extension, unless otherwise specified, the Manuals shall either form an Addendum to the existing Manuals or (if the project is relatively minor in nature), additional technical information required as a result of the project works shall be incorporated in the existing Manuals.

Where sufficient generic information exists in retained documentation associated with the building in which the project was carried out, then this shall not be repeated in the addendum. Where existing information for the whole building is no longer appropriate or relevant, this shall be removed from the original manual and replaced with revised information.

C3 GENERAL REQUIREMENTS - contd

C3.1 Preparation of the Manual - contd

Prior to commencement of production of the Manual, the Author shall confirm with the Client's Advisor whether the Manuals are to be:

- Entirely new and standalone
- Written as an Addendum to the existing Manuals
- Integrated with the existing Manuals

C3.2 Writing Style and Use of English

All documentation shall be in plain English. The text of descriptive sections shall be concise and complete. The overall aim of the document shall be to provide clarity in conjunction with brevity on a need-to-know basis. All new terms shall be defined when first introduced. Where appropriate, terminology shall accord with BS 3811: 1993 and BS 543: 1984.

Abbreviations shall only be used once their meaning has been made unambiguous. Imperatives shall be used for instructions regarding the operation, maintenance and disassembly of Engineering Services.

C3.3 Graphics and Illustrations

All graphical material shall be legible and fully annotated to suit the purpose for which they have been included in the O&M Manuals. Illustrations, drawing and diagrams that are incorporated in the Manual shall be easily understood in conjunction with the supporting text.

Where possible, original artwork shall be used rather than second generation scans. If original artwork cannot be obtained and images are not clear, diagrams and illustrations shall be redrawn if requested by the Client.

Where diagrams are provided in electronic format, the resolution and file format of the imagery shall be agreed prior to Manual production (eg JPEG, TIFF or EPS). Whichever format is used, the name and version of the original software that created them shall be supplied and the O&M Manuals shall include a suitable viewer.

Electronic copies of the As-Built drawings shall be provided in electronic format (CD, DVD or other prevailing technology) and saved in the drawing software package and version as detailed in the Particular Specification.

C3.4 Content, Layout, Indexing and Cross-Referencing

The Manual shall follow the guidance and proformas set out in Part 2 of the BSRIA Guide BG1/2007 Handover, O&M Guides, and Project Feedback. The order of engineering systems will be determined by the Author and submitted for approval to the Client's Representative.

Manuals shall comprise loose-leaf A4 pages on at least 100 gsm paper in four-ring binders constructed from PVC-covered heavyweight card. Dividers between sections and parts shall use stepped, overlapping, printed card.

All Manuals shall be laid out in accordance with Appendix B and have an alphabetical index or indexes. The index(es) should follow the text and comply with BS ISO 999: 1996 Information and Documentation - Guidelines for the Content, Organisation and Presentation of Indexes.

The indexing and cross-referencing included in other parts of the Manual shall be arranged to provide easy access to any required information. Where project Manuals are spread over multiple binders, binders shall be individually numbered; and each binder shall clearly state what is contained in each of the other binders associated with the project.

C3.4 **Content, Layout, Indexing and Cross-Referencing** - contd

The Author shall be responsible for the correction of any errors or omissions in the documentation provided to the Client.

C3.5 **Collection of Information**

Three principle sources of information will be used by the Author:

- The Scheme Designer
- The Installation Contractor/Sub-Contractors
- Equipment Manufacturers and Suppliers

If the project involves refurbishment of or extension to an existing building and the Manuals are to form an Addendum to or be integrated into existing Manuals, then these shall also be obtained from the Client for reference/updating.

The Author will be responsible for ensuring that close liaison is maintained with each of these sources and that they are aware of the information required by the Author. Such liaison will be arranged to give all parties adequate time to collate the necessary information.

The Installation Contractors will provide copies of all orders for plant, equipment and sub-let packages of work to the Author. The Author will ensure that the performance and technical data included within the Manual is for the actual equipment installed by means of a Site Inspection.

The Author shall use all the information provided and such other information believed to be necessary to produce a uniform suite of Operating & Maintenance Manual, modifying information where appropriate to provide a single, uniform presentation for the project as a whole.

C3.6 **Reader Ability**

Upon appointment, the Author shall identify (from the Client's professional Advisor) the intended maintenance strategy for the installation and the level of technical competence and comprehension of the personnel employed. The Author shall prepare the Manual to suit this level of reader and the Manual shall state the reader's assumed level of technical comprehension and competence.

Unless otherwise specified, the personnel expected to use the Manual will be General Technical Staff with broad-based maintenance skills. The Author will provide a ½ day's training in the use of the Manual for searching for specific items, so that the Building Operators will be able to use them after the building is handed over.

C3.7 **Checking and Approval**

The Author shall supply the Client's professional Advisor with a single copy of the first draft of the Manual immediately prior to the commissioning of the installation. The first draft shall contain all the information identified in this Specification, except that unavailable at the time (such as Commissioning Test Results).

The professional Advisor will check the draft and return it to the Author within a period of 2 weeks from the date of despatch by the Author, together with all comments necessary to obtain a final approved document; or, in the case of a Manual with extensive issues to resolve, a schedule of items to address.

C3 GENERAL REQUIREMENTS - contd

C3.8 Issue of Draft and Final Information - contd

The following is a generic programme for the latest that the sections of the documentation (as detailed in Section 7.4 of this document) shall be issued for comment/approval, which shall be adhered to unless otherwise agreed:

- Sections 1-6 8 weeks prior to Handover
- Sections 7 & 8 4 weeks prior to Handover
- Section 9 2 weeks prior to Handover - hand drawn if late changes have occurred
- Section 10 As commissioning and witnessing is carried out - at latest by Handover

All final information shall be collated and updated within 2 weeks of Handover; with final electronic format information issued within 3 weeks of Handover.

In order to ensure that the Client have sufficient drawn information at time of Handover, it is imperative that a set of marked up drawings indicating installation progress and design changes is kept on site and updated as the installation progresses. These drawings will be tabled by the Main Contractor for review at monthly Project Progress Meetings.

C4 THE CONTENT, STRUCTURE AND LAYOUT OF O&M MANUALS

The O&M Manuals for Building Services installations will need to contain information in accordance with the categories scheduled in BS 4884, ie:

1. General Description
2. Contact Details/Contractual and Legal Guides
3. Operating Procedure/Detail Description
4. Maintenance Procedure and Spares
5. Fault Finding Procedures/Remedial Action
6. Health and Safety/Emergency Procedures
7. Equipment/Plant Schedule
8. Manufacturers' Literature
9. As-Built Drawings/Details/Schematics
10. Commissioning Data
11. Disposal Instructions and Modification Information

The following sections describe what is required under each heading.

C4.1 General Description

This section should be kept as brief as possible and provide a general overview of the original design intent (available in outline from the Design Brief and in detail from the Specification). It should include a summary for each engineering system installed, giving:

- The parameters and conditions within which it has been designed to operate a system
- The type of each service (gas, electricity and water) required to operate a system
- The intended method of control

C4.2 Contact Details, Contractual and Legal Guides

The contractual and legal records of an installation should include:

- The name and address of the installation
- Details of Local and Public Authority consents
- Details of the Design Teams, Consultants, Installation Contractors and Sub-Contractors
- Dates for the start of the installation, Handover and expiry of the Defects Liability Period
- Information on all guarantees affecting components, systems and plant items, together with expiry dates and names, addresses and telephone numbers of relevant contacts.

C4 THE CONTENT, STRUCTURE AND LAYOUT OF O&M MANUALS - contd

C4.2 Contact Details, Contractual and Legal Guides - contd

For each item of plant and equipment installed within the building and contained in the list of services covered by the O&M Manual, copies of the following documents should also be provided, where applicable:

- Test Certificates
- Manufacturers' Guarantees and Warranties
- Insurance Inspection Reports
- Safety and Fire Certificates

A clear statement should be made in this section concerning hazards and safety precautions, of which the Operators and Maintainers need to be aware. This should include:

- Any known feature or operational characteristic of the equipment or systems installed which may produce a hazard
- Any known hazards against which protection can be provided
- Any mandatory requirements relating to safety
- Any other safety precautions which should be observed
- Any other relevant warning

C4.3 Operating Procedure/Detail Description

This section should provide a detailed description of each engineering system installed. It should include:

- The system type (such as a cold water supply)
- System location and what it serves
- What the system depends upon in order to function
- Design data, basic design parameters, basic assumptions made during design
- Reasons for selecting particular plant
- Expected service life
- Planned operational efficiency

Instructions must be given for the safe and efficient operation of each engineering system, under normal and emergency conditions. These will be in addition to Manufacturers' literature for plant items and should include:

- A recommended strategy for operation and control
- An outline of the general operating mode
- Control data (location, effect, object, sequence, limits of capability, modes, set points)
- Standard operating and emergency operating procedures, and sequences for start-up, running and shutdown, under normal and emergency conditions
- Interlocks between plant items
- Operating procedures for standby plant
- Precautions necessary to overcome known hazards
- The means by which any potentially hazardous plant can be made safe
- Target figures for both energy consumption and energy costs
- Forms for recording plant running hours, energy consumption and energy costs

C4 THE CONTENT, STRUCTURE AND LAYOUT OF O&M MANUALS - contd

C4.4 Maintenance Procedures and Spares

i) Instructions

The Manufacturer's recommendations and instructions for maintenance must be detailed for each item of plant and equipment installed. Clear distinction should be made between planned tasks (preventative maintenance) and work done on a corrective basis. Instructions should be given on each of the following:

- The isolation and return to service of plant and equipment
- Adjustments, calibration and testing
- Dismantling and reassembly
- The exchange of components and assemblies
- Dealing with hazards that may arise during maintenance
- The nature of deterioration and checks for defects
- Special tools, test equipment and ancillary services

ii) Schedules

Maintenance Schedules should be provided for all preventative maintenance tasks. These should be based on both Manufacturers' recommendations and other authoritative sources (such as Statutory or Mandatory requirements). The Schedules should include:

- Inspections
- Examinations
- Tests
- Adjustments
- Calibration
- Lubrication
- Periodic overhaul

The frequency of each task may be expressed as specific time intervals, running hours or completed operations as appropriate. Collectively, the schedules will form a complete maintenance cycle, repeated throughout the working life of the installation.

The source of the schedules should be stated, and necessary periodic inspections and tests for instance, insurance or Supply Authority purposes should also be noted.

iii) Lubrication

A schedule of all plant requiring lubrication should be provided, together with Manufacturers' recommendations on the type of lubricants and the method and frequency of application. Where a type of lubricant is identified by product name, a generic reference (such as a British Standard) should also be given. Information must also be provided on special requirements for the handling and storage of lubricants.

iv) Parts Identification and Recommended Spares

This should comprise a parts identification list detailing and identifying replaceable assemblies, sub-assemblies and components. It should include Suppliers' recommendations for both spares and running spares (parts required for replacement due to wear or deterioration). Items normally held in stock by a Supplier, or for which a refurbishment service is available, should be identified separately.

C4 THE CONTENT, STRUCTURE AND LAYOUT OF O&M MANUALS - contd

C4.4 Maintenance Procedures and Spares - contd

v) Spares Policy

This section should offer a guide to the setting up of a spares facility including recommended stock levels. It should be prepared after consultation with the Occupier regarding the consequences of failure, risk to core business, and the period of acceptable downtime. It should also take into account Suppliers' recommendations as given above. Again, those items normally held in stock by a Supplier (or for which a refurbishment service is available) should be clearly identified.

C4.5 Fault Finding

Procedures for the logical diagnosis and correction of faults should be provided.

C4.6 Emergency Health & Safety and Procedures

This should include name, address, telephone and fax number, and E-mail addresses of the appropriate contacts in the event of fire, theft or burglary, and gas, electricity or water failures, and leaks. It should also list firms or staff to contact in the event of the failure or breakdown of plant, such as lifts, boilers or pumps. Where applicable, the location of fire-fighting equipment, hydrants and rising mains should be described. Special attention should also be given to hazards particular to the building. Depending on Client Policy, a note of security installations may also be included.

C4.7 Equipment/Plant Schedule

The Type, Model Number and Serial Number of all component items within the system should be listed, together with the names of their respective Manufacturers or Suppliers.

C4.8 Manufacturers' Literature

Details of all Manufacturers and Suppliers of equipment listed in the Manual should be provided, including name, address, telephone and fax number, E-mail contact and website. Any additional information likely to help the building operator make contact with, or obtain advice from; a Manufacturer or Supplier should also be included.

Where appropriate, details of local stockists of spare parts, replaceable assemblies or complete units should also be provided. Details should be arranged in alphabetical order of Manufacturer or Supplier name to provide a logical information retrieval procedure.

A complete set of all Manufacturers' literature should be provided for the plant and equipment installed, and assembled for each Building Services system. This literature should provide the following information:

- Description of the product as purchased
- The cost and date of purchase
- Performance behavioural characteristics of the equipment in use
- Applications (suitability for use)
- Operation and Maintenance details
- Labour, plant, materials and spatial resources required
- Methods of operation and control
- Cleaning and maintenance requirements
- Protective measures
- Labour safety and welfare associated with the equipment
- Public safety considerations

Where the data is not adequately provided in Manufacturers' literature, the author of the O&M Manual should attempt to gather the information. If the information proves unavailable, or if a Supplier is unwilling or unhelpful, this should be treated as a breach of contract.

C4 THE CONTENT, STRUCTURE AND LAYOUT OF O&M MANUALS - contd

C4.9 Plans and Drawings

Where the project affects existing buildings for which records exist, the As-Fitted drawings shall use the existing Record Drawings as their basis; and these shall be requested from the Project Manager before commencing work.

The drawing files will be issued to the Project Team by the Project Manager in the Client standard format/media to be returned in the same format/media once updated. All work undertaken must be clearly shown to enable accurate updating of records in accordance with the requirements of the following sections.

The Client cannot warrant or guarantee the accuracy of drawing files. Checking information and correcting critical dimension and information is the Project Team's responsibility and part of their appointment terms and conditions. Where errors are found to exist between the information received and the building layout and/or services installed, these are to be notified to the Project Manager at the earliest opportunity and instruction as to how to proceed sought.

The Health and Safety File/Operation and Maintenance Manual should contain a complete list of all As-Built drawings. All As-Fitted or As-Built drawings will be supplied in both hard copy form and AutoCAD format (.dwg files) on CD ROM; PKZip or Winzip formats should not be used. The As-Fitted drawings supplied in AutoCAD format shall be true representation of the hard copy drawings supplied.

Where the As-Built CAD drawings are not available at the Handover meeting, or if the project has a phased Handover, at (each) Handover, 2 No sets of hard copies shall be passed hand marked up to clearly show all the changes between the latest set of CAD drawings and the installation.

The Contractor shall ensure that all software used is fully converted to be compatible with the Client's software currently in use.

C4.10 Commissioning Data

The results of all commissioning work and associated tests should be given; this should include:

- Measured data
- Measurement points
- Test equipment used
- Details of Calibration Certificates
- A statement of whether design requirements were achieved

The Commissioning Certificates shall include plant data such as Model, Type and Serial Number. To enable crosschecking against As-Installed Data Sheets, this information shall also be provided in Excel format such that it can be easily transferred into an Asset Database.

C4.11 Disposal Instructions and Modifications Information

Where relevant, information should be provided on the following details:

- Any known dangers likely to arise during the disposal of specific items of plant or equipment, together with the necessary precautions and safety measures
- Methods for safely disposing of or destroying the equipment or parts thereof, including packing, insulation and fluids
- Sources from which further advice can be obtained
- Recycling information for the specific item of plant

Modifications are authorised changes which affect safety, reliability, operation or maintenance of a system or any of its components.

C4 THE CONTENT, STRUCTURE AND LAYOUT OF O&M MANUALS - contd

C4.11 Disposal Instructions and Modifications Information - contd

Information on permitted plant, or system modifications allowed for by Manufacturers or System Designers, should be included for each system. Space must be provided in the Manual for the recording of all modifications and changes as they occur (this would initially comprise a series of appropriately headed blank pages). Furthermore, it is essential that a procedure is devised and incorporated to ensure that all modifications are noted in every copy of the Manual, wherever they are located.

C5 DRAWING RECORDS GENERALLY

C5.1 Drawing Content

i) Mechanical layout drawings should show:

- The size and route of ductwork and pipework
- The arrangement of plant in Plantrooms, including the identity, size and rating of plant
- The identification and location of services concealed within the building structure or buried underground, including the depth and point of entry to the building of services
- The location and identification of pipework regulating, isolating and control valves
- The location and identification of regulating and fire/smoke dampers, and access points
- The location of silencers, grilles, diffusers and terminal units
- Details of vibration dampers

ii) Mechanical schematic drawings should detail:

- All ducting, piping and plumbing systems, including flow rates, temperatures and pressures
- The arrangement of control systems including sensors, field controllers, outstations and control panels

iii) Wiring and Controls Drawings should be provided for all equipment which should indicate:

- The origin, route and destination of each cable
- The conductor size and number of cores, insulation type & rating, cable BS or industry code
- Cable identification method and colour
- Joints and draw boxes
- Power supply cables and their fuse reference
- Location and type of sensors

iv) Electrical layout drawings should show:

- HV/LV switchboards & equipment
- Primary cable/trunking distribution routes
- Distribution switchgear & Distribution boards
- Trunking tray and ladders in Switchrooms and Plantrooms
- Single and three-phase wiring and cable routes, including sub-circuits
- Isolators, starters, socket outlets, control equipment and other associated equipment
- Lighting configuration, including distribution boards, switch locations and circuit ID.
- Emergency lighting luminaires and supply circuits
- Lightning conductors, air terminals, earth electrodes, test clamps, earth tapes & terminals
- Cables providing specialist earth circuits
- Telephone (voice) and IT (data) cabling
- The identification and location of cabling concealed within the building structure or buried underground, including the depth and point of entry to building of cabling
- Cable origin, path, destination, loading, conductor metal and size, insulation type and colour (if required for identification), number of cores in cable, number of cables in trunking
- Whether cables, conduit and trunking are concealed in wall chases, screed, cast in-situ or run on the surface
- The location, route and depth of underground cables

C5 DRAWING RECORDS GENERALLY - contd

C5.1 **Drawing Content** - contd

v) Electrical schematic drawings should detail:

- Electrical systems, including cable size, type and number of cores
- Fire alarm systems
- Emergency lighting
- Other ancillary systems, such as security and public address systems

vi) Production Drawings of factory-built equipment - should form part of the Record Drawings.

C5.2 **Drawing Set Up**

The drawings are to be in AutoCAD format and must be virus checked. Raster images, hard copy, scanned images are not acceptable. Each drawing shall be created as a separate CAD file and carry a filename that is both unique and identifies the drawing.

All drawings are to be contained within their own drawing border suitably completed. Where Client drawing borders are used, all attributed data to be completed in order for drawing details to be imported into Automanager Workflow.

A basic layer standard has been established requiring a 'named layer', which consists of a general prefix and a name indicating the element so that layers can be readily recognised and filtered as scheduled below. Text layers should also be created where text is discipline specific; all associated text to be included on the associated layer. Only those layers actively used on a drawing are to existing in the AutoCAD file, switched on, thawed and unlocked, with the drawings purged of all unused or empty layers. Should additional layer names be created, they should be consistent throughout the project.

C5.3 **Line Definition, Text and Scale Standards**

Drawings that are required to be plotted in colour should be created with a specific plot style. This should be consistent across the project and should be supplied when drawings are distributed.

Line types should be standard AutoCAD line types; and Ltscale needs to be kept to a standard setting to maintain uniformity of appearance between drawings.

The AutoCAD font ROMANS.shx should be used in all drawings. Alternative standard AutoCAD fonts may be used to emphasise particular aspects on the drawing. Dimensions and general notes should be 2.0 mm or 2.5 mm, sub-headings should be 3.5 mm high and main headings should be 5.0 mm high.

All scale drawings must be created at 1:1 (full size) and even where paper space is being used, the model should still be at 1:1. Where scale drawings are created, text heights and other variables such as Ltscale and Dimscale need to be altered to suit as follows:

Drawing Scale	Lt Scale	Dim Scale	General Text and Dimensions		Sub-Headings 3.5 mm Text	Main Headings 5.0 mm Text
			2.0 mm	2.5 mm		
1:1	10	1	2	2.5	3.5	5
1:20	200	20	40	50	70	100
1:25	250	25	50	62.5	87.5	125
1:50	500	50	100	125	175	250
1:100	1000	100	200	250	350	500
1:200	2000	200	400	500	700	1000

C5 DRAWING RECORDS GENERALLY - contd

C5.4 Layering Convention

The standard layer convention does not determine the allocation of screen colours or line types to any particular layer, but these should be determined in accordance with the line definition described herein.

Prefix Layer Usage

B Building; Walls, Doors, Windows, etc
E Electrical Services
F Furniture and Fittings
G General; Title Blocks, Grids, etc
M Mechanical Services; HVAC, etc
S Substructure; Piles, Foundations, etc
X External Services; Road, Survey Data, etc

An index should be provided of all As-Fitted drawings supplied during the installation process, identified by number and title. The index should also include a Schedule of Drawings issued by Manufacturers and Suppliers during the course of the installation work, such as control panel wiring diagrams. Refer to the following sections for the specific requirements of the drawings.

List of Layer Definitions (Abridged)

Layer Name	Layer Usage		
0	AutoCAD Block Insertion	F_KITCHEN	Kitchen, Bar and Vending Fittings
		F_SANITARY	Sanitary Fittings
B_SHELL	Building Shell (M&E Services)		
		G_DWGSHT	Drawing Sheet
E_ALARM	Nurse Call	G_DIMENSION	Dimensions
E_COMM	Comms and Telecomms	G_GRID	Grids
E_EARTH	Earthing	G_TEXT	Text
E_EHV	Extra high Voltage >3000v	G_UPDATE	Drawing Update (temp layer green)
E_HV	High Voltage 650 – 3000v	M_AIR CON	Air Conditioning
E_LV	Low Voltage 250v max	M_GASES_MED	Medical Gases
E_ELV	ELV 50 – 250v max	M_GASES_NAT	Natural gases
E_MV	MV 250 – 650v max	M_GENERAL	Heating
E_FIRE_LEGEND	Fire Legend	M_PLUMB	Plumbed Services
E_FIRE_ALARM	Fire Alarm System	M_STEAM	Steam Main
E_FIRE_APPLIANCE	Fire Appliances	M_CWM	Cold Water Main
E_FIRE_ESCAPE	Fire Escape Routes	M_GEOTH	Geothermal
E_FIRE_STRUCTURAL	Fire Doors etc	M_VENTILATION	Ventilation
E_FIRE_ZONE_LEGEND	Fire Zone Legend	M_DRAINAGE	Drainage
E_FIRE_ZONE1 etc	Fire Zones		
E_GENERAL	General - Electrical	X_DRAIN	Land Drainage
E_LIGHT	Lighting	X_DUCT	Duct ways, Subways
E_POWER	Electrical Power Supply	X_GENERAL	General – External Works
E_SECURITY	Security Systems	X_SERVICE	Engineering Services
E_TRANSPORT	Lifts, Escalators etc	X_SURVEY	Survey Information
E_TRUNKING	Trunking		

C6 MECHANICAL RECORDS

C6.1 Documentation

Documentation should record the following as installed:

a) The location, including level if buried, of all public service connections (eg fuel, gas and cold water supplies) together with the points of origin and termination, size and materials of pipes, line pressure and other relevant information.

b) The layout, location and extent of all piped services showing pipe sizes, together with all valves for regulation, isolation and other purposes as well as the results of all balancing, testing and commissioning data.

c) The location, identity, size and details of all apparatus and control equipment served by, or associated with, each of the various services together with copies of any Test Certificates for such apparatus where appropriate. The information with respect to size and details may be present in schedule form.

d) The layout, location and extent of all air ducts showing dampers and other equipment, acoustic silencers, grilles, diffusers or other terminal components. Each duct and each terminal component should be marked with its size, the air quantity flowing and other relevant balancing data.

e) The location and identity of each room or space housing plant, machinery or apparatus.

C6.2 Drawings

Drawings should record the following as installed:

a) Detailed general arrangements of Boiler Houses, machinery spaces, air handling plants, Tank Rooms and other plant or apparatus, including the location, identity, size and rating of each apparatus. The information with respect to the size and rating can be presented in schedule form.

b) Isometric or diagrammatic views of Boiler Houses, Plantrooms, Tank Rooms and similar machinery, including valve identification charts. It is useful to frame and mount a copy of such drawings on the wall of the appropriate room.

c) Comprehensive diagrams that show power wiring and control wiring, including size, type of conductor or piping used and identifying the terminal points of each.

C7 ELECTRICAL RECORDS

C7.1 Documentation

Documentation should record the following, including locations, as installed:

a) Main and sub-main cables showing origin, route, termination, size and type of each cable; cables providing supplies to specialist equipment, eg computers, should be identified separately.

b) Lighting conduits and final sub-circuit cables showing origin, route, termination and size of each, together with the number and size of cables within each conduit. The drawings should indicate, for each conduit or cable, whether it is run on the surface or concealed, eg in a wall chase, in a Floor screed, cast in situ, above a false ceiling, etc. These drawings should also indicate the locations of lighting fittings, distribution boards, switches, draw-in boxes and point boxes, and should indicate circuitry.

C7 ELECTRICAL RECORDS - contd

C7.1 Documentation - contd

c) Location and purpose of each emergency lighting fitting, including an indication of the circuit to which it is connected.

d) Single and three-phase power conduits and final sub-circuit cables showing locations of power distribution boards, motors, isolators, starters, remote control units, socket outlets and other associated equipment.

e) Other miscellaneous equipment, conditions and cables.

f) Lightning conductor air terminals, conductors, earth electrodes and test clamps.

g) Location of earth tapes, earth electrodes and test points other than those in f); cables providing each circuits for specialist equipment, eg computers, should be identified separately.

Documentation should also include, when applicable:

h) Distribution diagrams or schedules to show size, type and length (to within 1 m) of each main and sub-main cable, together with the measured earth continuity resistance of each.

i) Schedule of lighting fittings installed, stating location, Manufacturer, type or catalogue number, together with the Manufacturer's reference, voltage and wattage of the lamp installed.

j) Schedule of escape and emergency lighting fittings installed, stating location, Manufacturer, type or catalogue number, together with the Manufacturer's reference, voltage and wattage of the lamp installed. For battery systems, the position of the battery, its' ampere hour rating and battery system rated endurance in hours should be stated.

k) Records of smoke detectors, sprinklers, fire precautions generally, as well as security precautions (see BS 8220: Part 1).

l) Incoming supply details; the type of system, voltage, phases, frequency, rated current and short circuit level, with the details of supply protection and time of operation as appropriate.

m) Main switchgear details; for purpose-made equipment this should include a set of Manufacturer's drawings and Site Layout.

n) Transformer, capacitor and power plant details; the leading details should be given, eg for transformers, the V.A rating, voltages and type of cooling.

o) Completion Certificate, according to IEE Wiring Regulations.

C8 COMMUNICATION SYSTEMS RECORDS

C8.1 Application

The detailed recommendations given in this sub-Clause apply primarily to telecommunication, intercommunication and paging systems but much of it is also applicable to more sophisticated information systems.

C8 COMMUNICATION SYSTEMS RECORDS - contd

C8.2 Drawings

Drawings should be in accordance with the provisions of C5 as appropriate, and should show the following as installed:

a) Telephone extension wiring, exchange lines and all other similar communications cable for direct speech intercommunication systems, and the following for digital data communications:

i) Details of cable routes, sizes and types of conduits and ducts; number of cable pairs fitted for immediate use, and also spare ways; joint boxes, sub-distribution frames and extension instruments or other terminal apparatus (circuit reference numbers should be shown)

ii) In the case of digital communication cabling, detail of the type of cable in use (eg twisted pair, fibre optic, etc), and the type of wall mounting outlet (ie simple type or loop-around)

iii) Floor plans of Equipment Rooms showing location and type of equipment; main distribution frame; batteries and charging equipment; operators' consoles and all associated cabling, trunking and ducts (any special provision such as anti-static or computer Flooring should be noted and Floor plans should also include details of any switching or processing equipment associated with direct speech telecommunication or digital data communication systems)

iv) Radio paging and loop systems, including routes and details and the location and details of equipment

APPENDIX D

PRE-CONSTRUCTION INFORMATION FORM

Client	**National Oceanography Centre, Southampton**		
Project	**Aquarium Seawater Circulation System Modifications**		
Job No **J2180202/3AB**	Completed By	Date **6th March 2018**	

Pre-Construction M&E Engineering Information Form - Sheet 2 of 32

Item		Comments
1.0	**DESCRIPTION OF PROJECT**	
1.1	**Name**	Aquarium Seawater Circulation System Modifications
1.2	**Location**	NOCS Levels 0 & 1, MEDA 492
1.3	**Description of the Works**	Refurbishment of Aquarium Seawater system
1.4	**Mechanical Engineer Details**	
1.5	**Electrical Engineer Details**	
1.6	**Existing Records and Plans**	
1.6.1	Existing Mechanical O&M Manual:	Yes obtained from NOCS Estates Department
1.6.2	Existing Electrical O&M Manual:	Yes obtained from NOCS Estates Department
1.6.3	Existing Main Services Drawings:	Yes obtained from NOCS Estates Department
2.0	**THE SITE ENVIRONMENT**	
2.1	**Location of Existing Primary Services (Buried/Overhead, etc)**	
2.1.1	Oil:	Not in our precise location but present onsite.
2.1.2	Gas:	Yes
2.1.3	Water:	Yes
2.1.4	Electrics:	Yes
2.1.5	Communications:	Yes
2.2	**Details of Existing Primary Services**	
2.2.1	Oil:	None in the laboratory
2.2.2	Gas:	To laboratory outlets
2.2.3	Water:	To laboratory outlets
2.2.4	Electrics:	N/A
2.21.5	Communications:	Data and telephone

Pre-Construction M&E Engineering Information Form - Sheet 3 of 32

2.0	**THE SITE ENVIRONMENT** - contd	
2.3	**Details of Existing and New Mechanical Services**	
2.3.1	Heating:	To existing radiators and heated air supply - existing
2.3.2	Cold Water:	Yes to sanitary ware - existing
2.3.3	Hot Water:	Yes to sanitary ware - existing
2.3.4	Chillers:	Yes main primary units at energy centre - existing
2.3.5	Air Conditioning (Refrigerant):	Yes to cold room - existing
2.3.6	Drainage:	Yes to sanitary ware - existing
2.3.7	Ventilation:	Yes to laboratory - existing and new extension to cold room
2.3.8	BMS:	Yes trend - existing
2.3.9	Medical Gases:	N/A
2.3.10	Industrial Gases:	Yes – existing
2.3.11	Sprinklers:	No
2.4	**Details of Existing and New Electrical Services**	
2.4.1	Mains Power:	Reconnection of power to new motors
2.4.2	Lighting:	Existing
2.4.3	Fire Alarm:	Existing
2.4.4	Nurse Call/Panic Alarm/ Disabled/Refuge:	Existing
2.4.5	Voice/Data:	Existing
2.4.6	Security/Access/CCTV:	Existing
2.4.7	Lightning Protection:	Existing
2.4.8	Radio/TV/AV:	Existing
2.4.9	Lifts/Escalators:	Existing
2.4.10	Generators:	Existing
2.4.11	UPS:	Existing
2.4.12	IPS:	N/A

APPENDIX E

PHOTOGRAPHS

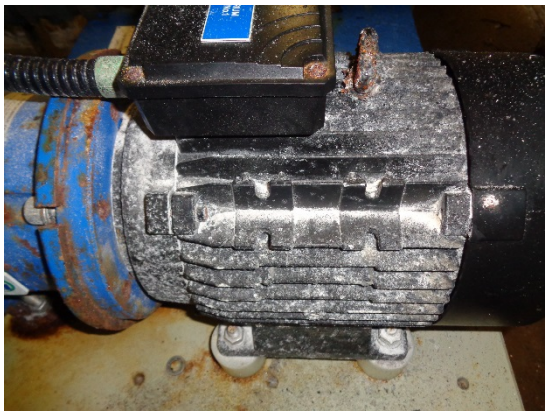
APPENDIX E - PHOTOGRAPHS

Laboratory & Aquarium Seawater Pumps

External Fill Point

Corrosion on Laboratory Seawater Pumps

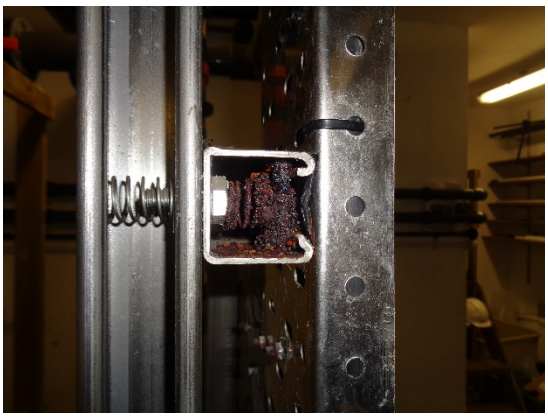
Corrosion on Seawater Holding Tank Connections



Corrosion on Aquarium Pump Motors

Typical Corrosion on Fixings

Corrosion on Pipe Connector



Typical Corrosion on Brackets

APPENDIX E – PHOTOGRAPHS - contd

Typical Corrosion on Brackets in External Hatchery

Typical Corrosion on Pipe Bracket

Corrosion on Control Sensor

Corrosion on Flow Meter Fixings

Corrosion on Flow/Return Sensors & Pipe Bracket

Corrosion on Pump Pressure Differential Switch

APPENDIX F

AS-FITTED DRAWINGS

EM001 – Aquarium Level 2 Seawater Layout
EM002 – Aquarium Level 1 Seawater Layout
EM003 – Seawater Schematic (Exc Hatchery)
EM004 – Hatchery Level 1 Seawater Schematic
EM005 – Aquarium Level 2 Seawater Layout as Proposed
EM006 – Aquarium Level 1 Seawater Layout as Proposed