**Technical Support – Work Order Specification**

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| **Title: Provision of Technical Support for the Mechanical Engineering (HVAC Systems) Assessment for GDA of UK HPR1000** |
| 1. Background to the project

ONR is undertaking a phased Generic Design Assessment (GDA) of the UK Hualong Pressurised Water Reactor (UK HPR1000). The Requesting Party (RP) for this reactor design is General Nuclear System Limited (GNS). GNS is a joint venture company of EDF and China General Nuclear Power Corporation (CGN). The RP’s submissions to ONR over the course of GDA will provide increasing detail and evidence as the UK HPR1000 generic design is developed and finalised in line with the UK regulatory expectations. In November 2017, the UK HPR1000 GDA entered its second step, which mainly focuses on an examination of the claims put forward by the RP to establish the basis of the safety case for the reactor. ONR’s Step 2 assessment of the mechanical engineering aspects of the UK HPR1000 design <http://www.onr.org.uk/new-reactors/uk-hpr1000/reports.htm> considered the Preliminary Safety Report (PSR) <http://www.ukhpr1000.co.uk/documents-library/step-2/>. In addition, a number of supporting submissions were also provided to establish the mechanical safety case claims. It should be noted that, in all submissions, there is no specific chapter on mechanical engineering. It is addressed within several chapters that cover specific UK HPR100 systems. Step 3 of the GDA process commenced on 15 November 2018 and is scheduled to last just over one year (13 months).To support ONR’s on-going assessment of the UK HPR1000 design, one of the areas identified as requiring Technical Support Contractor (TSC) support is the mechanical engineering aspects of the heating, ventilation, and air conditioning (HVAC) system(s). Nuclear HVAC systems play an essential role in:* Nuclear safety – containment of nuclear material arising from normal operation and fault conditions.
* Radiological safety – minimising the spread of contamination
* Clean up of plant discharges.
* Monitoring of exhaust air systems.
* Process requirements – cooling, dilution of gases and moisture removal.
* Maintaining plant operating environment – ensuring availability of safety related plant and equipment.
* Asset protection – preventing degradation of installed plant, equipment and building structures.
* Operator working conditions – delivery of clean air and provision of comfortable working environment.

ONR must be satisfied the design of the HVAC systems complies with statutory regulations, meets relevant good practice (RGP) for nuclear power plants and that relevant risks are reduced, or capable of being reduced, so far as is reasonably practicable (SFAIRP).  |
| 1. SCOPE OF THE SERVICES REQUIRED

The TSC is asked to review the mechanical engineering aspects of the current UK HPR1000 HVAC system(s) design against RGP, to identify areas of difference, including a judgement on their significance to nuclear safety. To do this, ONR expects the contractor to undertake three primary activities:Activity 1Consider RGP for HVAC system design and operation in Pressurised Water Reactors (PWRs). This should include the full scope of PWR HVAC system(s) and their key components, e.g. duct work, filtration units, flow control, air handling, performance monitoring and stack monitoring. The breadth and depth of the review needs to take into account the safety functions performed by the HVAC system(s) under consideration and their safety classification. It should be focussed on the design of HVAC systems and their constituent structures, systems and components (SSCs), which play the most significant role in maintaining nuclear safety. The consideration of RGP should be achieved by:* Preparing a summary of RGP, utilising the TSC’s own skills, knowledge, experience and resources. This shall take account of other widely available sources of RGP for nuclear power plant (NPP) HVAC system design. Examples include, but are not limited to:
* International Atomic Energy Agency (IAEA) Safety Standards;
* Western European Nuclear Regulators’ Association (WENRA) Reference Levels;
* International Standards Organisation (ISO) standards for containment and ventilation systems for nuclear facilities; and
* National Nuclear Ventilation Forum guidance: ES\_0\_1738\_1\_issue 1, *Ventilation Systems for Radiological Facilities Design.*
* Specific consideration of current (modern standards) PWR HVAC system design and the safety functions they provide. Unless there are compelling reasons to widen the scope, this should be restricted to PWR designs where the HVAC system(s) performs very similar claimed safety functions to the UK HPR1000.
* Review of any relevant OPEX from NPP HVAC system design and operation. This should include the identification of any specific modifications that have been required.

Activity 2Using the output from Activity 1, assess the mechanical engineering aspects of the current design of the UK HPR1000 HVAC system(s). This shall be based on the relevant ONR Safety Assessment Principles (SAPs) and Technical Assessment Guides (TAGs). The aim is to highlight any significant differences, considering: * Protection and mitigation of design basis accidents beyond design basis and severe accidents.
* Redundancy, diversity, segregation and layout.
* Maintaining suitable environmental conditions for essential safety systems.
* Protection against internal fires, e.g. fire compartmentation and smoke management.
* The role of HVAC systems in decommissioning the nuclear reactor.
* Examination, inspection, maintenance and testing (EIM&T). For example, efficiency testing, filter life and replacement of components.
* Asset management of ageing components.

Activity 3Review and form a judgement on the adequacy of the RP’s safety case submission in consideration of ONR Technical Assessment Guide NS-TAST-GD-051 (The purpose, scope and content of safety cases). The following qualities of a safety case should be assessed:* Intelligible
* Valid
* Complete
* Evidential
* Robust
* Integrated
* Balanced
* Forward looking

In addition to the above, identification of matters that allow the as built design to be realised should be considered. These may be in the form of claims, requirements, assumptions, and commitments etc. which form part of the UK HPR1000 generic safety case. These should be appropriately tracked. An assessment of the adequacy of the RP’s arrangements in this area, from a mechanical engineering perspective, of those related to the UK HPR1000 HVAC system(s) should also be considered. The TSC should note that the RP are in the early stages of developing these arrangements. At this point in GDA, ONR has received a limited amount of information on the design of the UK HPR1000 HVAC system(s). The RP is continuing to develop the UK HPR1000 design and safety case as GDA progresses, which is inextricably linked to developing the design of the HVAC system(s). This includes, but is not limited to, the application of a UK specific plant safety categorisation and classification scheme and developing support system fault analysis.Considering the overall scope of services required for this contract, this will have a minimal impact on the first activity. However, in order for the TSC to adequately scope the assessment of the UK HPR1000 HVAC system(s) required by the second activity, it is paramount these activities have been adequately progressed by the RP. Depending on the finalised programme of submissions for the remainder of GDA, this means this contract is likely to span multiple financial years and run into Step 4 of GDA. ONR has agreed a schedule of assessment deliverables in preparation for Step 3 of GDA. Appendix A provides a list of the RP’s Step 3 submissions pertinent to the mechanical engineering aspects of the design of UK HPR1000 HVAC system(s). Activity 2 will initially be based on this initial list, supported by other relevant submissions as they are developed throughout GDA, to complete the work package. the TSC will be required to: * Familiarise itself with all relevant RP submissions, the UK HPR1000 reactor technology, and the most relevant safety case claims being made on aspects of the mechanical engineering design and performance of UK HPR 1000 HVAC systems.
* Determine, based on the above, an appropriately targeted and proportionate sample to assess the mechanical engineering aspects of the design of UK HPR 1000 HVAC systems. This should include a consideration of all safety related HVAC structures, systems and components (SSCs).
* Review the suitability of any unusual or novel design approaches, e.g. a design that differs noticeably from that adopted for other NPP.

The TSC’s report should make recommendations to ONR where the mechanical engineering aspects of the design and safety justification of UK HPR1000 HVAC system(s) may require enhanced regulatory scrutiny as GDA progresses through Step 3 and into Step 4. The aim of this work package is to inform and advise ONR. However, it is ONR’s intention to brief the RP on the conclusions of the work. The RP will be provided with copies of any reports produced for information and will be invited to comment on their factual accuracy.ONR’s preference is that a single report is provided, detailing the full scope of work undertaken. However, ONR is flexible and, at the discretion of the TSC, two reports may be produced, i.e. one for each Activity. ONR is content to receive and review partial drafts at suitable points in the programme. The final report(s) shall address ONR’s comments and should be suitable for publication with minimal redaction. ONR does not intend to publish any reports produced through this contract. However, it is likely they will be referenced in publically available reports and therefore subject to freedom of information requests. This should not constrain or limit the reports produced but should be taken into account of (e.g. style and format).As part of this work, the successful TSC should plan to attend six meetings with ONR and the RP at its offices in London, to discuss relevant aspects of HVAC system design. The successful TSC will be provided with any relevant UK HPR1000 information supplied to ONR during GDA. It should be noted the RP’s submissions contain proprietary information, which shall be handled appropriately (see Section 9).To be able to undertake the required activities, the scope of work should also include, where appropriate:* The identification of any necessary UK HPR1000 information required from the RP. ONR will formally submit these to the RP as Regulatory Queries (RQs), but the contractor is expected to identify the information required.
* Review part, or all of, any responses provided by the RP in answer to any RQs raised in conjunction with completing the work described above.
* Regular brief progress meetings will be required during the course of the contract, mainly *via* teleconference or at ONR’s offices. These should be no more frequent than bi-monthly and minimal travel is required.

In summary, the key activities required to be able to complete the scope of work requested include: * Attend an initial start-up meeting at ONR’s offices in Bootle to discuss and agree the final scope of the work package.
* Produce a detailed work plan including full details of work package, timescales, invoice schedule and staff details for approval.
* Determine RGP for the mechanical engineering aspects of PWR HVAC system design and operations. This should utilise the contractor’s own knowledge and resources, ONR’s and other sources of relevant standards and guidance, information from other similar facilities and OPEX, as appropriate.
* Determine an appropriately targeted and proportionate sample to assess the mechanical engineering aspects of the design of UK HPR 1000 HVAC systems, and secure ONR’s acceptance of the scope of the proposed technical review/assessment.
* Assess the RP’s GDA submissions related to the mechanical engineering design aspects of the UK HPR 1000 HVAC systems, against RGP and ONR SAPs and TAGs, highlighting any significant differences and providing a view on their significance to nuclear safety.
* Attend up to six meetings with the RP and ONR, at the RP’s offices in London.
* Draft RQs and judge the adequacy of the RP’s responses.
* Produce a final report including full details of the work undertaken, references used, conclusions reached and recommendations. The report shall incorporate ONR comments, will be shared with the RP, and should be suitable for publication, if required.
* Provide monthly written progress reports for the duration of the contract. It is expected that a meeting (e.g. teleconference) will also be required to discuss points of clarity and identify any issues affecting delivery of the work programme.

In support of this work, the contractor shall:* Obtain ONR acceptance to the technical review scope, supporting programme and project costs.
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| 1. OBJECTIVES

The service deliverable shall be a single report identifying RGP for the mechanical engineering aspects of modern standards PWR HVAC system(s), combined with a review of the extent to which the UK HPR1000 HVAC system design meets RGP. The report should identify and explain any shortfalls that may exist and explain their impact on nuclear safety. The report should make recommendations to ONR for where the mechanical engineering aspects of the design, and safety justification of, UK HPR 1000 HVAC system(s), may require enhanced regulatory scrutiny as GDA progresses through Step 3 and into Step 4.Ultimately, ONR will use the outputs from this contract to:* judge if the claims, arguments and evidence presented by the RP for the mechanical engineering aspects of the UK HPR 1000 HVAC system design are adequate and can be substantiated;
* be satisfied the RP’s approach to the mechanical engineering design aspects of the UK HPR 1000 HVAC system meet RGP when judged against comparable reactor technologies and the expectations presented in our SAPs, TAGs and other relevant standards; and
* make a judgement whether relevant risks have been, or are likely to be, reduced SFAIRP.
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| 1. CONSTRAINTS

The following programme constraints shall apply:* The work is expected to start in January/February 2019 and to conclude in the first half of Step 4 of GDA (Step 4 is scheduled to commence in November 2019 and will last approximately 24 months). The TSC should plan on the understanding the precise end point for the work may be determined by the schedule of the RP’s relevant submissions being made to ONR during Step 4 of GDA, which is yet to be agreed. ONR will keep the TSC suitably informed as the RP’s programme develops.
* The agreed dates for HVAC-related submissions for the GDA Step 3 submission schedule for mechanical engineering will influence the precise timings for progressing review and assessment activities. The anticipated delivery dates for relevant Step 3 submissions are provided in Annex A. The successful contractor should use these dates for planning purposes, with the understanding they are potentially subject to change. The baseline programme for mechanical engineering Step 3 submissions will be agreed and issued by 30 November 2018.
* At this point in GDA, the RP is continuing to develop the UK HPR 1000 safety case. This captures important aspects related to this scope of work, including supporting system fault analysis and the application of a UK specific safety categorisation and classification scheme. Both of these activities will need to have reached a suitable of level of maturity to enable the contractor to adequately scope the assessment of the RP’s relevant HVAC submissions. ONR will advise the TSC when relevant parts of these activities are likely to be completed by the RP.

The following conflict of interest constraints shall apply* The contractor shall ensure that, insofar as is possible, the work is undertaken in a manner whereby there is no conflict of interest with GNS, CGN or EDF.
* Any individual or company related conflicts of interest should be declared. Please complete Schedule B as appropriate.

The following working constraints shall apply:* Where applicable, the contractor (and its sub-contractors), shall provide assurances that it has, or is able to obtain, all necessary export control licenses for the transfer of relevant information out of the UK, and its return.
* Working locations must have adequate security provisions for the handling of the documentation bearing the UK protective marking OFFICIAL – SENSITIVE or equivalent. This is a prerequisite to placement of contract.
* The transmittal of all documents between ONR and the contractor will be through ONR's Joint Programme Office (JPO). This will be through encrypted DVDs, regardless of the security marking. The exception to this is documents that are publically available on the internet.
* There are no constraints as to where the work will be undertaken. However, contractor personnel must be available to respond to emails and telephone calls during normal working hours. They must also be able to attend face-to-face meetings subject to a reasonable period of notice.
* Where ONR requires the contractor’s personnel to attend meetings, travel and subsistence will be reimbursed at cost to ONR, following the initial outlay by the contractor. Meetings will be held at a suitable UK location. It is expected that the majority of the meetings with the RP will take place in London. Some meetings may be held at ONR’s offices in Bootle.

ONR expects individuals providing the technical support to have the following attributes:* Knowledge and experience of design and installation of HVAC system within nuclear facilities.
* Knowledge and experience of nuclear safety cases. Individuals should understand the link between the safety analysis and the mechanical engineering SSCs that delivery safety.
* Knowledge and experience of engineering substantiation of nuclear HVAC systems.
* Knowledge and experience of applying RGP for nuclear HVAC systems.
* Knowledge and understanding of the relevant UK health and safety regulations applicable to the design, installation and use of HVAC systems.
* Knowledge and understanding of relevant ONR SAPs.
* Knowledge and understanding of relevant ONR TAGs.

It is desirable that individuals providing the technical support have experience of the following:* Active participation in the National Nuclear Ventilation Forum
* Attendance at the National Glovebox Forum
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| 1. CONTRACT MANAGEMENT

A contract start-up meeting shall take place at ONR’s offices at Bootle. The cost of attendance shall be included in the contract value.ONR shall be kept informed about progress and delivery of the specified work via monthly reports. These reports will be discussed at monthly progress meetings arranged by the ONR Project Office. |
| **TECHNICAL RESPONSE** |
| 1. Response

The Technical Response should demonstrate a clear understanding of the work required.Please provide: * a description of how you will deliver the scope of work (methodology) and the proposed delivery team you will use, clearly signposting to relevant sections within your Capability Prospectus where appropriate/relevant
* a description of proposed deliverables and/or outputs
* an outline of anticipated engagement (project meetings & management)
* details of proposed cost and associated effort assumptions
* a project delivery plan showing activities and milestones
* a planned invoice schedule
* details of any assumptions or constraints
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**APPENDIX A: Step 3 Mechanical Engineering HVAC-related submissions**

A.1 The Requesting Party (RP) has identified 18 HVAC systems, which are presented in the PCSR.

PCSR Sub-chapter 10.6

* Nuclear Auxiliary Building Ventilation System (DWN) [NABVS]
* Fuel Building Ventilation System (DWK) [FBVS]
* Containment Cooling and Ventilation System (EVR) [CCVS]
* Containment Internal Filtration System (EVF) [CIFS]
* Containment Sweeping and Blowndown Ventilation System (EBA) [CSBVS]
* Annulus Ventilation System (EDE) [AVS]
* Safeguard Building Controlled Area Ventilation System (DWL) [SBCAVS]
* Electrical Division of Safeguard Building Ventilation System (DVL) [EDSBVS]
* Main Control Room Air Conditioning System (DCL) [MCRACS]
* Access Building Uncontrolled Area Ventilation System (DVW) [ABUAVS]
* Access Building Controlled Area Ventilation System (DWW) [ABCAVS]
* Diesel Building Ventilation System (DVD) [DBVS]
* Essential Service Water Pumping Station Ventilation System (DXS) [ESWVS]
* Extra Cooling Water and NI Firefighting Building Ventilation System (DXE) [ECW & FFBVS]
* Waste Treatment Building Ventilation System (DWQ) [WTBVS]
* Safety Chilled Water System (DEL) [SCWS]
* Operational Chilled Water System (DER) [OCWS]

PCSR Sub-chapter 10.7.5

* Smoke Control System (DFL) [SCS]

A.2 The RP’s submission is in three tiers forming the claims, arguments and evidence that make up the safety case and current programme dates (for submission to ONR) are as follows:

**GDA Step 3 Submissions**

Tier 1 – Claims

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| **Document Title** | **Scope** | **Submission** |
| Pre-Construction Safety Report (PCSR) | * Overview
* Demonstration that UK HPR1000 design requirements are met
* Forward Action Plans
 | 31/08/18 |

Tier 2 – Arguments

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| **Document Title** | **Scope** | **Submission** |
| ALARP Report | * Demonstration of ALARP
 | 31/08/18 |
| Cross-Cutting Reports | * Safety categorisation and classification methodology
* General design requirements for protection against internal and external hazards
* Material selection methodology
* Definition of normal operating modes and corresponding parameters
* Decomposition of safety functions
* General safety requirements
* General principles for application of laws, regulations, codes and standards
 | 31/08/18 |
| System Design Manuals | * Overview
* Functional requirements and basis of design
* System and component design
* Layout requirements and environmental conditions
* Operation and maintenance
* Flow diagrams
 | 31/08/18 |
| Equipment Classification Lists | * Classification methodology
* Classifications
 | 31/12/18 |
| System Commissioning Programme | * Commissioning methodology
* System commissioning
* Acceptance tests
 | 15/04/19 |

Tier 3 – Evidence

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| **Document Title** | **Submission** |
| HSG 253 Compliance Analysis | 31/08/18 |
| Relevant Good Practice (RGP) Compliance Analysis* Version 1
* Version 2
 | 31/10/1828/02/19 |
| Applicable codes and standards for mechanical engineering* Version 1 (received in Step 2)
* Version 2
 | 31/10/18 |

**GDA Step 4 Submissions**

Tier 3 – Evidence

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| **Document Title** | **Submission** |
| System classification list | 31/10/19 |
| System pre-service inspection list | 31/10/19 |
| System commissioning programme | 31/10/19 |
| System periodic test completeness note | 31/10/19 |
| Technical specification | 31/10/19 |
| Qualification report | 31/05/20 |
| Calculation report | 31/05/20 |
| Layout drawings | 31/05/20 |
| Equipment operation and maintenance manual | 31/05/20 |
| Design drawings | 31/05/20 |