Title: Electrochemical Process and Equipment Development Framework

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1. Introduction
   1. Specification Outline

The National Nuclear Laboratory supports a wide range of customers and deliver environmentally and financially affordable solutions to some of the biggest challenges of the twenty-first century. We are building on the world-class solutions and successes we have already delivered as part of a new agenda with four Focus Areas: Clean Energy, Environmental Restoration, Health and Nuclear Medicine and Security and Non-Proliferation.

Delivery of sustainable solutions to current and future challenges will include the development of electrochemical processes and equipment. Electrochemical processes offer unique benefits to the constraints that the nuclear industry works under, as they offer can offer efficiency and selectivity benefits over conventional chemical processes. This procurement specification aims to develop a framework contract to allow the selected companies to work with NNL to develop electrochemical processes and equipment. This framework is divided into two lots:

Lot 1 – Practical electrochemistry – the development of electrochemical processes and equipment

Lot 2 – Consultation on electrochemical processes and equipment

1. Scope
   1. Electrochemical engineering

The development of processes in the nuclear industry requires a detailed understanding of chemistry and equipment to ensure that environment, conventual and nuclear safety is maintained. A range of practical electrochemical projects can be foreseen in the future, to deliver these projects a range of expertise are needed. These will include:

* Working with NNL technical and engineering teams to perform optioneering and develop designs (from concept to detailed) for electrochemical engineering solutions. It is highly desirable to have design experience for nuclear applications.
* The development of unique pieces of equipment for the purpose of performing in-house assessment or the supply of equipment to NNL, who would then carry out research and development studies. The equipment must be UKCA marking (CE marking), where appropriate.
* Construct and test process-scale electrochemical equipment for use in nuclear environment.
* Technical input and support for the preparation of safety case related documentation or assessments (e.g. DSEAR assessments, HAZOP workshops etc.), a requirement for use of equipment in a nuclear environment.
* It is essential that the company has staff that could achieve necessary security clearance[[1]](#footnote-2) (if necessary).
  1. Lot 1 : Practical electrochemical engineering

Lot 1 includes the construction and testing of the electrochemical equipment. This is a key step to

the utilisation of equipment in a nuclear environment. Key capabilities and experiences to carrying out practical studies include:

* Technical and practical background in applied electrochemistry.
* Facilities, expertise, and personnel to construct and carry out laboratory or process equipment applied electrochemical studies.
* Analytical equipment and experienced laboratory personnel to allow analysis of samples from electrochemical processes to understand key process parameters.
* Awareness/experience of nuclear engineering design principles.
  1. Lot 2 : Electrochemical consultation

Desk based studies are a key part of the selection and development of an engineering solution and safety case for any new equipment or process in the nuclear industry. There are two main types of desk based studies, including:

* Review of application or process
* Review of process equipment, such as compatibility of materials with process chemistry.
* Involvement in engineering and safety case development process.
  1. Environmental conditions

This is a general framework, so specific equipment environmental conditions are not detailed, several examples are provided.

* The front-end of the nuclear fuel cycle makes extensive use of fluorine chemistry, which requires careful material selection and operating practises.
* Many of the chemical process at the back-end of the fuel cycle operate in nitric acid (0.01-10 mol/l) under reducing and highly oxidising conditions. These conditions are further complicated by trace to high-activities of radioactivity and radiation, which places further demands on materials and operating practices. Radiolysis can lead to enhanced material degradation rates, such as alpha-radiolysis of Nafion separator. Radiolysis of electrochemical processes can produce potentially flammable atmospheres so management of these hazards must also be considered.
* Decontamination process can be carried out in dilute aqueous solutions, complexing media or highly acidic solutions. The radioactivity of items to be decontaminated could range from low contact handle items to high activity and radiation remote access.
* There is an increasing interest in the use of molten salt in nuclear applications. These are typically at high temperatures, >500 °C and are very corrosive in the presence of oxygen and moisture. Handling such materials required specialist equipment and the ability to do this would be a significant advantage.
  1. Mandatory Requirements

Essential requirements:

* Technical expertise in electrochemical process development and manufacture.
* Proven track record at the conducting laboratory scale electrochemical experiments.
* Facilities, equipment and personnel to carry out supporting analysis of samples.
* Proven track record of scale up of electrochemical equipment, testing and deployment.
* Technical staff to carry out technical review of electrochemical application or process.
* Demonstrable expertise to lead or contribute to in engineering and safety case development process.

1. Other Requirements
   1. Security

Some projects may require clearance, for these cases the willingness of the contracting company to undergo security clearance will be essential.

* 1. Maintenance / servicing requirements

A key aspect of the development sustainable solutions is to do develop solutions that fore fill the service lifetime and be maintainable.

1. <https://www.gov.uk/government/publications/united-kingdom-security-vetting-clearance-levels/national-security-vetting-clearance-levels> e.g. BPSS. [↑](#footnote-ref-2)