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TECHNICAL NOTE

IN SUPPORT OF THE MARKET SURVEY FOR THE MANUFACTURING, ASSEMBLY, INSTALLATION, TESTING AND COMMISSIONING OF THE MONORAIL CRANE SYSTEM (MCS) FOR THE ITER NEUTRAL BEAM REMOTE HANDLING SYSTEM

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1 Abstract

This Technical Note presents preliminary information on the future procurement for manufacturing, assembly, installation, testing and commissioning of the Monorail Crane System (MCS), forming part of the ITER Neutral Beam Remote Handling System (NBRHS). The procurement is expected to cover the MCS railway and switching points, driver boxes and penetrations, the Monorail Crane trolley, lifting adaptors, associated electrical and control equipment, dedicated tooling and the activities required to deliver an integrated system at ITER site. The MCS is an under-slung crane operating on a railway network suspended below the Neutral Beam Cell ceiling and is intended to transport and accurately position heavy equipment in a constrained, radiation-exposed environment. The contract will require multidisciplinary industrial capabilities in precision heavy mechanical systems, welded structures, special lifting equipment, electrical and instrumentation systems, nuclear-quality manufacturing, factory acceptance testing and on-site installation.

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4 Introduction to the ITER Project and Fusion for Energy

The ITER project aims to build a first-of-a-kind experimental fusion device, the International Thermonuclear Experimental Reactor (ITER), with the objective of demonstrating the scientific and technical feasibility of fusion power. ITER is a joint project involving the European Union, China, India, Japan, the Republic of Korea, the Russian Federation and the United States of America. The ITER facility is being constructed at Cadarache in southern France.
Most ITER components are manufactured by the participating parties and contributed in kind through their Domestic Agencies. Fusion for Energy (F4E) is the European Union Domestic Agency and is responsible for providing major European contributions to the ITER project.
F4E is preparing a market survey related to the future manufacturing and installation contract for the Monorail Crane System (MCS) of the Neutral Beam Remote Handling System (NBRHS). This note provides preliminary technical information to allow interested economic operators to assess their potential interest and industrial capability.

5 Neutral Beam Remote Handling System (NBRHS) and Monorail Crane System (MCS)

The Neutral Beam systems require remote-handling equipment for assembly, maintenance and replacement activities in the Neutral Beam Cell. The MCS provides overhead handling capability for the transport, lifting and accurate positioning of equipment in a constrained environment. It comprises an under-slung removable crane trolley travelling on a ceiling-mounted railway network, together with switching points, driver boxes and penetrations, lifting adaptors, electrical and control equipment and interfaces to the wider NBRHS.

The principal MCS sub-systems are:

- Railway system (RW), including rail structures[(1)], end stops, temporary extensions where applicable, cable routing and Switching Points (SW).
- Driver Boxes (DB) and associated penetrations transmitting motion to the switching-point mechanisms.
- Monorail Crane trolley (MRC), including long-travel unit, hoisting unit and lifting frame.
- Lifting Adaptors (LA), including the Generic Lifting Adaptor (GLA) and Multipurpose Lifting Adaptor (MLA).
- MCS Control System (CS), including power distribution, cubicles, cabling, controllers, sensors, actuators, camera and lighting functions.
- Crane Deployment Hoist (CDH) and interfaces with other NBRHS and building systems.

(1) The system is based on a traditional 2-rail structure. The monorail naming remained from previous design trade-off phases.

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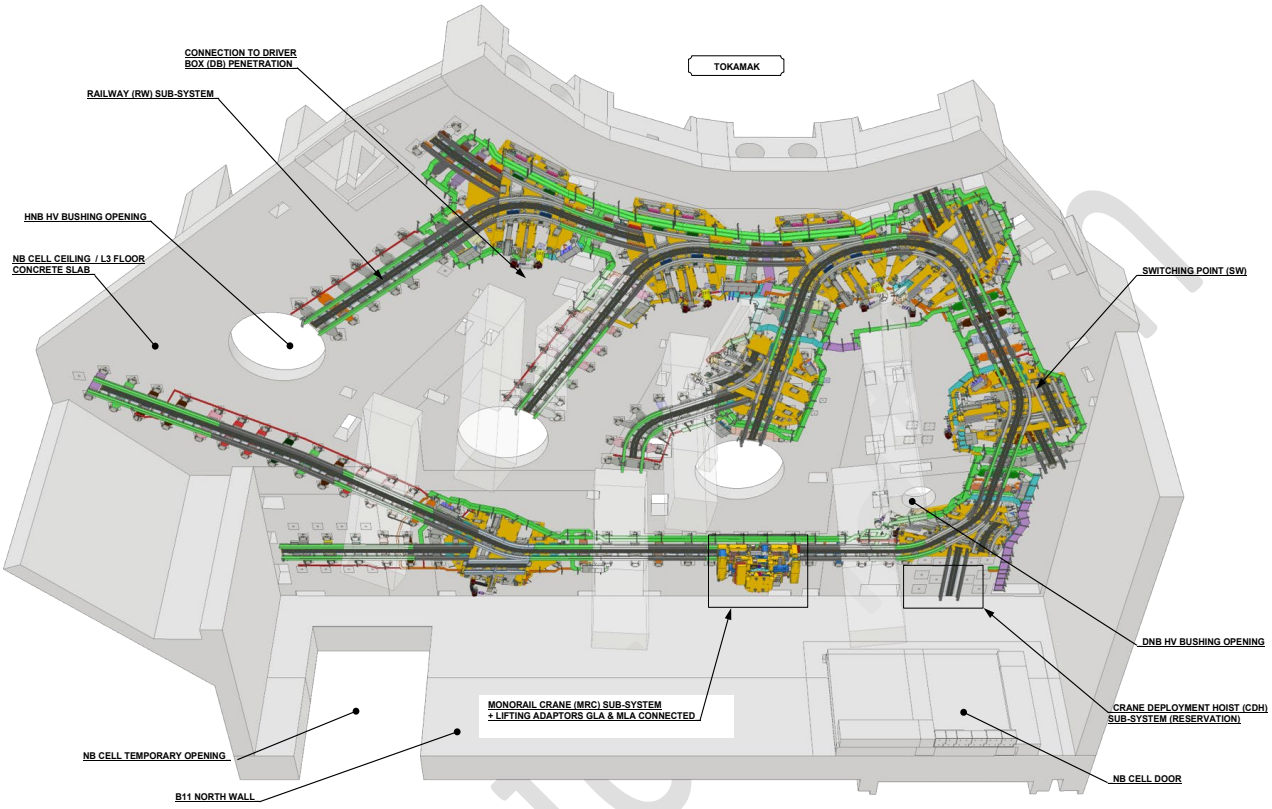


Figure 1: MCS Overview (NB Cell view from below)

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6 MCS Technical Description

6.1 Railway, Switching Points and Driver Boxes

The railway is suspended below the Neutral Beam Cell ceiling at L2 of the Tokamak Building and provides the travelling paths required by the MRC. It is divided into rail segments fixed to embedded plates and includes junctions and switching points allowing the trolley to change route and access the required areas. The railway design includes rail structures, interfaces to embedded plates, end stops, local transitions and provisions for cable routing. The switching system includes eight switching mechanisms in the current design baseline. Each switching point is composed of a mounting plate, switching rail frame and drive system.

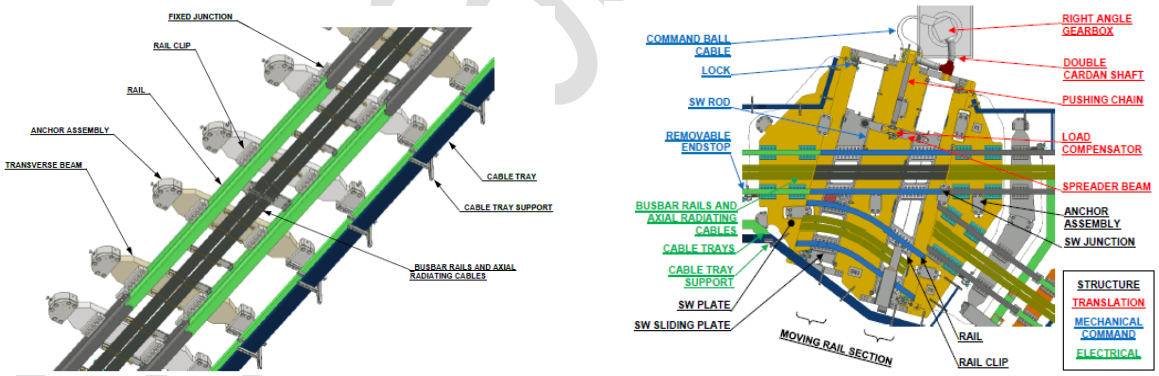


Figure 2: (a) Railway (RW) typical segment assembly (NB Cell bottom view); (b) SW main sub-assemblies

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Driver-box equipment is located above the operating area, with mechanical transmission through penetrations to the switching components below. Certain driver-box and penetration assemblies are classified for nuclear safety and will require the corresponding quality assurance, traceability, inspection and technical-control provisions.

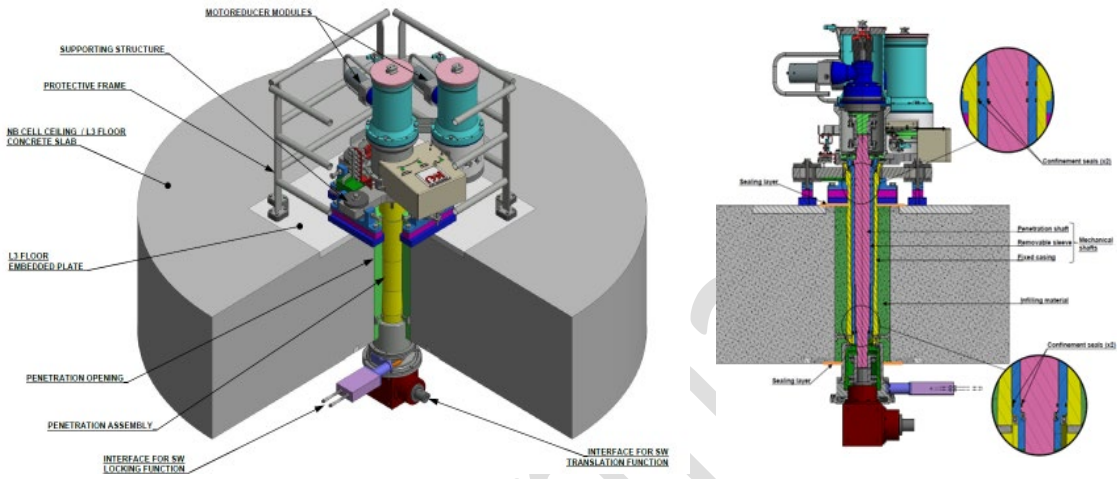


Figure 3: Driver Boxes (DB) global architecture

Manufacturing challenges include control of rail profile and alignment, interfaces between segments, dimensional stability of welded and machined structures, accurate installation relative to embedded plates, repeatability of switching movements and management of tolerances across civil, mechanical and electrical interfaces.
The future supplier is expected to develop and qualify manufacturing and installation processes capable of achieving the specified geometry after fabrication, transport, assembly and site installation. Survey, metrology and adjustment methods will be integral to the proposed industrial approach.

Sub-system	Typical content	Key industrial aspects
Railway (RW)	Rail segments, supports, end stops, temporary extensions	Welding, machining, straightness, interfaces, metrology
Switching Points (SW)	Mounting plates, switching rail frames, locking and drive interfaces	Precision movement, locking, alignment, maintainability
Driver Boxes (DB)	Drive mechanisms and penetration assemblies	PIC controls where applicable, sealing, transmission alignment
Cable routing	Trays, power and control routing provisions	Segregation, accessibility, installation sequence

Table 1: Indicative Main Elements

6.2 Monorail Crane Trolley

The MRC is the removable trolley of the MCS. It consists of the long-travel unit, hoisting unit and lifting frame. The current configuration is approximately 4.1 m long, 2.0 m wide and 1.45 m high, with a mass close to 22 tons, subject to finalization of radiation shielding and component selection. These values are indicative and shall not be treated as final procurement requirements.

The long-travel unit provides guided movement along the railway. The hoisting unit provides lifting and lowering through the required reeving, drives, gearboxes, brakes, drums, couplings and wire ropes. The lifting frame transfers the load to the trolley and includes load monitoring and interfaces to lifting adaptors. Uncoupling devices reduce the transfer of dynamic excitation between the railway and trolley structure.

The design must address heavy-load positioning, geometric constraints, seismic and electromagnetic loads, radiation exposure, rescue and recovery, inspection and maintenance, replacement of on-board equipment, contamination control and compatibility with the operational sequence. Removable shielding is foreseen for non-radiation-tolerant equipment where applicable.

Critical components include wire ropes, hoisting gearboxes and brakes, couplings, load-measuring pins, long-travel and guiding wheels, seals, bushings, friction plates, uncoupling devices, twist-lock actuators and selected lubricants. The procurement strategy may require early qualification or purchase of long-lead items.

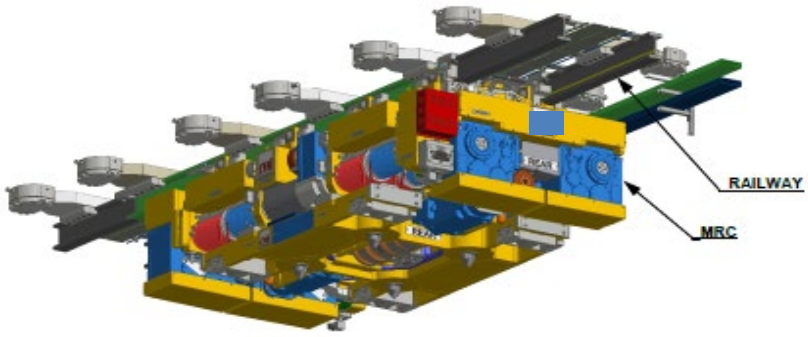


Figure 4: Monorail Crane (MRC) Trolley

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6.3 Lifting Adaptors and Crane Deployment Hoist

Lifting adaptors are stand-alone handling devices connected below the MRC lifting frame to provide dedicated interfaces for specific loads. The current scope includes the Generic Lifting

Adaptor (GLA) and Multipurpose Lifting Adaptor (MLA). Their design includes mechanical load paths, locking interfaces, actuators, sensors, local control equipment and interfaces to the MRC.

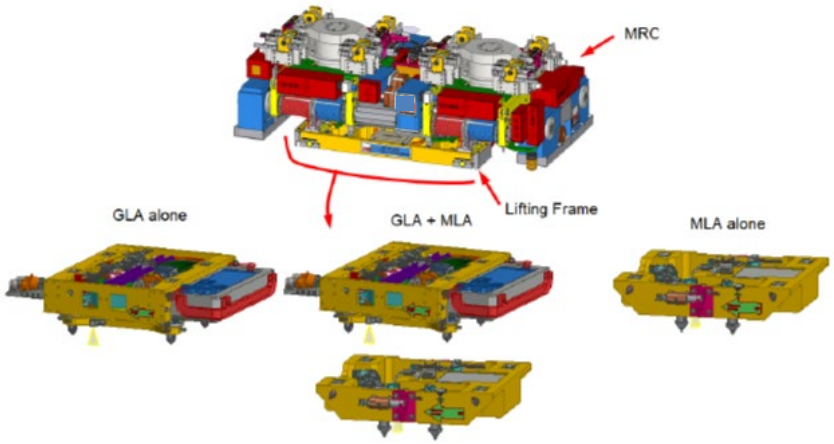


Figure 5: LA / MRC sub-systems interfaces and possible configurations

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The MRC must also be compatible with the Crane Deployment Hoist (CDH), whose function is to deploy or retrieve the trolley onto or from the railway. The CDH manufacturing and installation will be part of the MSC call for tender.

The MCS supplier will manage the mechanical, electrical, control and operational interfaces required for system integration.

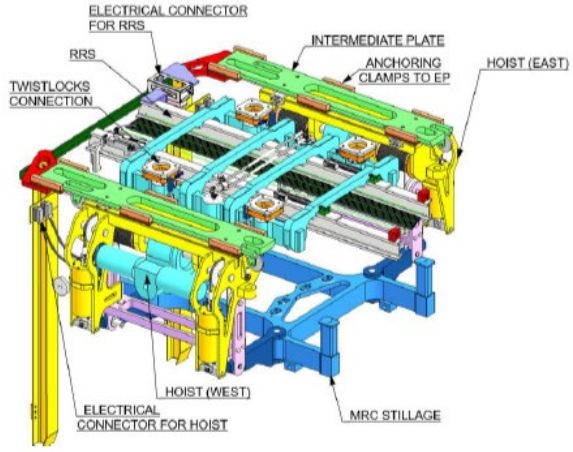


Figure 6: Crane Deployment Hoist (CDH) global architecture

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6.4 MCS Control System

The MCS control system follows ITER remote-handling control principles but is specific to the NBRHS MCS.
It implements a three-layer architecture comprising the High-Level Control System (HLCS), the Low-Level Control System (LLCS), and the field layer of sensors and actuators. It is integrated with the wider NBRHS and ITER control and interlock environment.
The HLCS provides operator functions such as Command and Control with joystick input, operations management, remote diagnostics, virtual-reality support and viewing.
The LLCS comprises power and control cubicles, controllers, I/O, protection circuits, actuator drives, sensor interfaces and communications linking the HLCS to MCS equipment. The field layer includes sensors and actuators on the railway, switching points, trolley, lifting frame and lifting adaptors.
The current LLCS organization includes an MCS Interlock Controller and conventional controllers. Conventional controllers include a Supervisory Controller, Switching Points Controller, MRC Controller and controllers associated with lifting adaptors. The Supervisory Controller provides interfaces to the HLCS and wider NBRHS, routes commands and transfers monitoring data. Interlock and protection functions are segregated according to the applicable architecture and safety requirements.

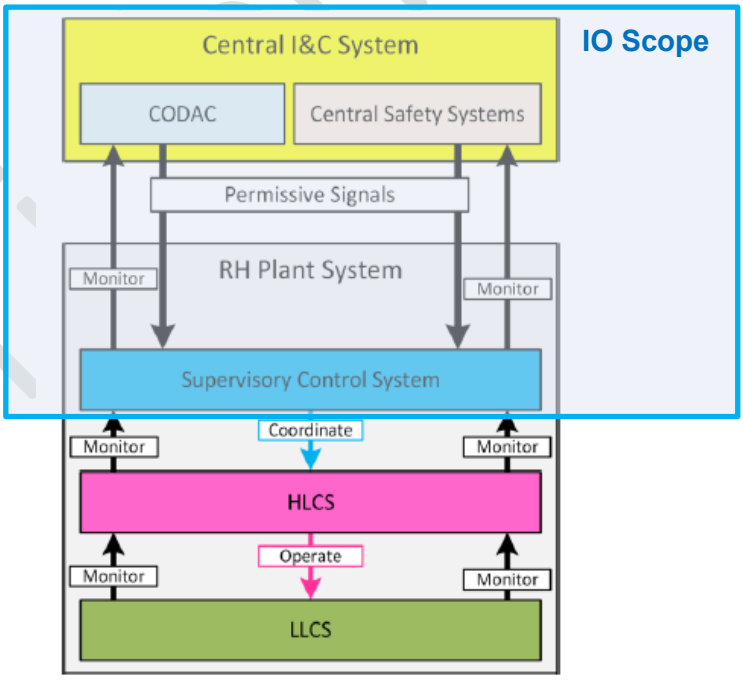


Figure 7: MCS RH Control System Architecture

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The future manufacturing contract is expected to include manufacture, supply, assembly, wiring, configuration, integration and testing of MCS electrical and control hardware, including:

- Power and control cubicles and distributed cabinets on the MRC, lifting frame and lifting adaptors.
- Controllers, I/O modules, sensor drivers, protection circuits, actuator drives, transformers and power distribution.
- Internal and external wiring, cable assemblies, connectors, junctions, routing and radiating cables for communications.
- On-board sensors, actuators, cameras and lighting, including radiation-tolerant equipment where required.
- Software configuration and application integration for control, monitoring, diagnostics, recovery and commissioning.
- Factory and site integration with HLCS, NBRHS supervisory functions, plant interlocks and conventional control interfaces.

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6.5 Manufacturing, Installation and Verification Considerations

The MCS is a multidisciplinary engineered system whose performance depends on the combined accuracy and reliability of structures, mechanisms, lifting equipment, electrical systems, control functions and site installation. The future supplier will establish an integrated manufacturing and installation plan from procurement of raw material through final commissioning.

The manufacturing plan should cover the manufacturing sequence for each main component, make-or-buy strategy, special processes, pre-qualification and qualification, mock-ups or prototypes, inspection and test plans, hold points, critical tolerances, dedicated tooling, non-conformity management, configuration control and preservation during transport and storage. Particular attention is expected for railway system elements precise machining and pre-assembly, welded structures, NDT, bolted joints, coatings/surface protection and electrical assembly. For the lifting adaptors, the plan shall specifically address the GLA fully machined high-strength structural parts, the slewing ring, transversing screw and bogies, twist lock mechanisms, MLA soft-sling hooks, automatic inter-adaptor electrical connectors, radiation shielding, dedicated assembly fixtures and transport stillages.

Factory activities are expected to include dimensional inspection, functional tests of mechanisms, electrical checks, control-system integration, software and I/O tests, load tests where applicable, interface and recovery demonstrations, and a factory acceptance test using representative facilities. Lifting-adaptor acceptance shall include verification of GLA translation and rotation performance, MLA twist lock and sling interfaces, anti-crushing and out-of-range

detection, redundant drive or recovery features, electrical continuity and grounding, connector mating, camera-assisted alignment and regulatory load testing.

On-site activities are expected to include receipt inspection, storage and preservation, transport within the ITER site, assembly and installation of railway and embedded-plate interfaces, switching points and driver boxes, cable routing, cubicles, trolley and adaptors, followed by alignment, connection, testing and commissioning. Site work will take place in a complex environment with co-activity, constrained access, interfaces with civil works and other systems, and applicable Nuclear Safety and site rules.

The installation approach shall be supported by detailed methods, lifting and handling studies, temporary works, access and logistics plans, survey and alignment procedures, inspection records in close coordination with other suppliers and the ITER Organization.

Equipment and commercial tooling used on site are expected to comply with applicable standards, safety requirements and site procedures.

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Expected verification stages

- Material and source inspection
- Manufacturing-process qualification and production controls
- Dimensional inspection and metrology
- NDT and weld acceptance
- Assembly and functional testing
- Electrical, I&C and software integration tests
- Factory Acceptance Test (FAT)
- Transport and receipt inspection
- Site installation, alignment and connection
- Site Acceptance Testing (SAT) and commissioning

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7 Indicative Scope of the Future Contract

The final scope will be defined in the call for tender. For market-survey purposes, the anticipated scope may include the following activities and supplies:

Workstream	Indicative content
Industrialization and manufacturing engineering	Review the final-design data package, complete manufacturing drawings and work instructions where required; confirm manufacturability; establish manufacturing, inspection, test, installation and commissioning plans.
Procurement and manufacture	Procure materials and components; manufacture railway elements, switching mechanisms, driver boxes, MRC, lifting adaptors, cubicles, cables and associated equipment.
Assembly and integration	Perform mechanical assembly, electrical integration, cabling, software configuration and integrated testing. Provide production and test tooling and temporary equipment.
Control system supply	Deliver a functional MCS LLCS and field equipment, integrated with the specified HLCS and plant interfaces.
Qualification and acceptance	Execute qualification, inspections, NDT, load and functional testing, interface tests, FAT and acceptance data packages.
Transport and site installation	Pack, preserve and transport equipment; perform or support receipt, storage, internal logistics, assembly, installation, alignment and connection.
Site testing and commissioning	Perform site acceptance tests and commissioning, including fault resolution, recovery demonstrations and final performance demonstration.
Documentation and certification	Provide acceptance data packages, as-built drawings, records, certificates, manuals, software/source files, maintenance instructions and CE-marking evidence as allocated.
Project, quality and configuration management	Manage schedule, interfaces, requirements, risks, design changes, configuration, quality assurance, nuclear safety requirements and supply chain.

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8 Technical and Industrial Capabilities Sought

F4E intends through the market survey to identify economic operators, including possible consortia and supply chains, with relevant capability for complete or partial execution of the anticipated scope. Respondents should identify work packages they could perform directly and those requiring partners or subcontractors:

- Industrialization and manufacture of large, complex, high-precision heavy-load handling equipment.
- Manufacture and installation of crane systems, special lifting machines, rails or monorail systems and switching mechanisms.
- Fabrication of welded and machined steel structures with controlled distortion and comprehensive dimensional inspection.
- Electrical engineering and manufacture of control and power cubicles, cabinets, cables, connectors, instrumentation and actuators.

- Industrial control-system integration, motion control, protection circuits, interlocks, diagnostics, networks, cameras and operator interfaces.
- Integrated factory testing, including representative load, motion, interface, failure and recovery tests.
- Heavy transport, site logistics, assembly and installation in constrained industrial or nuclear facilities.
- ISO 9001 or equivalent quality management, configuration, traceability, inspection and test planning and manufacturing records.
- CE marking and conformity assessment of complex machinery and lifting equipment.
- Implementation of Nuclear Safety management requirements and supply-chain propagation where applicable.
- Qualified personnel, project controls and interface management for a long-duration international project.

9 Information Expected from Market Participants

a) Available manufacturing, assembly and test facilities, including lifting capacity, machining, welding, NDT, metrology and electrical integration resources.
b) Proposed contracting model, partners and key subcontractors for uncovered capabilities.
c) Preliminary view of major industrial risks, long-lead items and schedule-driving activities.
d) Comments on packaging of the scope, opportunities for early procurement and recommended qualification or prototype activities.

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10 Market survey

With this market survey, F4E would like to identify capable companies and entities with relevant past experience and industrial capacity related to the anticipated manufacturing and installation scope. The survey is intended to improve F4E understanding of market capability, potential supply-chain arrangements, technical constraints, industrial risks and appropriate procurement packaging.

Interested economic operators are invited to answer the market-survey questionnaire and submit the requested supporting information in accordance with the instructions published by F4E. Information submitted will be handled according to the conditions specified in the survey documentation.

This note does not constitute a call for tender, a pre-qualification exercise or a commitment by F4E to launch a procurement. Participation or non-participation in the survey will not determine eligibility for a future procurement procedure. F4E may contact respondents to clarify submissions or further explore market and technical conditions.

Please answer the survey by clicking this LINK or via the hereunder QR code

Pre-information