IDM UID
4KC7NJ

VERSION CREATED ON / VERSION / STATUS
01 Oct 2021 / 1.1 / Approved

EXTERNAL REFERENCE / VERSION

Technical Specifications (In-Cash Procurement)

Heavy Duty Radiation tolerant Tool Changer and Force & Torque Sensor

This Technical Specification specifies the scope of work for the development, qualification and procurement of two types of bespoke components for the ITER Blanket Remote Handling System (BRHS) robot:Lot A: Heavy Load Radiation Tolerant Tool Changer (TC) Lot B: Heavy Load Radiation Tolerant Force and Torque Multi-axis transducer (F/T Sensor) The procurement method for this project will be through framework contract(s).
This method allows a staged development of the products, given the ...

Table of Contents

1 Purpose

This Technical Specification specifies the scope of work of a Framework contract for the stepwise development, qualification and procurement of two types of bespoke components for the ITER Blanket Remote Handling System (BRHS) robot:

1. **Lot A:** Heavy Load Radiation Tolerant Tool Changer (TC)
2. **Lot B:** Heavy Load Radiation Tolerant Force and Torque Multi-axis transducer (F/T Sensor)

The procurement method for this project will be through framework contract(s).
This method allows a staged development of the products via individual Task Orders, given the uncertainties before reaching a technical maturity allowing a Contractor to commit on a firm price for the delivery of qualified production units.
Multiple Framework Contracts can be awarded (up to 2 Contracts) as a result of the tendering process. Following Contract award, Task Orders will be issued for the implementation of the services. All Task Orders to be executed under this (these) contract(s) will be on a deliverable basis. At the tender process, IO will attach, as part of the invitation to the tender, the Technical Specifications for the first Task Order of each Lot detailing its scope and main activities.

2 Scope

The ITER project is an International Organization that aims to demonstrate the scientific and technological feasibility of fusion power for peaceful purposes and to gain the knowledge necessary for the design of the next stage device.

The ITER Blanket Remote Handling System (BRHS) robot is designed to remotely handle heavy components inside ITER Tokamak (toroidal vacuum vessel) for its maintenance. A large variety of end effectors and ancillary tooling are required to perform the Tokamak components maintenance with the BRHS.

In order to increase the efficiency and flexibility of these operations, the BRHS will use a Tool Changer, equipped with automatic services connections to feed services to the different end effectors.

To monitor and secure the docking/undocking control of the robot to its fixed targets within the vessel, the BRHS will integrate a Force and Torque sensor.

2.1 Lots

This Technical Specification provides the high level requirements and scope of work for a Framework Contract covering the engineering, R&D, Manufacturing, Assembly Testing and qualification of two types of bespoke components:

1. **Lot A:** Heavy Load Radiation Tolerant Tool Changer
2. **Lot B:** Heavy Load Radiation Tolerant Force and Torque Multi-axis transducer

2.2 Task Orders

All of the work executed under this Framework Contract shall be implemented through Task Orders. A tentative list of Task Orders, together with the expected activities and dates is presented in the following sections.

When the IO requires work to be performed under this Framework Contract, the IO shall raise a Task Request that defines the technical requirements, the input data, the schedule and deadline for deliverables, and requirements for meetings.

Upon receipt of the Task Request, the Contractor shall respond within the time specified in the Task Request with an offer, indicating the firm price for delivering the services and confirming the schedule for performing the work. Following agreement between the IO and the Contractor, the IO shall issue a formal Task Order.
The Contractor will be required to provide quality and implementation plans for all Task Orders.

3 Estimated Contract Duration

The estimated duration for the complete development framework contract is expected to be 36 months, with Lots to be developed during the following timeframe:

Table 1- Framework Contract Task Orders timeframe

Lot	Task Orders	High level Scope description	Timeframe
Lot A – Tool Changer	TO 1	Preliminary design and R&D: Mechanical concept design, structural integrity report, dry lubrication test	Q1 2022 - Q3 2022
Lot A – Tool Changer	TO 2	Detailed Final design: Detailed radiation tolerant mechanical, electrical (including automatic connectors and docking/connection monitoring) and pneumatic design. Structural integrity report update. Manufacturing of a first of a kind master + tool side, Payload + proof loads tests (1.3 x payload). OPTION: Functional irradiation tests	Q3 2022 – Q4 2024
Lot B – Force/Torque Sensor	TO 1	Preliminary Design: Mechanical concept design, structural integrity report, Instrumentation and Control preliminary design	Q1 2022 - Q3 2022
Lot B – Force/Torque Sensor	TO 2	Detailed design and First of a Kind qualification testing: Structural integrity report update, Detailed radiation tolerant, mechanical, electrical and communication design, experimental load testing. Structural integrity report update. Manufacturing of a first of a kind; Payload + proof loads tests (1.3 x payload). OPTION: Functional irradiation tests	Q3 2022 – Q4 2024

4 Definitions

Abbreviation	Definition	Type
BRHS	Blanket Remote Handling System	Technical
CAD	Computer Aided Design	Technical
DET	Data Exchange Tasks	Technical

Abbreviation	Definition	Type
FW	First Wall	Technical
F/T	Force and Torque	Technical
IDM	ITER Document Management system	Technical
INB	Basic Nuclear Installation (Installation Nucléaire de Base)	Technical
IO	ITER Organization	Organization
MQP	Management and Quality Program	Technical
QA	Quality Assurance	Technical
RH	Remote Handling	Technical
RO	Responsible Officer	Organization
SB	Shield Block	Technical
SL	Seismic Load	Technical
TRO	Technical Responsible Officer	Organization
VV	Vacuum Vessel	Technical

5 References

Contract and Quality Assurance

[RD1] ITER Procurement Quality Requirements (ITER_D_22MFG4)

[RD2] Requirements for Producing a Quality Plan (ITER_D_22MFMW)

[RD3] Procedure for management of Nonconformities (ITER_D_22F53X)

[RD4] Procedure for the management of Deviation Request (ITER_D_2LZJHB)

[RD5] Quality Assurance for ITER Safety Codes (ITER_D_258LKL)

6 Blanket Remote Handling System (BRHS) Description

6.1 BRHS Overview

The Blanket Remote Handling System is a remotely operated robot that will perform the maintenance of the ITER vacuum-vessel (Figure 1). The main requirement of this maintenance system is to periodically replace (remove and re-install) all or part of the 440 protective structures of the internal surface of the vacuum vessel called Blankets.

The Blankets (Figure 2) consists in the assembly of a Shield Block (SB) and a First Wall (FW), which are designed to be individually handled by the BRHS.

The average volume of a SB is $1m^3$ and its maximum weight is 4 metric tons.

Figure 1 - ITER Tokamak section view showing the internal surface of the Vacuum Vessel protected from the burning plasma by the 440 Blankets modules

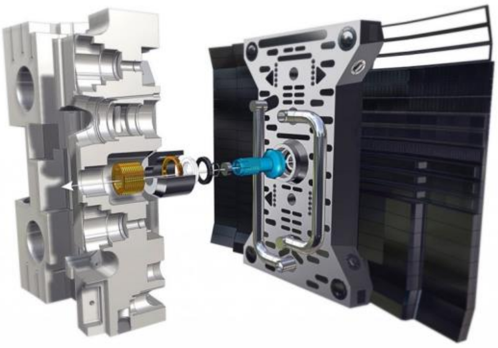

Figure 2- Section view of an individual Blanket assembly composed of a Shield Block (SB) on the left and a First Wall (FW) on the right

6.2 BRHS Operation description

During maintenance phases, the BRHS will be deployed inside the vacuum-vessel (Figure 3) and will perform alignment/insertion/locking(unlocking)/extraction of the components to be maintained (Figure 4).

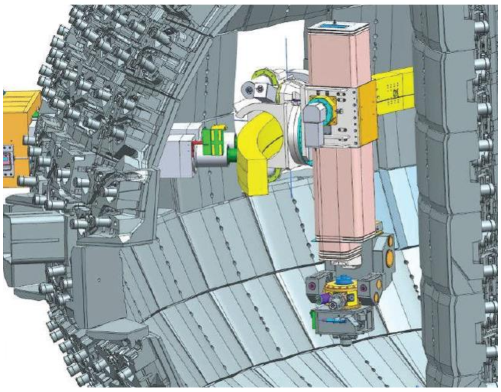

Figure 3 - BRHS during maintenance inside the ITER Vacuum Vessel

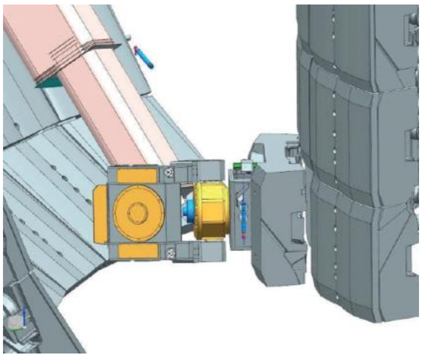

Figure 4 - BRHS installing a SB onto the Vacuum Vessel

The Components and Tools to be replaced by the BRHS will be imported or exported by another system via an equatorial port (Figure 5).

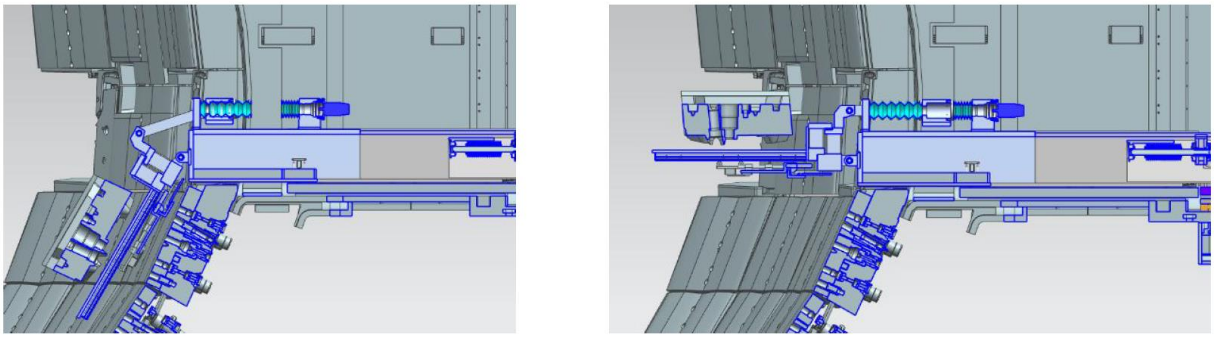

Figure 5 - Import/export system delivering a component to the BRHS inside the vacuum-vessel

6.3 Target Tool/Component Alignment Insertion/Extraction process

The BRHS alignment and insertion processes are automated, based on non-contact sensing (robot Vision system) and contact sensing (F/T sensor) (Figure 6).

Large motion of the robot up to a stand off position at 300mm from the target

- Robot coarse positioning at a stand off position to the target, based on theoretical coordinates
- Relative positioning error: ±100mm ; ±5°

Fine positioning at stand-off position

- Robot fine positioning at a stand off position to target based on vision system feedback
- Relative positioning error: ±5mm ; ±3°

Insertion in robot compliant mode

- Tool changer master/tool insertion or end-effector insertion to the Target in robot compliant mode based on the F/T sensor feedback up to preset positionand compression treshold/range
- Relative positioning error: ±0.5mm ; ±0.1°

Locking/unlocking and Load transfer compensation

- Locking/unlocking the Tool Changer master and tool side or the end to the Target
- Load transfer anticipation by relative positioning based on structural model and feedback from the F/T sensor

Target extraction

- Extraction and transfer of the Tool or the Target to a stand off position above the import/export system

Figure 6 - Target Tool or Component Alignment/Extraction process

6.4 Integration of the Force and Torque sensor and Tool changer within the BRHS

The F/T Sensor and Tool Changer will be integrated at the tip of the BRHS robot wrist.

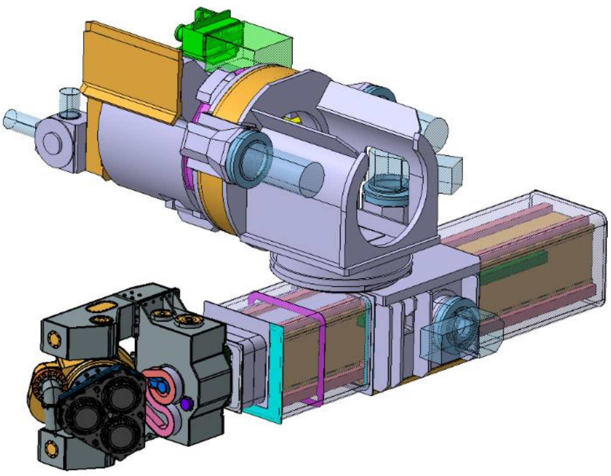

Figure 7 - BRHS equipped with an example of tool changer and F/T sensor

An example of integration design of tool changer and F/T sensor on the BRHS wrist is provided in Figure 8 below:

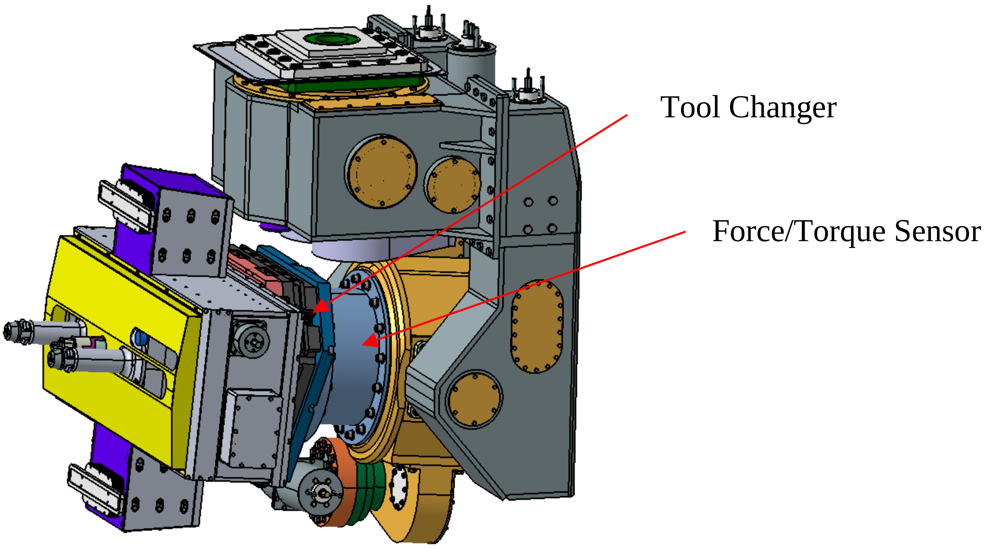

Figure 8 –BRHS Wrist equipped with an example of Tool Changer and F/T sensor, coupled to a Tool (automatic connectors and rescue interfaces are not shown)

A number of different Tools will be coupled to the BRHS as shown in Figure 9 below:

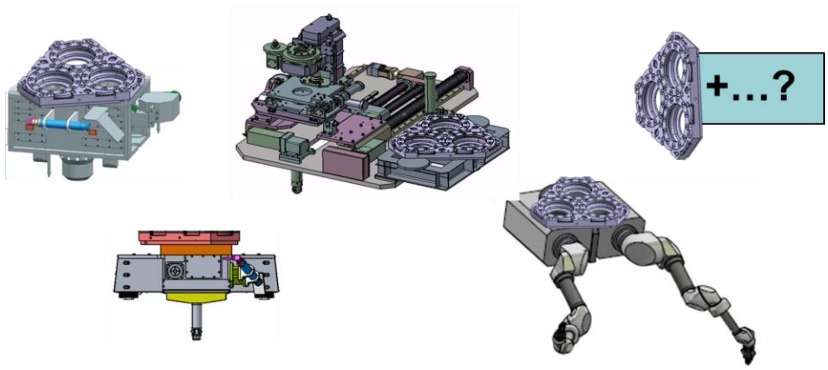

Figure 9 - Tools to be coupled to the BRHS with examples of Tool side interfaces

7 Technical Requirements

7.1 Common Requirements for Lot A and Lot B

7.1.1 Origin Reference datum definition

The loads specified in the following sections are expressed in below origin reference datum:

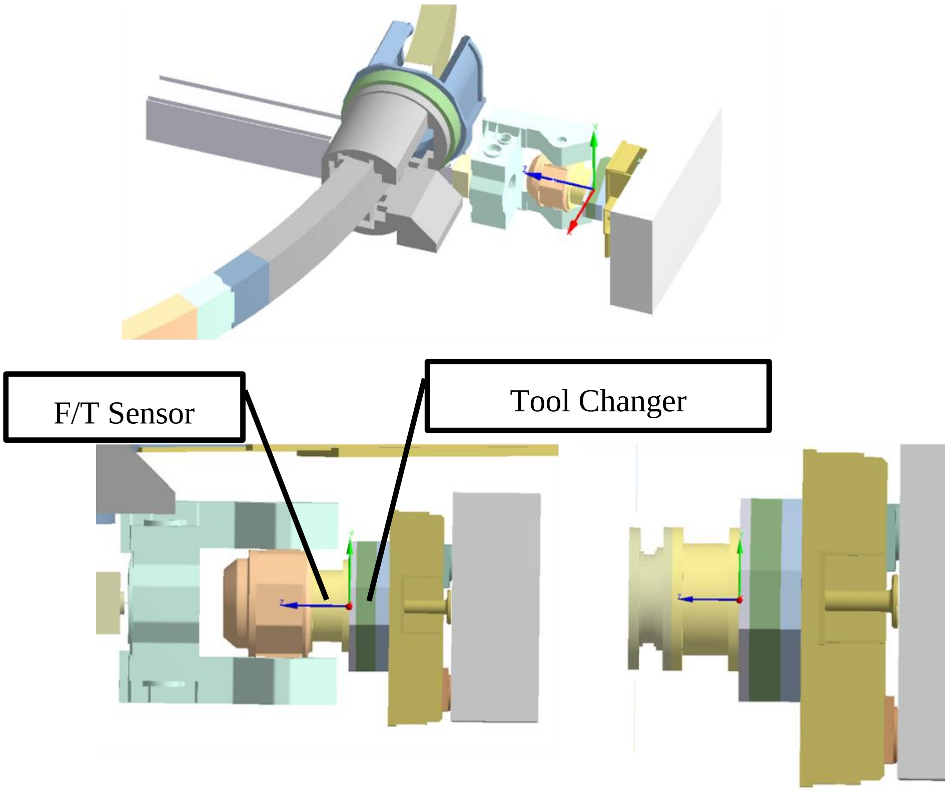

Figure 10 - F/T Sensor Reference datum origin

7.1.2 Nominal load conditions

The nominal conditions for operation of the F/T sensor and Tool Changer are as follow:

	Forces (±KN)		Torques (±KNm)	
Load Case	Fx, Fy	Fz	Tx,Ty	Tz
Payload	45	45	25	4

Table 2 - Nominal Payload conditions for the F/T sensor and for the Tool Changer

7.1.3 Off-normal loading conditions

- In case of major seismic event (Called SL1) the tool changer and F/T sensor must be capable of securely holding the tool (if coupled at the time of the event) and remain operational after the seismic event.

- In case of extreme seismic event (Called SL2) the tool changer and F/T sensor must be capable of securely holding the tool. It can be permanently damaged (local plastic deformation are admitted) but shall be able to be uncoupled from the tool, using an external means if necessary.

	Forces (±KN)		**Torques (±KNm)**	
Load Case	Fx, Fy	Fz	Tx,Ty	Tz
Max. Off-Normal conditions 1 (Payload + SL1)	65	70	45	25
Max Off-Normal conditions 2 (Payload + SL2)	105	150	80	70

Table 3 -Off-Normal Load conditions for the F/T sensor and for the Tool Changer

Note: the Off-normal loading conditions may be adjusted for the Task Order 2 according to the preliminary design (which is an outcome of the Task Order 1).

7.1.4 Safety factor

The following safety factors are requested to be applied to the loading conditions:

Load Case	**Safety factor to be applied**	
	Factor	Demonstration
Payload	1.3	Experimental Load Test
Max. Off-Normal conditions 1 (Payload + SL1)	1.1	Analytical
Max Off-Normal conditions 2 (Payload + SL2)	1	Analytical

Table 4 - Safety factor to be used for structural analysis per type of load case

7.1.5 Structural Integrity

The structural integrity of the Tool Changer and Force/Torque sensor, when submitted to each Load Case described in this document, shall be analysed by the Contractor using relevant method. The Contractor shall then provide a Structural Integrity report detailing at least:

- The breaking mode of the component
- The criteria for the normal loads (rated loads), high loads (permissible peak loads) and breakage loads (or equivalent)
- The bases of the criteria, one of which can be structural analysis

The applicable code for the BRHS is EN 13001-2:2011.
The Contractor shall preferably perform the structural analysis following EN 13001-2:2011 code, unless a different code is agreed in writing by IO.

7.1.6 Environmental Requirements: conditions inside the Vacuum-Vessel during maintenance

The main conditions for final production equipment are:

Cleanliness requirements

- the BRHS will be used in a vacuum vessel, however the system will not be used under vacuum conditions but must not contaminate the environment:
  - the use of grease shall be limited to confined space, protected by double sealed interfaces. Example: If one or more pneumatic cylinders are proposed as a solution for operating the tool changer, its pistons must be compatible with greaseless operation. If grease is mandatory for the cylinders, grease drops shall be avoided by systematically implementing double seals between enclosure and the external environment.

- **Note:** The grease that directly exposes to the outside is prohibited in ITER nuclear vacuum vessel because of:
  - Risks of grease drops that would affect the degassing performance of the vacuum vessel
  - Difficulties in the decontamination process
  - Risks of contamination of the plasma

Radiation Tolerance requirement

  - The maximum dose rate is 530 Gray/Hour
  - The components shall be developed to withstand a targeted radiation tolerance total integrated dose up to 3 MGy (3 x 10^6 Grays)
- Radiation compatible design
  - Material selected shall be resistant to radiations.
    - Examples of compatible candidate materials:
      - For the structures and bolts: Stainless steel or Aluminium shall be preferred, carbon steel is not authorized. Austenitic stainless steel shall be preferred. In case martensitic stainless steel cannot be replaced, specific surface treatment to prevent oxidation shall be added. Example: electro polishing in combination with surface coating such as Diamond Like Coating(DLC) or dry lubrication solution such as S-compound film : (https://tech.thk.com/upload/catalog_claim/pdf/343E_oilfree.pdf)
      - for seals EPDM rubber or PEEK,
      - for insulator: Polyimide,
      - for grease(protected within a double sealed enclosure) polyoxyethylene alkyl phenyl ether sulfate
  - Selected Components shall be resistant to radiations (Example: radiation hardened or shielded electronic boards, radiation hardened sensors etc.)

Temperature requirements

  - The atmospheric operating temperature range will be from 20°C to 50°C

Hygrometric requirements

- The system shall comply with a relative humidity of 25% at 35 °C

Decontamination requirements

- The components shall be designed to ease the decontamination and prevent contamination ingress (smooth external surfaces, no sharp edges, avoid open crevices)

7.1.7 Lifecycle Duty

The components to be developed shall be designed to withstand:

- Minimum number of coupling/insertion sensing cycles: 10 000
- Maximum frequency of coupling/insertion sensing cycles : 2 to 10 cycles per 24H

7.2 Specific Technical Requirements for Lot A: Heavy Load Radiation Tolerant Tool Changer

7.2.1 Coupling requirements

- Failsafe coupling mechanism: Once the master side Tool Changer has been coupled with the Tool side interface it shall securely hold the load even in case of complete loss of compressed air or electrical power.

- Dry coupling system: The locking mechanism for the Master Tool Changer shall be greaseless. If lubricating function is necessary on exposed surfaces, dry lubricant or surface coating could be applied.

- Maximum linear and angular misalignment in all directions before engagement of the alignment pins of the Master side to the Tool side holes: during coupling: Translation: ±5mm; Rotations: ±3degree

- Maximum linear and angular misalignment in all directions before locking the Master side to the Tool side: Translation ±1 mm; Rotations: ±0.5degree

- Coupling Monitoring:

    - Ready To Lock status monitoring: A sensor monitoring when the Master Tool changer can be actuated without risk to damage it or to fail to lock shall be integrated (ie. Sensing when the Tool side coupling is in the catch range of the Master side).
    - Locked/Unlocked status monitoring: two sensors shall be integrated within each locking mechanism of the Tool Changer Master side to monitor both their Locked and Unlocked status
    - **Note:** ITER Organization can propose references of radiation tolerant proximity sensors if necessary

- Coupling Rescue interface: a recovery interface shall be integrated within the Master side to allow to force the unlocking of the Master Tool Changer in case the services supply fails (cables or air line breakage) or after a major seismic event (SL2). This external interface shall be compatible with an external tool handled by another remote handling manipulator (external compressed air line interface or mechanical interface).

- Robot wrist orientation during Tool changer master and tool side locking/unlocking : Between 0° and 60° from gravity axis

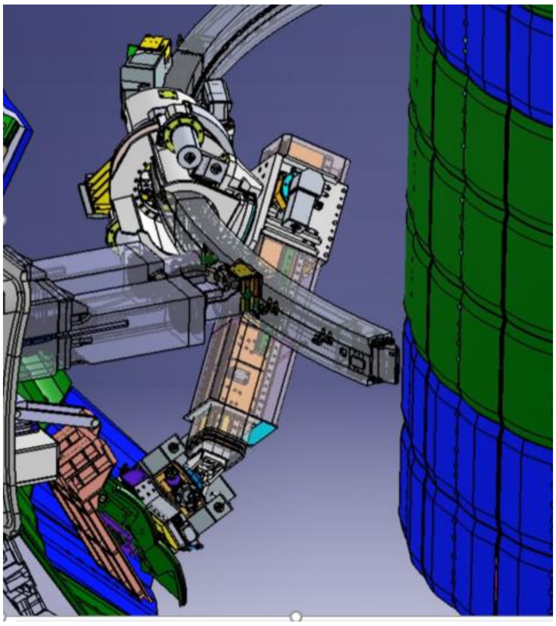

Figure 11 - In-Vessel Delivery System maximum tilted orientation: 60 degrees

7.2.2 Automatic Electrical Connector

Automatic power and signal connectors shall be integrated within the Master side and Tool side.

- Maximum Preliminary contacts list (To Be reduced):

Core size(mm2)	Quantity
1.5	60
0.75	30
0.5	150
Coax.	4

The automatic power and signal couplers shall not protrude from the allowed design volume (see 7.2.3).

The Contractor are required to propose a solution to prevent contamination ingress on the automatic connectors. This system shall not protrude from the allowed design volume (see 7.2.3).

7.2.3 Integration Requirements

- Mounting Interface: The Master side and Tool side shall be designed with through holes allowing it to be bolted to interface frames on their support.

- Allowed design Volume:

  Once locked together, the Master and Tool side Tool changer shall fit within the following space constraints, including automatic connectors (millimetres):
  - **Maximum diameter: 590mm**
  - **Maximum thickness (flange to flange): 150mm**

Note: these figures are a generic target but more detailed geometry specification could be adapted if technically required.

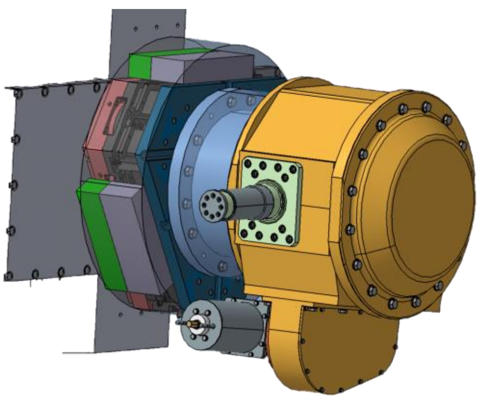

Figure 12 - Example of Tool changer and Force Torque sensor fitting within the allowed design volume (in transparent grey)

- Inner holes: Both the Master and the Tool side tool changer shall be fitted with through holes of minimum 40mm diameter located at their centre.

7.3 Specific Technical Requirements for Lot B: Heavy Load Radiation Tolerant Force and Torque Multi-axis transducer (F/T Sensor)

7.3.1 Rated range

	Forces (±KN)		Torques (±KNm)	
	Fx, Fy	Fz	Tx,Ty	Tz
Sensing Range	45	45	25	4

7.3.2 Effective Resolution

The effective resolution of the Force and Torque transducer when monitoring loads within the sensing rated range shall be better than:

- 3 axis Forces: ±100 N
- 3 axis Torques: ±100 Nm

7.3.3 Integration Requirements

- Mounting Interface: The Force and Torque transducer shall be designed with mounting flanges drilled with through holes patterns (size and number to be agreed with IO) allowing it to be bolted to its interface frames.

- Allowed design Volume:

  The Force and Torque transducer shall fit within the following space constraints (millimetres):
  - **Maximum diameter: 405 mm**
  - **Maximum thickness (flange to flange): 190mm**

Note: these figures are a generic target but more detailed geometry specification could be adapted if technically required.

- Inner holes: The Force and Torque transducer shall be fitted with a through hole of minimum 85mm diameter located at its axial centre.

- Options to ease cable routing: the feasibility to perform radial sealed penetrations on the transducer body to allow the routing of external cables coming from the inner hole is to be studied by the Contractor.

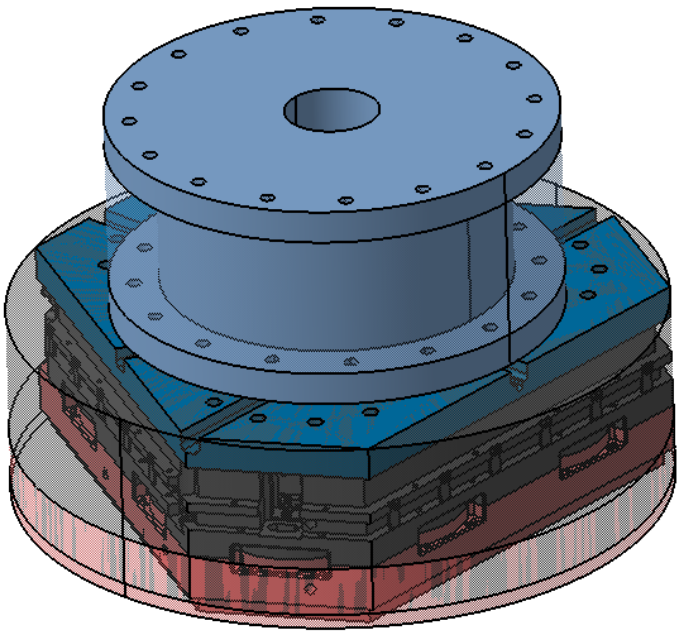

Figure 13 - Example of Force and Torque transducer assembled to the coupled Master and Tool side Tool Changer via an interface plate fitting within the related required space constraints(automatic connectors and rescue interfaces are not shown)

7.3.4 Signal conditioning and communication

- Maximum distance between the F/T transducer and the control cubicle integrated with the power supply and interface board(s): 150m
  - **Note:** The F/T sensor will be integrated within the BRHS robot deployed inside the nuclear vacuum vessel (therefore exposed to the radiations) and the cubicle will be installed in a non-nuclear rated cubicle room.

- Communication architecture: the Contractor shall provide an Instrumentation and Control architecture design suitable to optimize the signal transmission performance (minimized latency) and reduce the noise compliant with the environment requirements.

- The ASIC electronic chips embedded within the F/T sensor shall be radiation tolerant (See chapter 7.1.6).
  - **Note:** For information, rad-hard ASIC Resistive bridge sensor signal conditioner are being developed as part of a front-end BiSS Input/Output module designed by MAGICS Instruments within Fusion for Energy remote handling activities (F4E-OMF-0633-01-03). https://www.magics.tech/portfolio/rad-hard-asics/sroic2100/

8 Work Description for Lot A - Heavy Load Radiation Tolerant Tool Changer

The Contractor work for Lot A is split into two Task Orders:-

I. Task Order 1: Preliminary design and R&D
II. Task Order 2: Final Design, First of a Kind production and qualification testing

8.1 Lot A - Task Order 1: Preliminary design

8.1.1 Quality Plan

The Contractor shall produce a Quality Plan and an Implementation Plan for the Contract (see [RD2]).

8.1.2 Preliminary Mechanical design

During that phase the Contractor will perform the preliminary mechanical design of the Tool Changer, Master side and Tool side according to present specification.

The tasks to be performed are:-

- to provide existing test reports of similar products submitted to irradiation tests, if any
- to develop a concept design which fits within the specified geometrical constraints (CAD model and General Assembly drawing), based on a similar existing product if possible, providing the functions described in this specification
- to select the material for the structures suitable for the specified loads cases and the nuclear environment description, and to provide the associated Bill of Material
- to perform a structural analysis demonstrating the structural integrity of the Tool Changer Master and tool side when submitted to the load cases (Payload, SL1, SL2)
- to provide a structural analysis report describing the model, its contacts between the different parts, and for each load case (Payload, SL1, SL2) the loads and their point of application and the results in terms of stresses and deformations
- to design a dry locking mechanism (using plain corrosion free material, or dry grease, or surface coating) and to demonstrate in a representative manner experimentally, on a test bench, that the proposed approach is suitable for the load cases and number of cycles described in this specification
- to perform a preliminary assessment of the automatic couplers selection/design mechanical integration within specified space constraints
- to propose a concept for Tool Changer rescue actuation after electrical breakage, pneumatic breakage or after a major seismic event (SL2)

8.2 Lot A - Task Order 2: Final Design, First of a Kind Production and qualification testing

8.2.1 Final Detail design

The Contractor will perform the detailed manufacturing design of the full specifications Tool Changer and associated automatic connectors (including manufacturing drawings, pneumatic design diagrams, and electrical design diagrams, material selection justification, structural integrity report update for final design loads).

8.2.2 First of a Kind Production and testing

The Contractor will perform the manufacturing, assembly, functional testing and Load testing (Payload × safety factor 1.3) of one First of a Kind master and one tool side tool changer.

The Contractor shall produce a Final Design, production and test reports as well as the preliminary documentation version related to the operation and maintenance of the developed Components.

8.2.3 OPTION: Irradiation Testing

If and when the IO releases the Task Order Irradiation Testing OPTION the Contractor will perform the master and tool side tool changer functional testing in an irradiation test facility up to 3 MGy cumulated dose (with intermediate integrity check at 1 MGy and 2 MGy) and produce the associated test plan and test report.

9 Work Description for Lot B - Heavy Load Radiation Tolerant Force and Torque Multi-axis transducer (F/T Sensor)

The Contractor work for Lot B is split into two Task Orders:-

I. Task Order 1: Preliminary design and R&D
II. Task Order 2 : Final Design, First of a Kind production and qualification testing

9.1 Lot B - Task Order 1: Preliminary design

9.1.1 Quality Plan

The Contractor shall produce a Quality Plan and an Implementation Plan for the Contract (see [RD2]).

9.1.2 Preliminary Mechanical design

During that phase the Contractor will perform the preliminary mechanical design of the Heavy Load Radiation Tolerant Force and Torque Multi-axis transducer according to present specification.

The tasks to be performed are:-

- to provide existing test reports of similar products submitted to irradiation tests, if any
- to develop a concept mechanical design which fits within the specified geometrical constraints (CAD model and General Assembly drawing), based on a similar existing product if possible, providing the functions described in this specification
- to select the material for the structures suitable for the specified loads cases and the nuclear environment description, and to provide the associated Bill of Material

- to perform a structural analysis demonstrating the structural integrity of the Force and Torque Multi-axis transducer when submitted to the load cases (Payload, SL1, SL2) with the specified associated Safety Factors
- to provide a structural integrity report describing the model, the material used, its contacts between the different parts, and for each load case (Payload, SL1, SL2) the loads and their point of application and the results in terms of stresses and deformations
- to design a preliminary electrical and communication architecture compatible with present technical specification

9.2 Lot B - Task Order 2: Final Design, First of a Kind Production and qualification testing

9.2.1 Final Detail design

The Contractor will perform the detailed manufacturing design of the Force and Torque Sensor (including at least, manufacturing drawings, electrical design diagrams, material selection justification, structural integrity report update for final design loads).

9.2.2 First of a Kind Production and testing

The Contractor will perform the manufacturing, assembly, functional testing and Load testing (Payload × safety factor 1.3) of one First of a Kind Force and Torque Sensor.

The Contractor shall produce a Final Design, production and test reports as well as the preliminary documentation version related to the operation and maintenance of the developed Components.

9.2.3 OPTION: Irradiation Testing

If and when the IO releases the Task Order Irradiation Testing OPTION the Contractor will perform a Force and Torque Sensor functional testing in an irradiation test facility up to 3 MGy cumulated dose (with intermediate integrity check at 1 MGy and 2 MGy) and produce the associated test plan and test report.

10 Responsibilities

10.1 IO Responsibilities

The chosen analysis software and methodology to demonstrate design structural integrity shall be approved by the ITER Organization prior to commencement of the work.

The IO shall make available to the Contractor all technical data and documents which the Contractor requires to carry out its obligations pursuant to this specification in a timely manner. For delays of more than two weeks in making them available, the Contractor shall advise IO representative of the potential impact on the delivery of the sub-tasks, to agree and define all the correction actions to take in place.

The IO shall assign one *ITER Organization Technical Responsible Officer* (IO-TRO), to work as sole Contractor interface for management and technical functions. The IO-TRO will assess the performance and quality of the work and shall be responsible for:-

- Ensuring all the input data is made available to the Contractor,
- Responding to requests for information from the Contractor in a timely manner,
- Monitoring the progress of the work,
- Checking the deliverables against requirements.

The IO shall assign one *ITER Organization Responsible Officer* (IO-RO) for the contract who is responsible for the approval of deliverables. The IO-RO is typically the line manager of the IO-TRO.

The *ITER Organization's Contract Officer*, as representative of the Procurement and Contract Division is responsible for all legal, contractual and administrative aspects of the framework Contract and the related Task Orders. He/She assists and advises the IO-TRO in all matters having legal, contractual and administrative implications during Contract negotiations and Contract execution.

10.2 Contractors Responsibilities

The Contractor shall assign a *Project Manager* who is responsible for the execution of all Contractor tasks. The Contractor shall assign a *Contracts Officer* who is responsible for all legal, contractual and administrative aspects of the Task Order.

- The Contractor shall guaranty that all input information provided to perform the task remain property of IO and shall not be used for any other activity than the one specified in this specification.
- The Contractor shall be in charge of the training & coaching of all its resources.
- The Contractor shall provide an organization suitable to perform the work as describe in this specification;
- The Contractor shall work in accordance with the QA plan approved by IO;
- The Contractor shall provide to the IO representative full access to its work premises and related documentation, to permit to follow up the progress of the work

Prior to the start of work on each activity, the Contractor shall review the input technical information provided to it by IO for completeness and consistency, and shall advise the IO representative of any deficiencies it may find. The Contractor shall not be responsible for errors in the input technical information which could not be reasonably detected during such review. The duration of this review will be agreed between Contractor and IO representative and will have no impact on the delivery schedule.

11 Acceptance Criteria

11.1 Engineering

Deliverables shall be prepared in accordance with the Technical Specifications and the requirements detailed in the individual Task Orders.

Deliverables will be considered complete and acceptable once they have been performed in accordance with the Task Orders and submitted to, reviewed by and accepted by the IO. The IO will review the deliverable(s) and provide comments to the Contractor within the agreed time frame. Revision iterations will follow as necessary.

11.2 Analysis

IO shall be able to reproduce all reported results. To that end, the following shall be provided with every report:

- All calculation and finite element models used for generating the reported data.
- The models shall come with all the boundary conditions (BCs), loads, and element and material properties applied, making the model ready to run. Alternatively, pre-processing subroutines or macros that apply these BCs, etc. shall be supplied, along with clear instructions for which macros need to be run in order to reproduce the reported results. In other words, the number of manual operations required to rerun the analyses shall be reduced to the strict minimum. Any manual operation that is required to rerun the analyses shall be described either in the analysis report or in a document attached to the model.
- All pre- and post-processing subroutines, macros, batch scripts, spreadsheets, etc. used in the preparation of the work.
- If macros and subroutines are used, they shall be well commented. All text shall be written in English, including names (parameters, models, files…), comments (scripts, source code…), etc. Macros and subroutines shall be documented to a sufficient extent that a user proficient in the relevant programming language can easily understand the purpose of each macro, and how different macros link to each other.
- FE models shall be attached to geometry, unless otherwise agreed in writing by IO. If macros are used for the generation of the model, these form part of the deliverables.

11.3 CAD Data

The CAD data produced in the frame of this contract shall be delivered to IO in its native format (preferably CATIA V5) and as STEP files and PDF for 2D drawings.

12 Specific requirements and conditions

The official language of the ITER project is English. Therefore all input and output documentation relevant for this Contract shall be in English.

For all deliverables submitted in electronic format the Contractor shall ensure that the release of the software used to produce the deliverable shall be the same as that adopted by the ITER Organization.

All documentation and correspondence shall be through Microsoft Office software or Adobe PDF. If Adobe PDF is used, the corresponding version in Microsoft office format shall also be delivered.

The contractor shall ensure that all documents and records are uniquely identified and traceable.

The contractor will report as soon as possible to the IO any occurrence that could delay or jeopardize the proper execution of activities related to this contract.

13 Work Monitoring / Meeting Schedule

13.1 Kick-Off Meeting

At the start of the project a kick off meeting will be held to:

- Confirm the detailed scope of each of the tasks, the updated plan from the Contractor and the progress review
- Confirm all the reference documentation has been sent and received and its purpose understood.

The kick off meeting will be held remotely by video-conference on a date to be agreed between the Contractor and IO.

The meeting agenda, presentation and minutes will be provided by the Contractor.

13.2 Progress Monitoring

Bi-weekly or monthly meetings (To be agreed) shall be held between the IO-TRO and the Contractor to monitor work progress. These progress meetings shall allow the IO-TRO and Contractor to:-

- Allow early detection and correction of issues that may cause delays,
- Review the completed and planned activities and assess the progress made,
- Permit fast and consensual resolution of unexpected problems,
- Clarify doubts and prevent misinterpretations of the specification.

These meetings will be conducted remotely by video-conference. Additional persons may be invited to join the meetings as required by the task (for example the technical RO's for the RH equipment and Plant system).

The meeting minutes will be provided by the Contractor.

13.3 Site Visit

The IO (two representatives) could expect to be visiting the Contractor site to witness R&D test, prototype tests or for the Factory Acceptance Test.

14 Quality Assurance (QA) requirements

The organisation conducting these activities should have an ITER approved QA Program or an ISO 9001 accredited quality system.

The general requirements are detailed in ITER Procurement Quality Requirements (ITER_D_22MFG4).

Prior to commencement of the task, a Quality Plan must be submitted for IO approval giving evidence of the above and describing the organisation for this task; the skill of workers involved in the study; any anticipated sub-contractors; and giving details of who will be the independent checker of the activities (see Requirements for Producing a Quality Plan (ITER_D_22MFMW)).

Deviations and Non-conformities will follow the procedure detailed in Procedure for management of Nonconformities (22F53X) and Procedure for the management of Deviation Request (2LZJHB).

Documentation developed as the result of this task shall be retained by the performer of the task or the DA organization for a minimum of 5 years and then may be discarded at the direction of the IO. The use of computer software to perform a safety basis task activity such as analysis and/or modelling, etc. shall be reviewed and approved by the IO prior to its use, in accordance with Quality Assurance for ITER Safety Codes (ITER_D_258LKL). Where applicable, Software Qualification Policy (KTU8HH v1.2) shall be taken into consideration to ensure quality and integrity of software prior to application.

IO will monitor implementation of the Contract's Quality Plan. Where necessary, IO will assess the adequacy and effectiveness of the quality system specified in the Quality Plan through surveillance or audit. Where condition adverse to quality is found during monitoring, IO may request to the Contractor to take corrective action.