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EXTERNAL REFERENCE

Technical Specifications (In-Cash Procurement)

Engineering support for Neutral Beam PMS & ACCC design

The beam-line components, vessels passive magnetic shield and coils of the ITER heating neutral beam injectors (HNB) are to be supplied by the EU Domestic Agency (EU-DA) as well as the drawings. See Figure 1. The objective of this engineering contract is to support the NB H&CD team in: Following-up of design activities related to the following HNB components: Passive Magnetic Shield and the Active Correction Compensation Coils. (On-going under ITAC53TD55FE_NBI), to be supplied by the EU- ...

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Engineering support for Neutral Beam

PMS & ACCC design

Technical Specifications

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1. Abstract

This document describes technical needs of Neutral Beam Heating and Current Drive (NB H&CD) section in engineering support to design the Neutral Beam Injectors (NBI) including design activities and follow-up of activities.

2. Background and Objectives

The Neutral Beam (NB) Heating & Current Drive (H&CD) system is designed to:

- Help in accessing the H-mode and heating the ITER plasma at $Q > 10$,
- Provide steady state current drive capability (on-axis, off-axis) for DT, D, H and He plasmas,
- Modify current density and q profile,
- Provide plasma rotation,
- Provide power to sustain the density during shutdown and allow for controlled transition from H to L-mode at the end of burn.

The H&CD NB system consists of two injectors (see below a view of one injector). Space is available in the building and on the tokamak for a third system. Each H&CD injector will deliver an atomic deuterium beam of 16.5 MW, with an energy of 1 MeV, and will be able to operate for long pulses (up to 3,600 s for “steady state” operation). A system based on negative (D^-) ions is used.

In addition to H&CD, plasma rotation is also provided by the NB H&CD injectors. For the H - He operation phase of ITER, the H&CD injectors can be operated in hydrogen, with beam energy ≤ 0.87 MeV and neutral beam power ≤ 16.5 MW per injector to the ITER plasma.

Table NB Heating and Current Drive Parameters

		H - He	D & DT	Upgrade ⁽¹⁾
NB H&CD injection power	MW	≤ 33	≤ 33	≤ 50
Number of heating neutral beam injectors		2	2	3
Injected species		H ⁰	H ⁰ or D ⁰	H ⁰ or D ⁰
NBCD beam energy	MeV	0.87	0.87 or 1.0	0.87 or 1.0
NB H&CD - number of allocated equatorial ports		2	2	3
NB tangency radius ⁽¹⁾	m	5.31	5.31	5.31
NB lowest beam axis level at the tangency point	mm	417	417	417
NB highest beam axis level at the tangency point ⁽¹⁾	mm	+156	+156	+156
Approximate NB e-folding length of beam profile at the tangency point in vertical direction, B ⁽²⁾	m	≈ 0.32	≈ 0.32	≈ 0.32
Approximate NB e-folding length of beam profile at the tangency point in horizontal direction, A ⁽²⁾	m	≈ 0.22	≈ 0.22	≈ 0.22

⁽¹⁾Upgrading the H&CD system to 3 injectors is one of 4 upgrade scenarios proposed for the heating systems.

⁽²⁾Beam profile at tangency point described approximately as $\mathbf{P(x,y)} = \mathbf{C}e^{-\left[\left(\frac{x}{A}\right)^2 + \left(\frac{y}{B}\right)^2\right]}$

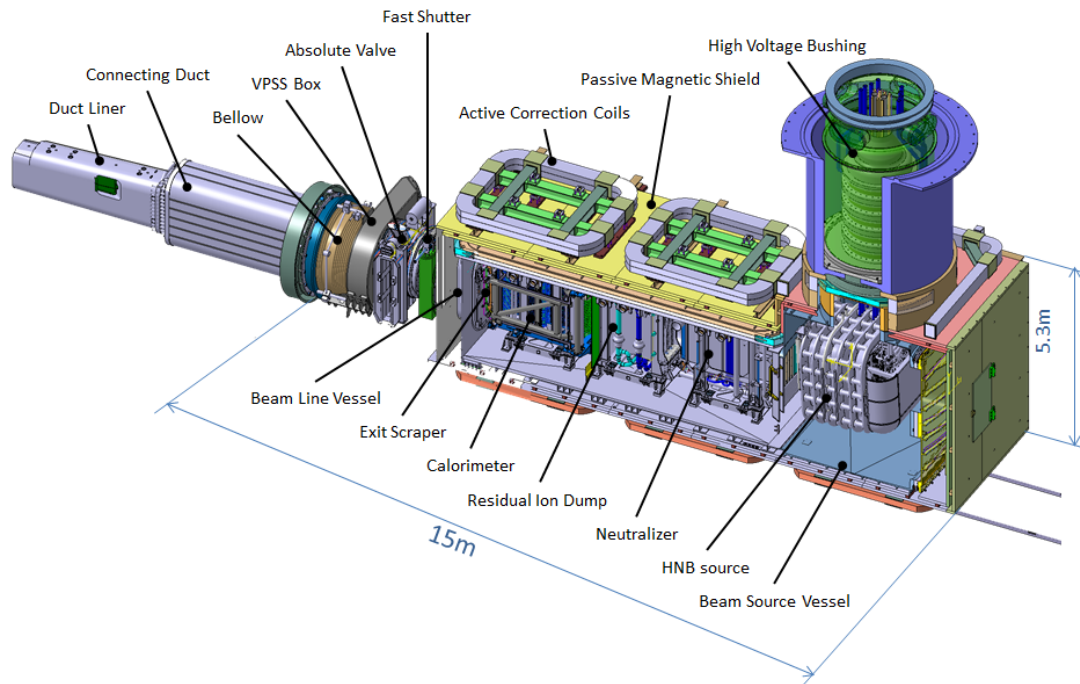


Figure 1 3D view of Heating Neutral Beam injector

3. Scope of Work

The beam-line components, vessels passive magnetic shield and coils of the ITER heating neutral beam injectors (HNB) are to be supplied by the EU Domestic Agency (EU-DA) as well as the drawings. See Figure 1.

The objective of this engineering contract is to support the NB H&CD team in:

- Following-up of design activities related to the following HNB components: Passive Magnetic Shield and the Active Correction Compensation Coils. (On-going under ITAC53TD55FE_NBI), to be supplied by the EU-DA.
- Updating the required documentation (Load Specification and the Development Requirements Document) to bring the maturity of the design from preliminary design review up to final design review.
- Communicating solutions and issues with interfacing teams/suppliers.
- Ensuring correct integration of these components in the NB-cell and the HV-deck room.
- Taking in charge the design, up to final design review, and the mechanical analysis of :
 - The rear PMS opening mechanism.
 - The bottoms ACCC support structure and its extraction system.

4. Estimated Duration

The duration shall be up to 2 years (440 working days) from the starting date of the contract. Up to 4 trips within the Europe area are foreseen. The work will be fully based at the ITER Organization Worksite.

5. Work Description

4.1 Subtask 1: Following-up of design activities related to ACCC and PMS:

The primary function of the ACCC and the PMS is to limit the magnetic field inside the BLV and BSV to acceptable levels by producing magnetic fields which counter the ITER stray fields.

The ACCC are made of copper and a thin layer made of epoxy is implemented between the pancake and the turns to guaranty an electrical insulation. The ACCCs component are cooled by water and supplied by 800A of current. See Figure 2.

The ACCC has the following functions:

- To shield the injector from external magnetic field (especially where the beam is not neutralized, ACCC shall work in combination with the PMS)
- To compensate the deformation of the tokamak magnetic field (due to the important mass of steel of the PMS)

The PMS for the HNB is an outer 2 layers of ferromagnetic steel 2x75mm thick, enclosing the HNB NB injector, including the HV bushing, the elbow of the transmission line and the HNB high voltage deck. See Figure 3.

The PMS has the following two main functions:

- To form, together with the active correction compensation coils the magnetic field reduction system that shields the injector volume from the tokamak magnetic field; to provide part of the radiation shield of the NB H&CD system.
- To provide part of the radiation shield of the NB H&CD system.

A mechanical engineer is needed

- to oversee the design of the components and the production of the drawings;
- to cross check all design details;
- to ensure correct integration and interfaces inside the NB cell and the HV deck room with all other systems (building, cooling water, power supply and remote handling);
- to review all deliverables produced within ITA ITAC53TD55FE
- to oversee the integration into Enovia;
- to propose mechanical concept for the component, the assembly and/or remote handling tools.

The engineer will have :

- to liaise with the different partners;
- to coordinate all the design exchanges and evolutions and write and/or review all the related technical documentation;
- to update the single loads and the load combinations of the load specifications;
- to update the development requirements documents.

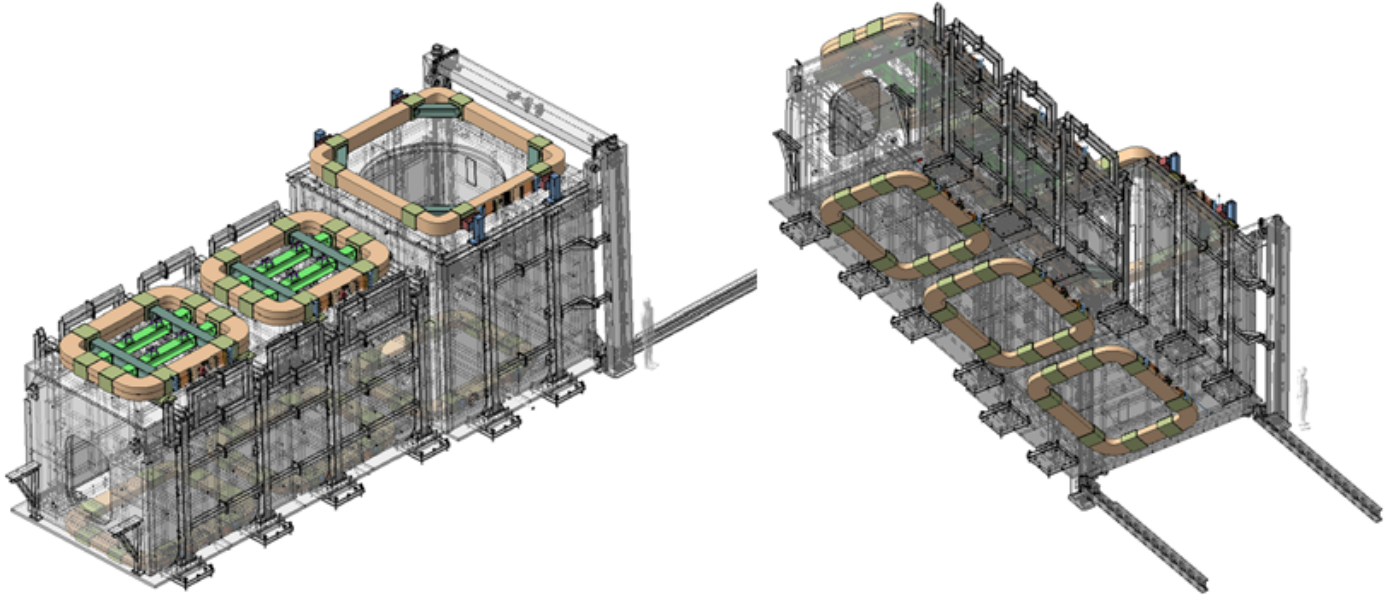


Figure 2: Active Correction Compensation Coils

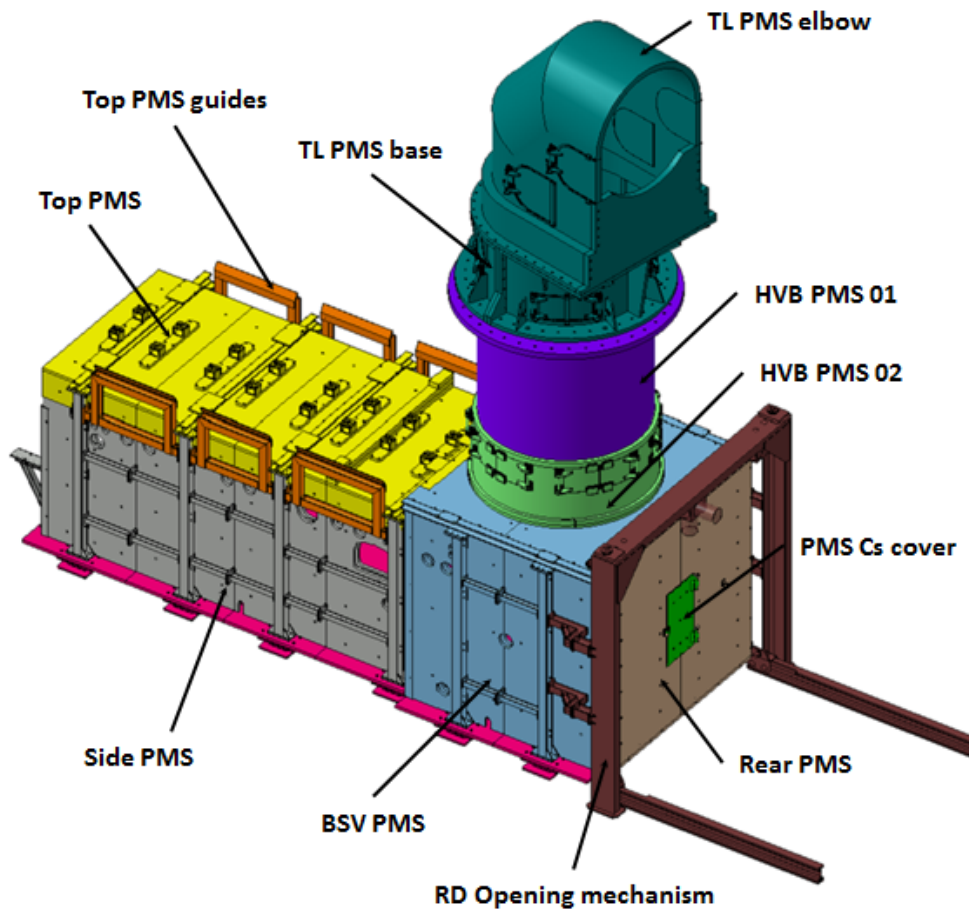


Figure 3: Passive Magnetic Shield

4.2 Subtask 2: Taking in charge the design of the rear PMS opening mechanism and the bottoms ACCC structure

The rear PMS door allows the opening of the vessel rear lid to access to the beam source by deploying the BSRHE. The weight of the door is 55 tons.

The bottom coils (1,2,3) consist of a single standard coil. All the support structures will be the same for each of them. The support structure has to guaranty the function of the coil and their stability. The bottom coils are remote handling class 3.Scenario and tools of the 1st assembly and maintenance need to be foreseen, hands-on operation are allowed during the maintenance.

A mechanical engineering is needed to develop the mechanical design and to do all the analysis required.

- Follow up designer for the CAD model, 2D drawings
- Write LS/DRD
- Write ICD/IS
- Review PDF/TDF
- Write technical specification and specification for manufacturing
- Mechanical analysis
- Analysis reports
- Prepare SIR
- Prepare design review documentation

4.3 Other objectives

Other objectives which are common to all tasks described here above must be ensured. They are:

- **Check of deliverables (technical specifications, drawings, analysis report, and documentation) and ensure traceability of modifications,**
- **Ensuring tasks schedule compliance with NBIs design main milestones,**
- **Organize necessary meeting/discussion between IO and other involved parties when necessary and ensure traceability of the discussions/choices made (Writing of minutes, memo and storage in IDM of all relevant documents),**
- **Organize design review meeting and ensure traceability of the discussions/choices made (Writing of minutes, memo and storage in IDM of all relevant documents),**
- **Ensure compliance with ITER needs, requirements and constraints (design choices done at ITER, codes and standards, maintenance scheme foreseen),**
- **Ensure quality of deliverables as defined by ITER and maintain it all along the progress of the task,**
- **Report activities progress to section leader and interact with NB team.**

6. Responsibilities

The engineer will work under IO neutral beam section member responsibility.

7. List of deliverables and due dates

Subtask	Deliverables	Dates
Overall	Report of on-going activities during each NB section's progress meeting.	Each two weeks

Overall	Report listing all documents/study performed within the contract.	End of the contract
Overall	Any presentations / documents requested by IO to support NB section	When needed by IO
1	Documents of ACCC and the PMS	At each delivery steps of on-going ITAs
2	Presentations and reports of the rear PMS mechanism and the ACCC structure including the extraction system	At the date fixed by IO



8. Acceptance Criteria

The selection will be done taking into account the following criteria:

- | | |
|--------------|-----|
| 1) Expert CV | 70% |
| 2) Price | 30% |

9. Specific requirements and conditions

The required resource is a mechanical engineer at least 5 years of working experience in mechanical design.

The engineer shall have:

- Experience on mechanical design activities follow up
- Knowledge of electromagnetic design components and magnetic parameters (field, hysteresis, permeability, ect..)
- Experience on hydraulic analysis (calculation of the pressure drop, definition of the cooling water parameters)
- Experience on international and French codes and standards (RCC-MR, ASME 8, ect..)
- Experience on written technical specification and documentation
- Experience in manufacturing processes (welding, machining, forging, ect..)
- Experience on Catia V5 (mechanical design software used in ITER)
- Experience on Enovia V5 (PLM software used in ITER)
- Experience on finite element mechanical and seismic analysis using Ansys-14 (knowledge of the modules: static analysis, modals analysis, transient analysis, response spectrum,)
- English fluent (written and spoken)
- Knowledge of Neutral Beam system is an advantage

10. Work Monitoring / Meeting Schedule

Final Reports should be self-contained, and relevant documentation, such as drawings, should be supplied together with it in electronic form. Deviations from the Task Order Specifications, approved by the ITER Organization, shall be recorded in a specific chapter of the relevant final report.

Meetings and progress reports

The work will be managed by means of Progress Meetings and/or formal exchange of documents transmitted by emails which provide detailed progress. Progress Meetings will be called by the ITER Organization, to review the progress of the work, the technical problems, the interfaces and the planning.

A progress meeting is organized by H&CD NB section each week. The engineer will have to report every two weeks in the progress meeting dedicated to mechanical activities.

The main purpose of the Progress Meetings is to allow the ITER Organization/H&CD NB section and the Contractor Technical Responsible Officers to:

- a) Allow early detection and correction of issues that may cause delays;
- b) Review the completed and planned activities and assess the progress made;
- c) Permit fast and consensual resolution of unexpected problems;
- d) Clarify doubts and prevent misinterpretations of the specifications.

In addition to the Progress Meetings, if necessary, the ITER Organization and/or the Contractor may request additional meetings to address specific issues to be resolved.

For all Progress Meetings, a document describing tasks done, results obtained, blocking points must be written by the engineer. Each report will be stored in the ITER IDM in order to ensure traceability of the work performed.

The quarterly Progress Report shall illustrate the progress against the baseline work plan and indicate variances that should be used for trending. Performance indicators suitable to measure the progress of the work as compared to the approved work plan shall also be reported in the Monthly Progress Report.

Experts from the Domestic Agencies may be invited by ITER Organization to participate in the meetings or other involved parties.

11. Payment schedule / Cost and delivery time breakdown

Interim monthly payments.

At the end of each month, the Contractor shall submit an invoice for the services rendered. This invoice will be accompanied with a duly signed time sheet. This time sheet will clearly indicate the contract reference number, the name of the assigned person, the dates and the total of the working days and the number of hours worked per day.

12. Quality Assurance (QA) requirement

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 document [ITER Procurement Quality Requirements \(22MFG4\)](#)

Prior to commencement of the task, a Quality Plan [Quality Plan \(22MFMW\)](#) 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.

Prior to commencement of any manufacturing, a Manufacturing & Inspection Plan [Manufacturing and Inspection Plan \(22MDZD\)](#) must be approved by ITER who will mark up any planned interventions.

Deviations and Non-conformities will follow the procedure detailed in IO document [MQP Deviations and Non Conformities \(22F53X\)](#)

Prior to delivery of any manufactured items to the IO Site, a Release Note must be signed [MQP Contractors Release Note \(22F52F\)](#).

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, it should fulfil IO document on Quality Assurance for ITER Safety Codes [Quality Assurance for ITER Safety Codes \(258LKL\)](#).

13. References / Terminology and Acronyms

IO:	ITER Organisation
ITA:	ITER Task Agreement
NBI:	Neutral Beam Injector
HNB:	Heating Neutral Beam
ACCC:	Active Correction Compensation Coils
PMS:	Passive Magnetic Field
BSRHE:	Beam Source Remote Handling Equipment
DWO:	Design Work Order
ICD:	Interface Control Document
IS:	Interface Sheet
PDF:	Plant Definition Form
TDF:	Task Definition Form
SIR:	System Integration Review
IDM:	ITER Document management