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EXTERNAL REFERENCE / VERSION

Technical Specification

Technical Specifications - Mechanical analyses and assessments for assistance in the DNB procurement

Technical Specifications - Mechanical analyses and assessments for assistance in the DNB procurement - 2016 to 2018- Mechanical engineering services for the preparation of the input documentation for the Final Design Reviews of the DNB vessel, the PMS and the ACCC's- Mechanical engineering services for assessments during the manufacturing follow-up of the DNB beamsource and beamline components- Mechanical engineering services for the preparation of inputs into safety documents, ESP classification and exemption documentation

Approval Process			
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Change Log			
Technical Specifications - Mechanical analyses and assessments for assistance in the DNB procurement (RWWXNS)			
Version	***Latest Status***	***Issue Date***	***Description of Change***
v1.0	Signed	15 Sep 2015	
v1.1	Approved	30 Sep 2015	Editing changes as requested by J. Berault.

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1 Purpose

The Diagnostic Neutral Beam (DNB) is designed to provide a probe beam of 100 keV H0 to be used by the Charge Exchange Recombination Spectroscopy (CXRS) diagnostic system. The main purpose of this diagnostic is to allow a measurement of the local density of thermal alpha particles (helium ash). It may also be used for other diagnostic measurements which provide information on:

- The local density of light impurities (Be, C, O, Ne)
- The plasma rotation velocity
- The ion temperature

The DNB can also be used for Motional Stark Effect (MSE) measurements and Beam Emission Measurements (BES).

The DNB is installed in the NB Cell which occupies a large part of the ground level of the Tokamak building. The DNB system has been designed for maximum commonality with the Heating Neutral Beam (HNB) systems, so that the injector utilises components identical to those of the HNB injector wherever possible. A 3D view of the injector is shown in Figure 1.

Table 1: DNB performance Parameters

Ion species	H^-
Beam energy	100 keV
Beam current	60 A
Duty cycle and modulation	3s ON/ 20s OFF, 5 Hz
Accelerated current density	300 A/m^2
Beamlet divergence (core)	<7 mrad

The DNB is covered by two procurement arrangements (PAs): one for the DNB Power Supplies and one for the DNB Beamline components. The first has been signed in April 2009 and the second one in March 2010. The Beamline PA covers items with built-to-print (BTP), Detailed Design (DD) and Functional specifications, necessitating different levels of IO involvement in the design effort carried out by the Indian DA. IO is not only responsible for monitoring the design effort of the Indian DA, but also for the integration of the system into the ITER Plant. Interface issues have to be addressed continuously for all components as the design of the interfacing systems evolves.

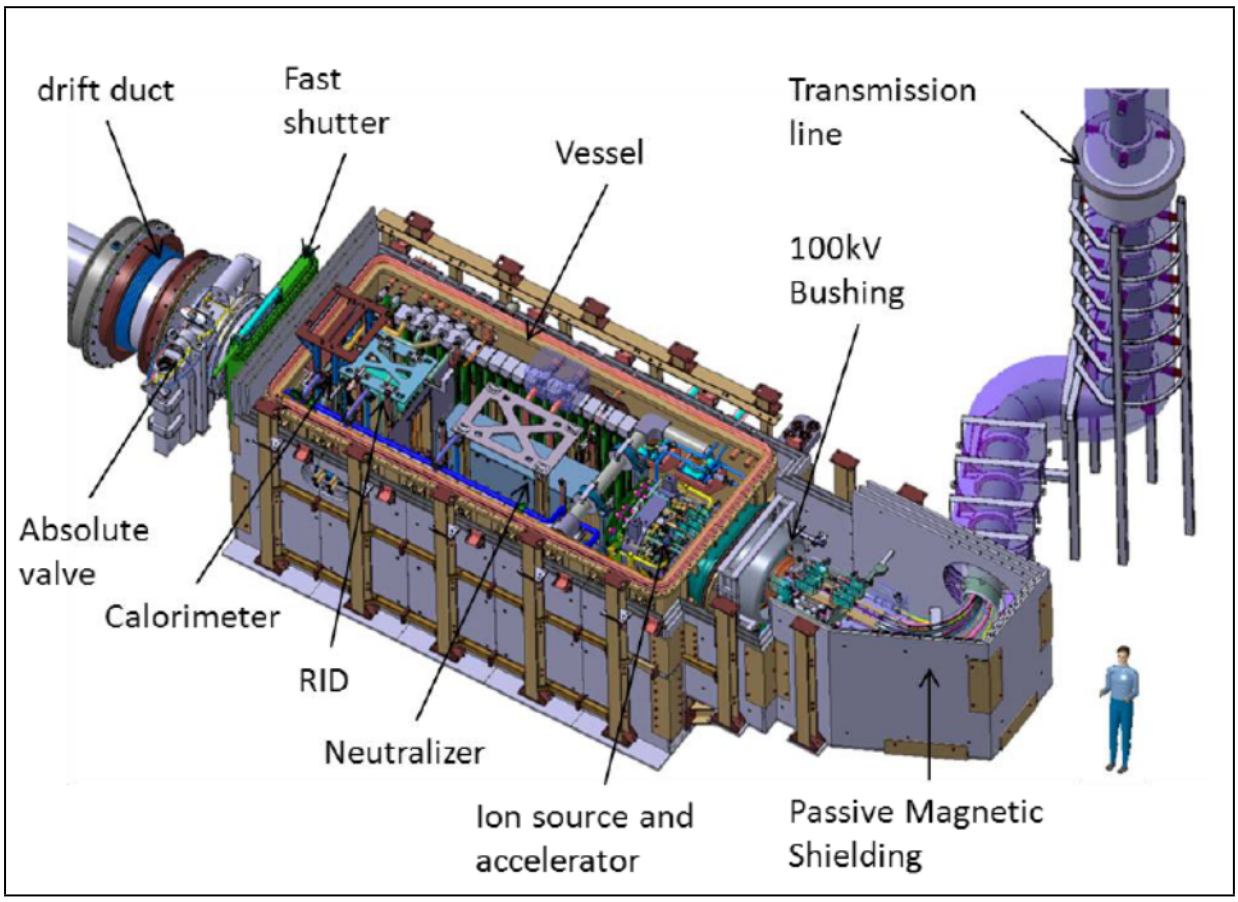

Figure 1: 3D view of diagnostic neutral beam injector

2 Scope

The objective of this contract is to perform mechanical analyses and assessments for assistance in the DNB procurement during 2016 to 2018. The services required will cover DNB Injector design activities with emphasis on the DD and Functional Specification items, analyses for the follow-up of the manufacturing of the DNB Beamsource and the Beam Line Components (BLCs) and associated updates of the DNB injector documentation. Specific engineering analyses (seismic, load analysis, FMECA) for the NB Section are also required as specified in Item 6. The deliverables cover input documentation for the Final Design Reviews of the DNB vessel, the PMS and the ACCC's, detailed assessments during the manufacturing follow-up of the DNB beamsource and beamline components (non-conformities, deviations and material assessments) and inputs into safety documents, ESP classification and exemption documentation

3 Definitions

ACCC	Active Correction and Compensation Coil
BES	Beam Emission Measurements
BLC	Beam Line Components
BoM	Bill of Material
BS	Beam Source
BTP	Built-to-Print
CAD	Computer-Aided Design

CDR	Conceptual Design Review
CXRS	Charge Exchange Recombination Spectroscopy
DD	Detailed Design
DDB	Drift Duct Bellow
DNB	Diagnostic Neutral Beam
DR	Deviation Request
FDR	Final Design Review
FMECA	Failure Mode, Effects and Criticality Analysis
H&CD	Heating & Current Drive
INDA	Indian Domestic Agency
IS	Interface Sheet
HNB	Heating Neutral Beam
MSE	Motional Stark Effect Beam Emission Measurements
NCR	Non-Conformity
PA	Procurement Arrangement
PMS	Passive Magnetic Shield
RAMI	Reliability, Availability, Maintainability & Inspectability
RH	Remote Handling
RID	Residual Ion Dump
SVS	Service Vacuum System
TRO	Technical responsible Officer

For a complete list of ITER abbreviations see: ITER Abbreviations (ITER_D_2MU6W5).

4 References

Not applicable.

5 Estimated Duration

The contract is estimated to cover a period of 24 months (see Item 12).

6 Work Description

Subtask 1: Following-up of design activities related to DNB Vessel

The vessel of the DNB injector is one of the most critical components of the injector. It is classified as a SIC / PIC component and fulfils a confinement function. The vessel has to guarantee the correct leak-tightness of the injector and also allow maintenance of the BLC's and the Beamsource. The final design review is foreseen at the beginning of 2018.

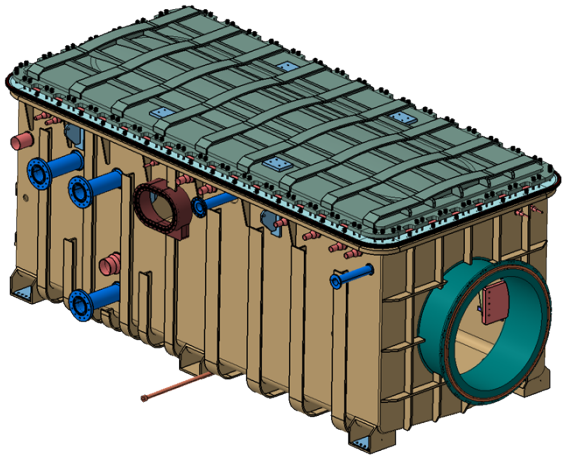

Figure 2: DNB Vessel

Mechanical engineering services are needed to validate the DNB vessel design proposed by INDA before presentation at the Final Design Review; this includes

- to cross check all design details including compliance with the design codes;
- to perform mechanical analyses in order to validate the design proposed by IN-DA;
- to ensure correct integration into the NB cell and correct integration with the interfacing systems (building, cooling water, cryopump and remote handling) and update the interface documentation;
- to prepare the input documentation required for the FDR.

The deliverables have to cover:

- compliance assessment reports;
- written analysis reports and updated load specifications;
- updated interface sheets and RH documents in line with the design of the vessel;
- input documents and presentation for the vessel FDR.

Subtask 2: Following-up of design activities related to the PMS

The PMS for the DNB is composed of three layers of ferromagnetic steel (all 3 layers are 50mm thick), enclosing the DNB injector, including the HV bushing and the elbow of the transmission line (see Figure 3).

The DNB PMS FDR is foreseen beginning of 2018.

The PMS has the following two main functions:

- to form, together with the active correction and 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.

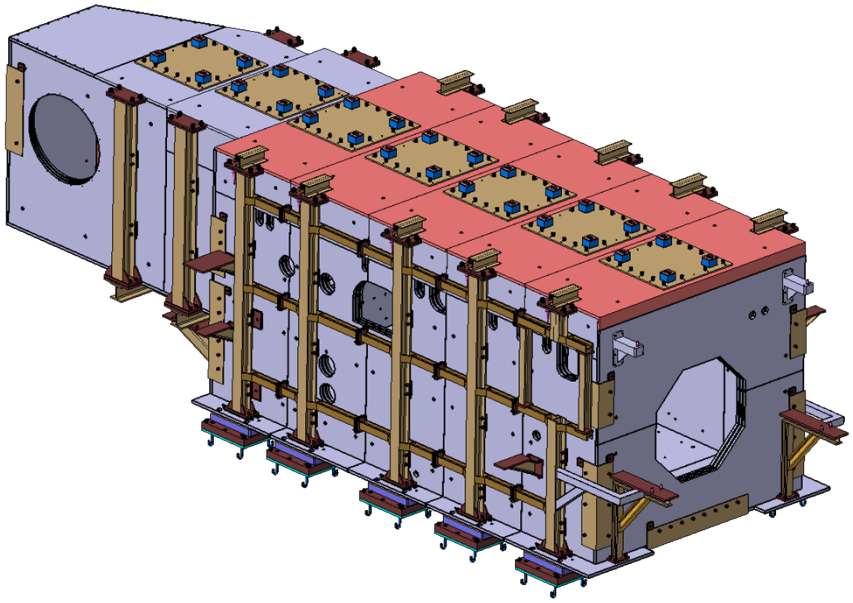

Figure 3: DNB Passive Magnetic Shield

Mechanical engineering services are needed to validate the DNB PMS design proposed by INDA before presentation at the Final Design Review; this includes

- to cross check all design details including compliance with the design codes;
- to perform mechanical analyses in order to validate the design proposed by IN-DA;
- to ensure correct integration into the NB cell and the HV deck room and correct integration with the interfacing systems (building, cooling water, power supply and remote handling) and update the interface documentation;
- to prepare input documentation required for the Final Design Review.

The deliverables have to cover:

- compliance assessment reports;
- written analysis reports and updated load specifications;
- updated interface sheets and RH documents in line with the design of the PMS.
- input documents and presentation for the PMS FDR.

Subtask 3: Follow-up of design activities related to ACCCs

The primary function of the ACCCs and the PMS is to limit the magnetic field inside the DNB vessel to acceptable levels by producing magnetic fields which compensate the ITER stray fields.

The ACCCs are made of copper with a thin layer of epoxy implemented between the pancakes and the turns to guaranty an electrical insulation. The ACCCs are water cooled and alimented by 800A of current at 110V potential (See Figure 4).

The ACCCs have the following functions:

- To shield the injector from external magnetic field (especially where the beam is not neutralized; the ACCCs 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).

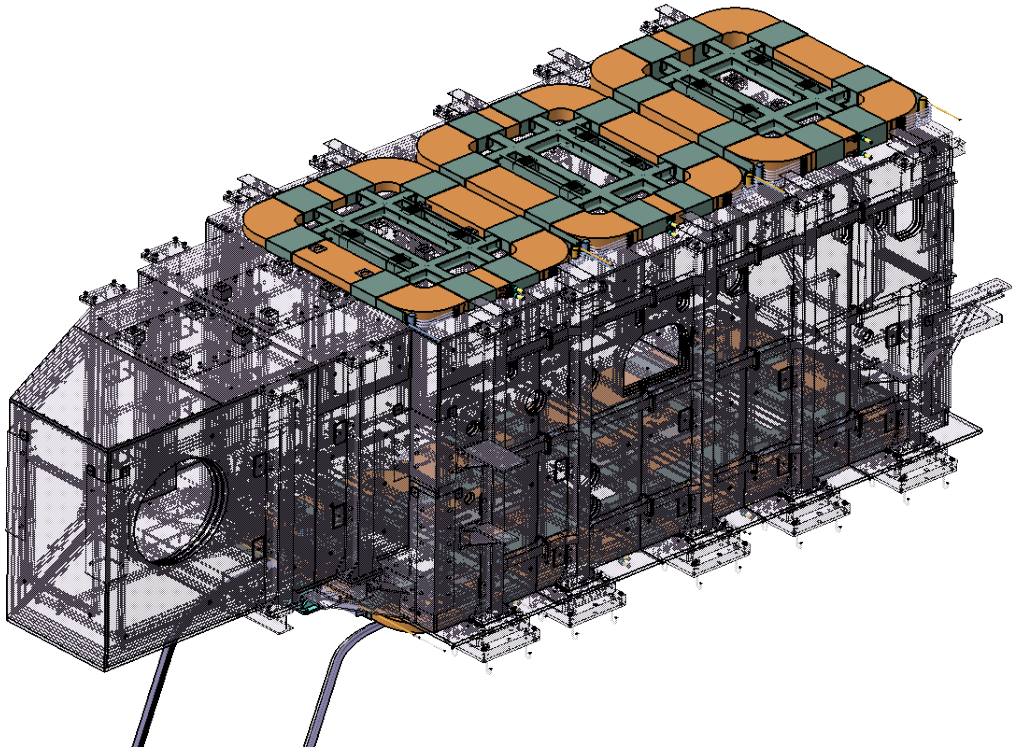

Figure 4: DNB ACCCs

Mechanical engineering services are needed to validate the DNB ACCC design proposed by INDA before presentation at the Final Design Review; this includes

- to cross check all design details including compliance with the design codes;
- to perform mechanical analyses in order to validate the design proposed by IN-DA;
- to ensure correct integration into the NB cell and correct integration with the interfacing systems (building, cooling water, power supply and remote handling);
- to prepare input documentation required for the Final Design Review.
- to propose a mechanical concept for the component, the assembly and/or remote handling tools.

The deliverables have to cover:

- compliance assessment reports;
- written analysis reports and updated load specifications;
- updated interface sheets and RH documents in line with the design of the ACCCs.
- input documents and presentation for the ACCC FDR.

Subtask 4: Follow up of DNB Beam Source Manufacturing

The DNB Beam source is under manufacturing at PVA Tepla in Germany. The component is part of the procurement arrangement PA53.P7B with the Indian DA. The manufacturing has started in January 2015 after the completion of the prototype testing of the acceleration grid and will continue through 2016-2017.

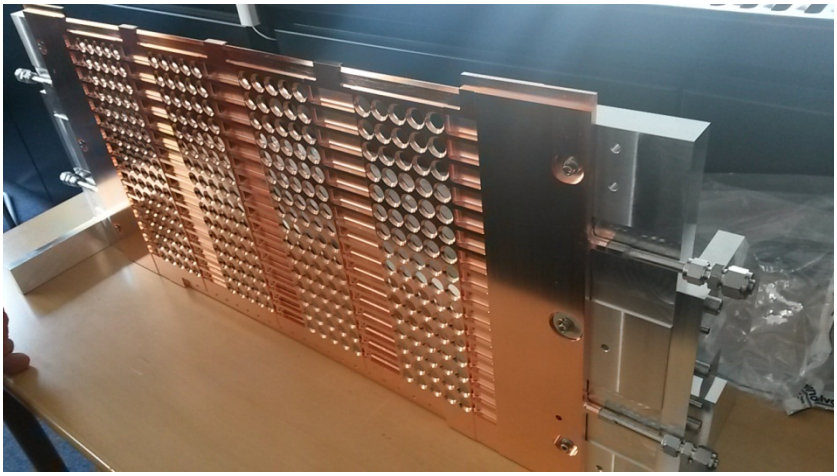

Figure 5: DNB Grid Prototype

Mechanical engineering services are needed to assure the follow-up of the manufacturing of the DNB beamsource:

- to support the RO of the DNB in the review of all manufacturing documents linked to mechanical issues (NCR's, DR's, manufacturing procedures such as welding, cleaning, testing procedures…);
- to attend notification points of the manufacturing inspection plan (witness points, factory acceptance tests, etc…) as required.

The deliverables have to cover:

- reviews of technical documents such as NCR's, DR's, manufacturing procedures such as welding, cleaning, testing procedures, including a review report to IO;
- report to the RO on any issue identified;
- compliance assessment reports;
- written analysis reports.

Subtask 5: Follow up of DNB Beam Line Components manufacturing

The contract for the manufacturing of the DNB beam line components has been signed between the Indian DA and the manufacturer PVA Tepla in Germany. The 3 components Neutralizer, RID and calorimeter (the first two are the ITER components, the third is will only be used at the Indian Test Facility) will be manufactured by this company.

Mechanical engineering services are needed to assure the follow-up of the manufacturing of the DNB BLCs:

- to support the RO of the DNB in the review of all manufacturing documents linked to mechanical issues (NCR's, DR's, manufacturing procedures such as welding, cleaning, testing procedures…);
- to attend notification points of the manufacturing inspection plan (witness points, factory acceptance tests, etc…) as required.

The deliverables have to cover:

- reviews of technical documents such as NCR's, DR's, manufacturing procedures such as welding, cleaning, testing procedures, including a review report to IO;
- report to the RO on any issue identified;
- compliance assessment reports;
- written analysis reports.

Subtask 6: ESP and ESPN Classification

The current design of the NB components is based on water cooled systems at relatively high pressure (20 bars). In consequence, their classification under ESPN rules must be examined and assessed.

A study is ongoing under ITER Safety Group who are collecting all data and prepare a report which must be submitted to the French Regulator in order to determine if components can be exempted or not. Consequently, the result of this work could have a strong impact on components design.

First reports had been submitted for the HNB bushing and the transmission line in order to exempt the components from ESPN; other reports have to be generated to be in accordance with the French regulation.

Updates of the documents must be foreseen as the process is iterative depending on the results, and / or if data are found to be missing. In parallel data regarding corrosion analysis inside the cooling circuit will have to be collected as activated corrosion products are an issue.

Mechanical engineering services are needed:

- to prepare a list of documents to be submitted to the French Regulator;
- to write the necessary documents in French and English;
- to present the documentation to the ASN.

The deliverables have to cover:

- written technical reports requesting the ESPN exemption;
- official presentations for the ASN as necessary;
- report on the impact of the classification on the components design.

Missions will be necessary during this contract to attend manufacturing follow-up meetings including witness points, factory and site acceptance tests for the DNB BS and the BLCs. These will be reimbursed under ITER Organization conditions.

7 Responsibilities

Not applicable as no issues with customs and / or other logistics.

8 List of deliverables and due dates

See Item 12 for the list of deliverables and the delivery dates.

9 Acceptance Criteria

Analyses and assessments listed in the deliverables table under Item 12 have to be provided in the form of reports uploaded in IDM, to be reviewed and approved. Deliverables covering document updates (load specification documents, RAMI and FMECA documents) are deemed as received once the updates are uploaded in IDM, and the associated activity report is approved in IDM.

10 Specific requirements and conditions

The entity applying company / consultants have to provide resources capable of providing mechanical engineering analyses. Expertise in the following specific fields is required:

• Expertise in design of components in vacuum environment;

• Expertise in design activities, follow up and project lead;

• Knowledge of international and French industrial codes and standards (RCC-MR, ASME 8, SDC-IC, etc…);
• Writing of technical specifications and documentation and quality follow-up;
• Knowledge of CATIA V5 (mechanical design software used in ITER);
• Experience in Finite element analysis (e.g.: ANSYS WB v14 (thermo-mechanical analysis)),
• Experience in piping analysis (e.g.: CAEASAR II);
• Expertise in the fusion field is an advantage;
• Experience in manufacturing processes (deep drilling, forging, machining, EB-TIG welding, hipping, diffusion bonding, technique of inspections, leak detection, etc …) is an advantage.
• English fluent (written and spoken).
• French fluent (written and spoken).

11 Work Monitoring / Meeting Schedule

Final Reports should be self-contained, and relevant documentation, such as drawings, should be supplied together with the report 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 asses 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.

12 Delivery time breakdown

No	Details	Deliverables	Estimated due date
1	Preparation of the Final Design Review of the DNB vessel. The following documents will be prepared in accordance with the updated design of the component by IN-DA: • Revision of load specification documents for the DNB Vessel (ITER_D_3RZA9D). The load specification shall address all loads applied to the component in normal operations, assembly and accidental conditions. The loads shall be in accordance. • Update of IS and ICD • Update of RH documents (PDF, TDF, RHCR) • FDR presentation	-1 Load Specification -1 IS -1 ICD -1 PDF -1 TDF -1 RHCR -1 PPT	T0 + 4 months
2	Preparation of the Final Design Review of the DNB PMS. The following documents will be prepared in accordance with the updated design of the component by IN-DA: • Revision of load specification documents for DNB PMS (ITER_D_AJEAK4). The load specification shall address all loads applied to the component in normal operations, assembly and accidental conditions. The loads shall be in accordance. • Update of IS and ICD • Update of RH documents (PDF, TDF, RHCR) • FDR presentation	-1 Load Specification -1 IS -1 ICD -1 PDF -1 TDF -1 RHCR -1 PPT	T0 + 8 months
3	Preparation of the Final Design Review of the DNB ACCCs. The following documents will be prepared in accordance with the updated design of the component by IN-DA: • Revision of load specification documents for DNB ACCCS (ITER_D_BF8F5K). The load specification shall address all loads applied to the component in normal operations, assembly and accidental conditions. The loads shall be in accordance. • Update of IS and ICD • Update of RH documents (PDF, TDF, RHCR) • FDR presentation	-1 Load Specification -1 IS -1 ICD -1 PDF -1 TDF -1 RHCR -1 PPT	T0 + 12 months
4	Review of the manufacturing documents delivered by IN-DA for the DNB Beam Source. All documents uploaded by the TROs will be reviewed and assessed; assessment reports to be provided to the TROs on any issue identified in the manufacturing progress of the DNB Beam Source. The following documents have to be reviewed (estimated numbers): - Deviation Requests (~50)	Monthly Report with list of documents reviewed + Mission report if needed	T0 + 16 months

	- Non-Conformity Reports (~20) - Drawings (~200) - Procedures (~20)		
5	Review the manufacturing documents delivered by IN-DA for the DNB Beam Line Components. All documents uploaded by the TROs will be reviewed and assessed; assessment reports to be provided to the TROs on any issue identified in the manufacturing progress of the BLCs. The following documents have to be reviewed (estimated numbers):: - Deviation Requests (~100) - Non-Conformity Reports (~30) - Drawings (~200) - Procedures (~20)	Monthly Report with list of documents reviewed + Mission report if needed	T0 + 20 months
6	Prepare the safety documents linked with the ESPN classification of NB components. The following documents have to be prepared and presented to the ASN if necessary: - List of NB components and corresponding safety classification - Requests for exemption of identified components agreed with the NB section leader - Presentations to the ASN	1 Technical report + Request for exemption + Mission report if needed	T0 + 24 months

Deliverables are phased in line with the PBS53 AWP notably to provide input into design reviews and the ongoing manufacturing.

On completion of each deliverable, the Contractor shall submit an invoice for the services rendered. This invoice will clearly indicate the contract reference number, the name of the assigned person and the IDM reference of the deliverable(s).

13 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 Procurement Requirements for Producing a Quality Plan (ITER_D_22MFMW).

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, in accordance with Quality Assurance for ITER Safety Codes (ITER_D_258LKL).

14 Safety requirements

ITER is a Nuclear Facility identified in France by the number-INB-174 (“Installation Nucléaire de Base”).

For Protection Important Components and in particular Safety Important Class components (SIC), the French Nuclear Regulation must be observed, in application of the Article 14 of the ITER Agreement.

In such case the Suppliers and Subcontractors must be informed that:

- The Order 7th February 2012 applies to all the components important for the protection (PIC) and the activities important for the protection (PIA).
- The compliance with the INB-order must be demonstrated in the chain of external contractors.
- In application of article II.2.5.4 of the Order 7th February 2012, contracted activities for supervision purposes are also subject to a supervision done by the Nuclear Operator.

For the Protection Important Components, structures and systems of the nuclear facility, and Protection Important Activities the contractor shall ensure that a specific management system is implemented for his own activities and for the activities done by any Supplier and Subcontractor following the requirements of the Order 7th February 2012 [20].