外部委託業者の募集

References: IO/24/CFT/10029247/JGO

“Supply Contract for Main Pumps of Integrated Blanket, Edge Localized Mode/Vertical Stability, and Divertor (IBED) Primary Heat Transfer System (PHTS)"

（統合ブランケット、エッジ局所モード/垂直安定用メインポンプ、ダイバーター、一次熱伝達システムの供給契約）

IO 締め切り 2024 年 8 月 1 日(木)

〇序文

1. 序文

この技術仕様書は、一般管理仕様書（GM3S）[d1] と組み合わせて読まれるものであり、技術的要件の完全な部分を構成します。矛盾が生じた場合、技術仕様書の内容が[d1] の内容に優先されます。
電気および制御キャビネットの技術仕様書[d2] に詳述された要件および機器は、この技術仕様書の供給範囲に完全に含まれているものとします。

2. 目的

統合ブランケット、エッジ局所モード（ELM）/垂直安定性（VS)、およびダイバーター主熱輸送システム（IBED PHTS）は、真空容器内のプラズマ面部品（ブランケットモジュールおよびダイバーターカセット）に脱塩水を供給することにより冷却サービスを提供します。また、ELM および VS コイル、および上部、水平部、および下部のさまざまなクライアントに冷却水を供給します。IBED PHTS は、8 つの主ポンプ/熱交換器トレインのセットを介して、5 つの冷却ループ（3 つのファーストウォール/毛布ループ、1 つのダイバーターループ、1 つの水平ポートループ）に冷却水を供給します。IBED PHTS は、冷却水外部の IBED PHTS クライアントおよびすべての運転モード中に漏れのない閉鎖性を維持するよう設計されています。
この仕様書は、IBED PHTS メインポンプ（タグ番号 26PHBD-PL-1910 から 26PHBD-PL-1980）の材料、設計、製造、検査、調査、試験、認証、資格付け、および納品準備を定義し、さまざまな運転モード中に IBED PHTS クライアントに冷却水を供給する 8 台の IBED PHTS メインポンプについて記載しています（詳細は付録 F - 簡略化 IBED PHTS PFD を参照)。IBED PHTS メインポンプの電気および制御パネルの詳細要件は[d2]に記載されています。

〇目的

ITER は平和利用の核融合発電の科学的および技術的な実現可能性の実証を目的とした、国際共同研究開発プロジェクトです。ITER 機構の 7 つのメンバーは、;欧州連合（EURATOM が代表）、日本、中華人民共和国、インド、大韓民国、ロシア連邦、および米国です。
ITER の敷地はフランス南東部のブーシュデュローヌ地区にあり、ITER 本社（HQ）もあるフランス CEA サン・ポール・レ・デュランス に近いところに位置しています。詳細については、ITER のウェブサイト http://www.iter.org を参照して下さい。

○作業範囲

契約者は、以下で定義される作業範囲に対する完全な設計、資格付け、製造、検査、試験、性能、塗装、梱包、積み込み、ITERへの安全な納品に責任を負います。
契約者は、本節の要件を包括する供給範囲を詳細に決定し、装置の機能および運用要件が満足されるように確認する責任を負います。

1 供給範囲

以下で定義される8つのポンピングトレインで構成される供給範囲は次のとおりです：
a. メインスキッドに取り付けるポンプ、モーターおよびアクセサリー（セクション5.1.1を参照）。
b. 電気および制御キャビネット（セクション5.1.2を参照）。
c. スキッド外または解体出荷される設備（セクション5.1.3を参照）、および必要な予備部品と特殊工具（セクション5.1.4を参照）。

2 サービスの範囲

a. 会議（契約者の人員の出張と宿泊費を含む）：
i. キックオフ会議
ii. 製造準備レビューに関連する事前検査会議
iii. エンジニアリング会議
iv. プロジェクトゲートで要求されるその他の設計レビューおよび契約レビュー（セクション17.2を参照）
b. セクション18で要求されるすべてのプロジェクト文書
c. 承認されたプロジェクト図面に従った供給範囲の完全な組み立て
d. 断熱材/ヒートトレーシング/防火断熱材/クラッディングによる人員保護の取り付け
e. ITERサイトへの安全な納品（フランス、サン＝ポール＝レ＝デュランスのITERサイトへのDAP納品）
f. 承認されたMIPに従ったすべての必要な非破壊検査（NDT）と証明書
g. 適用される法律と規格に従って必要な第三者のサービス
h. 製造および受け入れテスト活動と証明書
i. 資格文書、試験、および証明書
j. 機械が運用および偶発的な条件に耐える適格性を認証するために必要なすべての計算ノートと解析。解析モデルは[d1]のセクション7.4に従って提出されます。
k. 設置と立ち上げへの支援、現地受け入れテストへの参加。これには、メインスキッドおよび補助スキッドに供給される装置に特化した人員、および電気および制御キャビネットに関する人員も含まれます（[d2]を参照）。

3 除外事項

契約者の供給範囲から除外される項目：
a. スキッド上の接続ボックスから電源およびVFDへの電気ケーブル
b. スキッド上の接続ボックスからUCPへの計装ケーブル
c. メインポンプスキッドのバッテリーリミットとメカニカルシール支持スキッド間の接続配管

d. すべての端子点に溶接される配管（吸引および排出フランジを除く）（5.1.3を参照）
e. 断熱材/ヒートトレーシング/防火断熱材
f. メインポンプとモーター間に設置される放射線遮蔽壁
g. 消火システム
h. 土木工事およびコンクリート基礎

4 契約者の見積もり依頼

契約者は以下の別々の見積もりを提供するものとします：
見積もり＃1 8台のメインポンプユニットおよびそれらの補助機器の供給（5.1.1、5.1.3および該当する5.2の部分を参照）
見積もり＃2 VFD、VCB、UCP、LV MCCを含む電気キャビネット（5.1.2および該当する5.2の部分を参照）
見積もり＃3 予備部品および特殊工具（5.1.4を参照）
見積もり＃4 VFD、VCB、UCP、LV MCC間の接続配線（[d2]を参照）
見積もり＃5 設置、立ち上げ、SATsへの支援（5.2を参照）

5 納期

合意された納期は発注書に含まれます。契約締結から5年以内に納品される必要があります。最後のユニットが契約締結から5年以内に納品される限り、契約者はIOによる納品承認後、段階的な納品を行うことが許容されます。

【※　詳しくは添付の英語版技術仕様書「**Supply Contract for Main Pumps of Integrated Blanket, Edge Localized Mode/Vertical Stability, and Divertor (IBED) Primary Heat Transfer System (PHTS)**」をご参照ください。】
ITER 公式ウェブ　http://www.iter.org/org/team/adm/proc/overview からもアクセスが可能です。

「核融合エネルギー研究開発部門」の HP：　http://www.fusion.qst.go.jp/ITER/index.html では ITER 機構からの各募集（IO 職員募集、IO 外部委託、IO エキスパート募集）を逐次更新しています。ぜひご確認ください。

イーター国際核融合エネルギー機構からの外部委託
に関心ある企業及び研究機関の募集について

＜ITER 機構から参加極へのレター＞

以下に、外部委託の概要と要求事項が示されています。参加極には、提案された業務に要求される能力を有し、入札すべきと考える企業及び研究機関の連絡先の情報を ITER 機構へ伝えることが求められています。このため、本研究・業務に関心を持たれる企業及び研究機関におかれましては、応募書類の提出要領にしたがって連絡先情報をご提出下さい。

china eu india japan korea russia usa
Route de Vinon-sur-Verdon - CS 90 046 - 13067 St Paul Lez Durance Cedex - France

To:
Domestic Agencies

Date: 11 July 2024

Reference: IO/24/CFT/10029247/JGO

Subject: Call for Nominations – **Supply Contract for Main Pumps of Integrated Blanket, Edge Localized Mode/Vertical Stability, and Divertor (IBED) Primary Heat Transfer System (PHTS)**

Dear Colleagues,

The ITER Organization is pleased to invite the Domestic Agencies to nominate companies, institutions or other entities that would be capable of providing support for

china
eu
india
japan
korea
russia
usa

"Supply Contract for Main Pumps of Integrated Blanket, Edge Localized Mode/Vertical Stability, and Divertor (IBED) Primary Heat Transfer System (PHTS)"

Please find enclosed the Technical Specification and the Nominations template.

The potential candidates should have a recognized level of expertise, skills and demonstrated experience in the field mentioned above, as well the financial capability.

Could you please provide us with a list of suitable potential candidates, mentioning their up-to-date contact details using the attached excel template. Then, we will invite them to prequalify.

Please send your proposals by e-mail to Jingyu.Gao@iter.org and copy Yao.Wu@iter.org by latest 1st August 2024.

Yours faithfully,

Jingyu Gao
Procurement Officer
Construction, Assembly &Logistics Section

Annexes:
- Technical Specification ITER_D_9396JP v1.5
- Nominations template

IDM UID
9396JP

VERSION CREATED ON / VERSION / STATUS
27 May 2024 / 1.5 / Approved

EXTERNAL REFERENCE / VERSION

Technical Specifications (In-Cash Procurement)

Technical Specification for Main Pumps of Integrated Blanket, Edge Localized Mode/Vertical Stability, and Divertor (IBED) Primary Heat Transfer System (PHTS)

This is the Technical Specification for Integrated Blanket, Edge Localized Mode/Vertical Stability, and Divertor (IBED) Primary Heat Transfer System (PHTS) Main Pumps. This specification covers eight IBED PHTS Main Pumps, 26PHBDPL- 1910, 26PHBD-PL-1920, 26PHBD-PL-1930, 26PHBD-PL-1940, 26PHBD-PL-1950, 26PHBD-PL-1960, 26PHBD-PL-1970, 26PHBD-PL-1980.

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1 Preamble

This Technical Specification is to be read in combination with the General Management Specification for Service and Supply (GM3S) [d1] that constitutes a full part of the technical requirements. In case of conflict, the content of the Technical Specification supersedes the content of [d1].

The requirements and the equipment detailed in *Technical Specification for Electrical and Control Cabinets* [d2] shall be integrally included in the scope of supply of this Technical Specification.

2 Purpose

The Integrated Blanket, Edge Localized Mode (ELM)/Vertical Stability (VS), and Divertor Primary Heat Transfer System (IBED PHTS) provides cooling services by supplying demineralized water to the plasma-facing components (Blanket Modules and Divertor Cassettes) within the Vacuum Vessel. It also provides cooling water to the ELM and VS coils and to the various clients in the upper, equatorial, and lower ports. The IBED PHTS supplies cooling water to five cooling loops (three First Wall/Blanket Loops, one Divertor Loop, and one Equatorial Port Loop) via a set of eight main pump/heat exchanger trains. The IBED PHTS is designed to provide the primary confinement for Activated Corrosion Products and tritium entrained in the cooling water outside the IBED PHTS clients and maintains leak tight integrity during all operating modes.

This Specification defines the material, design, fabrication, inspection, examination, testing, certification, qualification and preparation for delivery of the **Eight (8) IBED PHTS Main Pumps** (tag No. 26PHBD-PL-1910 through 26PHBD-PL-1980) that provide cooling water to the IBED PHTS clients during different modes of operation (refer to Appendix F – Simplified IBED PHTS PFD). Detailed requirements for Electrical and Control panels of the IBED PHTS Main Pumps are given in [d2].

3 Acronyms and Definitions

3.1 Acronyms

The following acronyms are the main one relevant to this document.

Table 1 - List of Abbreviations

Abbreviation	Description
ACP	Activated Corrosion Products
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASN	Autorité de Sûreté Nucléaire (Nuclear Safety Authority)
ASTM	American Society for Testing and Materials
BB2	Radially split, one- and two-stage, between-bearings pump
BPVC	Boiler and Pressure Vessel Code
CE	Conformité Européenne (European Conformity)
CMTR	Certificated Material Test Reports
CFD	Computational Fluid Dynamics

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CRO	Contract Responsible Officer
DN	Nominal Diameter
DS	Datasheet
EDH	Electrical Design Handbook
EN	European Norm
EP	Embedded Plates
ESPN	Equipments sous Pression Nucléaires (Nuclear Relate Pressure Equipment)
ESR	Essential Safety Requirements
E-stop	Emergency Stop
FRS	Floor Response Spectra
GM3S	General Management Specification for Service and Supply
IBED PHTS	Integrated Blanket/Edge Localization Mode/Divertor Primary Heat Transfer System
HVAC	Heating, Ventilation, and Air Conditioning System
I&C	Instrumentation and Control
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
IO	ITER Organization
LCP	Local Control Panel
LV	Low Voltage
MAWP	Maximum Allowable Working Pressure
MCC	Motor Control Center
MTO	Material Take Off
MV	Medium Voltage
N/A	Not Applicable
NB/ANB	Notified Body/Agreed Notified Body
PCS	Plant Control System
PFD	Process Flow Diagram
PIA	Protection Important Activity
PIC	Protection Important Component
PLC	Programmable Logic Controller
PSS	Plant Safety System
PNI	Part Number Identification
PMI	Positive Material Identification
PQR	Procedure Qualification Record
PRO	Procurement Responsible Officer
QA	Quality Assurance
QC	Quality Class
ORP	Oxidation Reduction Potential

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RCC-E	Design and Construction rules for Electrical and I&C Systems and Equipment
RCC-M	Design and Construction Rules for the Mechanical Components of PWR Nuclear Islands
RTD	Resistance Temperature Device
SC	Seismic Class
SIC	Safety Important Class
SL	Seismic Level
SLD	Single-Line Diagram
SMHV	Séismes Maximaux Historiquement Vraisemblables (Maximum Historically Probable Earthquakes)
SR	Safety-Related
SRD	System Requirements Document
SSEN	Steady-State Electrical Network
TCWS	Tokamak Cooling Water System
TP	Terminal Point
TRO	Technical Responsible Officer
TTT	Function Category Designators
UCP	Unit Control Panel
VCB	Vacuum Circuit Braker
WPS	Welding Procedure Specification
VAC	Volts Alternating Current
VDC	Volts Direct Current
VFD	Variable Frequency Drive
VV PHTS	Vacuum Vessel Primary Heat Transfer System

3.2 Definitions

Contractor: the economic operator who have signed the Contract in which this document is referenced, as defined in the Special Conditions of the said Contract.

IBED PHTS Main Pumps: complete scope of supply as defined in sections 2 and 5.1.

Inline connections: connections that are directly connected to piping. These flanges will be exposed to piping interface loads (bending/torsion moments and axial/transverse forces) and thermal expansion. This includes but is not limited to Suction and discharge flanged nozzles of pumps.

Main Skid: Common baseplate on which main pump, motor and secondary baseplates will be installed.

Mandatory Template: model of document provided by IO that the Contractor shall use in order to submit the said document and which cannot be modified without the prior agreement of the IO.

Runaway speed: Maximum speed that can be reached by a centrifugal pump operating in turbine mode (as a driver or in the case of reverse flow because of a malfunction), at full flow (i.e. there is a pressure gradient) and no load.

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sub-Contractor: shall mean an economic operator who is under contract to a Contractor providing supplies, services or works to the IO, being understood that the subcontractor shall perform, under responsibility of the Contractor, with independence and free from any subordination, a specific part of the obligations of the Contract.

Supplier: a legally registered entity, that can provide standard / catalog goods or material, or standard services to a Contractor, or a subcontractor, that will enable the performance of the scope of work to be provided by the Contractor or subcontractor. In the frame of this technical specification the term **sub-Supplier** is used considering the presence of a main Contractor.

Typical Template: model document provided by IO for information that the Contractor may use to submit this type of document.

4 Applicable Documents & Codes and standards

4.1 Applicable Documents

It is the responsibility of the Contractor to identify and request for any documents that would not have been transmitted by IO, including the below list of reference documents.

All additional documents referenced in specification [d2] apply to the scope of supply.

Applicable version of references listed in 4.1.1, 4.1.2 and [d2] will be confirmed at the date of the Purchase Order.

Upon notification of any revision of the applicable document transmitted officially to the Contractor, the Contractor shall advise within 2 weeks of any impact on the execution of the contract. Without any response after this period, no impact will be considered.

4.1.1 Reference Requirements (Provided to Contractor)

Table 2 - Reference Requirements (Provided to Contractor)

Ref	Title	IDM ID	V.
[d1]	General Management Specification for Service and Supply (GM3S)	82MXQK	1.4
[d2]	Technical Specification for Electrical and Control Cabinets for Integrated Blanket, Edge Localized Mode/Vertical Stability, and Divertor (IBED) Primary Heat Transfer System (PHTS) Main Pump	ALWTJX	2.2
[d3]	Quality Classification Determination	24VQES	5.2
[d4]	IBED PHTS System Sizing Calculation	PAVZLW	4.0
[d5]	IBED-PHTS I&C functional requirements	UX8CPK	1.6
[d6]	Allowable values and limits in service level C and D for ITER mechanical components	3G3SYJ	3.1
[d7]	TCWS Load Specification	SZE5MR	2.6
[d8]	Equipment Specification for piping materials used in the design of process piping systems	SJE6S7	2.14
[d9]	Assessment of TCWS effluents, influents, and chronical leaks	U7YB3K	4.0
[d10]	Collection of Input Data to support Qualification Plan in charge of TCWS electro-mechanical equipment Contractor	YST3YH	2.3
[d11]	Radiation Environment for Equipment During Operations	3FM52L	1.1
[d12]	PBS26 IBED PHTS pressure vessels ESPN Classification Evaluation	UXKBZL	1.4

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Ref	Title	IDM ID	V.
[d13]	Chemical composition and impurity requirements for materials	REYV5V	2.3
[d14]	Working Instruction for Foreign Material Exclusion	3SJJVJ	1.4
[d15]	Technical specification for Coating and Tagging	S9YVVG	1.0
[d16]	TCWS Equipment Insulation	XB5DLJ	2.2
[d17]	ITER Document: EDH Part 1: Introduction	2F7HD2	1.4
[d18]	ITER Document: EDH Part 2: Terminology & Acronyms	2E8QVA	1.4
[d19]	ITER Document: EDH Part 3: Codes & Standards	2E8DLM	1.3
[d20]	ITER Document: EDH Part 4: Electromagnetic Compatibility (EMC)	4B523E	3.0
[d21]	ITER Document: EDH Part 5: Earthing and Lightning Protection	4B7ZDG	3.0
[d22]	IO cable catalogue	355QX2	6.11
[d23]	Electrical Single Line Diagram (SLD) for IBED PHTS	Y5Y9LM	1.5
[d24]	Technical Specification of LV Electrical Cubicles for TCWS 1st Plasma	4H8FPU	1.2
[d25]	deleted		
[d26]	deleted		
[d27]	Function Category Designators (TTT code)	43WDW9	-
[d28]	ITER Numbering System for Components and Parts	28QDBS	5.0
[d29]	HIRA PBS26 Risk Assessment Table	S3GEWG	2.0
[d30]	Procedure for Indication and Control of Items	U344WG	2.2
[d31]	How To Request PNI - Catalogue Part	2NGCBV	2.0
[d32]	Deliverables List - MTO (Material Take Off) - Template	4YADR6	1.2
[d33]	Procedure CMA Lifting Contract - Lifting and Handling	UBET8N	6.0
[d34]	Requirements for Producing a Contractors Release Note	22F52F	5.0
[d35]	Package & Packing List Template	XBZLNG	2.2
[d36]	Delivery Report Template	WZPYVZ	3.0
[d37]	Template - Equipment Storage & Preservation Requirements Form	WU9636	4.3
[d38]	Internal Regulations	27WDZW	3.1
[d39]	Health Protection and Safety General Consideration Plan – ITER Construction Site - Volume 0 - General Safety Rules	2NUEYG	5.7
[d40]	Commissioning Management Procedure	VH9352	1.5
[d41]	Procedure on procurement documentation Exchange between IO, DA and supplier	35BVQR	5.0
[d42]	ITER Procurement Quality Requirements	22MFG4	5.1
[d43]	Quality Assurance for ITER Safety Codes Procedure	258LKL	3.1
[d44]	Requirements for Producing a Quality Plan	22MFMW	4.0
[d45]	Provisions for implementation of the generic safety requirements by the external interveners	SBSTBM	2.3
[d46]	Order dated 7 February 2012 relating to the general technical regulations applicable to INB - EN	7M2YKF	1.7
[d47]	Procedure for management of non-conformities	22F53X	9.1

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Ref	Title	IDM ID	V.
[d48]	Procedure for the management of Deviation Request	2LZJHB	8.1
[d49]	Propagation of the Defined Requirements for Protection Important Components Through the Chain of External Interveners	BG2GYB	3.3
[d50]	List of ITER-INB Protections Important Activities	PSTTZL	2.2
[d51]	EDH Guide A: Electrical Installations for SSEN Client Systems	2EB9VT	2.7
[d52]	Requirements for Preparing and Implementing a Manufacturing and Inspection Plan	22MDZD	3.7
[d53]	Annex 2 - Detailed list of PIAs	Q8B5C4	1.2
[d54]	Qualification guidelines	WGFF3G	1.0
[d55]	Software Qualification Policy	KTU8HH	2.0
[d56]	Equipment Qualification Program	XB5ABP	1.2
[d57]	Test Method for ITER Equipment for Static (D.C) Magnetic Fields	98JL4W	3.3
[d58]	EEE Nuclear Radiation compatibility Handbook	U65BH5	2.1
[d59]	Safety Important Functions and Components Classification Criteria and Methodology	347SF3	1.8
[d60]	Working instruction for Manufacturing Readiness Review (MRR)	44SZYP	5.0
[d61]	Calculation of Seismic FRS on TCWS Mezzanines in Tokamak Building	U4MD7S	2.0
[d62]	Technical Specification for the Experimental Seismic Qualification of Active Electrical and Mechanical Components	AGL2QP	3.0
[d63]	Electrical Design Criteria for TCWS 2nd Plasma Systems	XSXVPZ	1.6
[d64]	Technical Specification for LV Electrical Cubicle and Systems for IBED PHTS, NBI PHTS & CVCS	Y4YGUZ	1.6
[d65]	I&C Design criteria document for TCWS - IBED PHTS, NBI PHTS, CVCS	Y6R3VX	1.4
[d66]	Guideline to manufacture NPE N2 or N3 cat 0 & PE cat 0	VHC4YM	1.3
[d67]	Guideline for the exclusion/exemption of equipment from the French regulation	35SVBG	2.2
[d68]	Total Neutron Flux	2UQTEE	1.4
[d69]	Working Instruction for the Delivery Readiness Review (DRR) (X3NEGB v2.0)	X3NEGB	2.0
[d70]	Instructions for Seismic Analyses	VT29D6	2.0
[d71]	Instructions for Structural Analyses	35BVV3	4.0
[d72]	IO Template of Qualification Synthesis Report	X3AUHZ	1.1
[d73]	Technical Specification for Coatings for Equipment	R45ME7	1.1
[d74]	Platform L4 Vault Platform14 16 17 – FRS	5UAZ7Z	1.0
[d75]	Tokamak Complex - Floor Response Spectra 2016	TFN4DN	1.3
[d76]	Radioprotection guide for ESPN application	2LTQ96	2.3
[d77]	Safety I&C specifications for TCWS	RW54RB	5.4

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4.1.2 Source References (Not Provided to Contractor)

Documentation of this section can be provided to Contractor on his demand.

Table 3 - Source References (Not Provided to Contractor)

Ref	Title	IDM ID	V.
[r1]	WP8.2.2 Final Report of RAMI analyses for TCWS	Y5X8X2	7.1
[r2]	Technical Specification for the VV PHTS Volume Control Tank 26PHVV-TA-5001	XKDVFV	4.2
[r3]	TCWS - Equipment Nozzle loads	5VUUXW	2.0
[r4]	Load Specifications	222QGL	6.2
[r5]	Codes and Standards for ITER Mechanical Components	25EW4K	4.0
[r6]	TCWS IBED PHTS System Process Loading Conditions	YQCUY5	2.1
[r7]	WP4.10 IBED PHTS. Screening of the water hammer and hydraulic load cases for L3 & L4	WUMC8Q	5.0
[r8]	WP4.16&4.18.Update of IBED PHTS & DYS water hammer analyses	3S3YGB	7.0
[r9]	Piping and Instrumentation Diagram (P&ID) IBED Primary Heat Transfer System (PHTS)	SNJ3LL	5.0
[r10]	System Requirement (SRD) Document SRD-26-PH,-CV,-DR,-DY (TCWS) from DOORS	2823A2	6.4
[r11]	System Requirement (SRD) Document SRD-26-CC (CCWS) from DOORS	2DVV9N	4.3
[r12]	Anticipated use of 2020 radiation maps for TCWS major components (superseded by [d12])	4655X7	1.0
[r13]	Safety Requirement Roombook (Figures 20 and 22 only)	KF63PB	2.11
[r14]	Magnetic Field Map Database Query Tool User Manual	53KMVD	1.4
[r15]	Practical approach in TCWS regarding fire event scenario	WRW2TW	1.4
[r16]	TCWS IBED PHTS Design Condition Calculation	S2KSZ9	3.3
[r17]	Radiation Maps During Plasma Operations (Mode-0)	RJLLFY	2.1
[r18]	Data Collection Table for PBS 65 Interface Requirements	34A96Z	4.23
[r19]	Construction Design - Tokamak complex - PBS 62.11,62.14 and 62.74 - Internal flooding	QV4FYF	7.0
[r20]	CMF Summary Report for IO Sensitive Components in B11 B2 B2M	Y59EDL	3.2
[r21]	Static and transient magnetic field maps at level L3 tokamak complex	QQGFU6	1.2
[r22]	Static and transient magnetic field maps at level L4 tokamak complex	QUDEGC	1.2
[r23]	Static and transient magnetic field maps at level R1 tokamak complex	R35C6B	1.2

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4.2 Applicable Codes and Standards

It is the responsibility of the Contractor to procure the relevant Codes and Standards applicable to this scope of work.

All additional Codes and Standards referenced in specification [d2] apply to the scope of supply. Applicable revision of Codes and Standards shall be verified at the date of the Purchase Order.

Table 4 - Applicable Codes and Standards

Ref	Title	Ed.
[s1]	API 610 - Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries	12th
[s2]	API 682 - Shaft Sealing Systems for Centrifugal and Rotary Pumps	4th
[s3]	API 614 - Lubrication, Shaft-sealing, and Oil-control Systems and Auxiliaries	6th
[s4]	API 671 - Special-purpose Couplings for Petroleum, Chemical, and Gas Industry Services	5th
[s5]	API RP 686 – Recommended Practice for Machine Installation and Installation Design	2nd
[s6]	ASME B 16.5 – 2013: Standard for Steel Pipe Flanges and Flanged Fittings	2013
[s7]	ASME Boiler and Pressure Vessel Code, Section II, Materials	2023
[s8]	ASME Boiler and Pressure Vessel Code (BPVC) - Section V-Non Destructive Examination	2023
[s9]	ASME Boiler and Pressure Vessel Code (BPVC) - Section VIII-Rules for Construction of Pressure Vessels Division 1 and Division 2	2023
[s10]	ASME Boiler and Pressure Vessel Code (BPVC) - Section IX-Welding, Brazing, and Fusing Qualifications	2023
[s11]	ASME B 16.5 – 2013: Standard for Steel Pipe Flanges and Flanged Fittings.	2013
[s12]	ASME B31.3-2010. Process Piping	2010
[s13]	ASME B36.19M – 2018: Stainless Steel Pipe	2009
[s14]	ASME NQA-1-2012, Quality Assurance Requirements for Nuclear Facility Applications.	2012
[s15]	ASME PTC – 19.1 – 2018, Test Uncertainty	2018
[s16]	ISO 21940-1:2016 1 - Mechanical vibration — Rotor balancing — Part 11: Procedures and tolerances for rotors with rigid behaviour	2016
[s17]	ISO 9906 – 2012: Rotodynamic Pumps – Hydraulic Performance acceptance tests Grade 1, 2, 3	2012
[s18]	ISO 10816-3 – 2004: Mechanical vibration - Evaluation of machine vibration by measurements on non-rotating parts	2004
[s19]	ISO 9001: Quality management systems — Requirements	2015
[s20]	ISO 3744: Acoustics — Determination of power levels and sound energy levels of noise sources using sound pressure	2010
[s21]	RCC-E - 2019, Design and Construction rules for Electrical and I&C Systems and Equipment	2019
[s22]	RCC-M -2017, Design and construction rules for mechanical components of PWR nuclear islands (for reference only)	2017
[s23]	EN 10204 – 2004: Metallic Products – Types of Inspection Documents	2004

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Ref	Title	Ed.
[s24]	EN 1591-1 – 2013: Flanges and Their Joints – Design Rules for Gasketed Circular Flange Connections – Part 1: Calculation.	2013
[s25]	EN 55011: Industrial, Scientific And Medical Equipment – Radio-Frequency Disturbance Characteristics – Limits And Methods Of Measurement	2016
[s26]	EN ISO 9712: Qualification and certification of NDT personnel	2012
[s27]	SNT-TC-1A: Personnel Qualification and Certification in Nondestructive Testing	2020
[s28]	IEC 60034 – all parts– 2017: Rotating Electrical Machines, all parts	2017
[s29]	IEC 60072 – 1 – 2022: Dimensions and output series for rotating electrical machines	2022
[s30]	IEC 61000 – 3 – 2021: SER, Electromagnetic compatibility (EMC) - Part 3: Limit - ALL PARTS	2021
[s31]	IEC 61000 – 4 – 2020: Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques – ALL PARTS	2020
[s32]	IEC 60068 – 2 – 2021: Environmental testing - Part 2: Tests - ALL PARTS	2021
[s33]	IEC 61226: Nuclear power plants - Instrumentation, control and electrical power systems important to safety - Categorization of functions and classification of systems	2020
[s34]	IEC 60947 – All Parts - Low-voltage switchgear and controlgear	2020
[s35]	ASTM A380 / A380M – 17: Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems	2017
[s36]	ASTM A802 / A802M – 10 2010, Standard Practice for Steel Castings, Surface Acceptance Standards, Visual Examination	2010
[s37]	ASTM E165 / E165M – 18, Standard Practice for Liquid Penetrant Testing for General Industry	2023
[s38]	ASTM A802-19: Standard Practice for Steel Castings, Surface Acceptance Standards, Visual Examination	2019
[s39]	Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH),	2006
[s40]	https://op.europa.eu/en/publication-detail/-/publication/3dbc738a-6d06-11e5-9317-01aa75ed71a1/language-en/format-PDF/source-261734527	
[s41]	IEC 60085:2007 - Electrical insulation - Thermal evaluation and designation	2007
[s42]	ISO 3746:2010 – Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane	2010
[s43]	ISO/IEC 17025:2017 - General requirements for the competence of testing and calibration laboratories	2017
[s44]	ASME QME-1 - Qualification of Active Mechanical Equipment Used in Nuclear Facilities	2023
[s45]	IEC-61000 Electromagnetic compatibility (EMC)	2016
[s46]	IEC/IEEE 60980-344:2020 - Nuclear facilities - Equipment important to safety - Seismic qualification	2020

It is Contractor responsibility to apply all Laws and Regulations that concerns the scope of supply in the Manufacturing Location and in the Installation Country (France). The list included here below is given for information only:

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a. Directive 2006/42/EC of the European Parliament and Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)
b. Directive 2014/68/EU of the European Parliament and Council of 15 May 2014 on the harmonisation of the laws of the member states relating to the making available on the market of pressure equipment (PED)
c. Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (recast) (known as the EMC Directive)
d. Directive 2014/35/EU of the European Parliament and Council of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits (recast). (known as the Low Voltage Directive)
e. French Order dated 30 December 2015 for Nuclear Pressure Equipment (ESPN), modified by order dated 03 September 2018

4.3 Conflicting Requirements

a. Order of Priority of Applicable documentation, Codes and Standards is listed here below (from higher to lower):
    i. Laws and Regulation:
        - French Nuclear Safety Authority (ASN) requirements,
        - European Directives and Regulations,
        - All other Legislations and Directives for nuclear facility in France,
    ii. This Technical Specification,
    iii. Applicable Codes and Standard and Applicable Documents (refer to section 4.1).
b. Contractor shall highlight conflicting requirements and information to seek clarification from IO. Conflicts between documents or a lack of information in this Technical Specification shall not relieve the Contractor from his responsibility of supplying the equipment correctly designed, manufactured and tested according to his own experience and for the specified operating conditions.
c. All requirements included in the applicable documentation are binding for the Contractor.
d. Any deviation to contractual documentation should be submitted by Contractor to IO during tendering process. Approved deviations shall be incorporated in applicable documentation included in Purchase Order.
e. Any deviation raised after Purchase Order shall be timely submitted by Contractor to IO Approval.
f. No work or action related to the approval of the deviation shall be performed without written acceptance by IO.
g. Deviations presented after Purchase Order shall always indicate the cost and schedule reduction for the Contractor related to its acceptance, compared to the implementation of the contractual requirement.

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5 Scope of Work

The Contractor is responsible for complete design, qualification, manufacturing, inspection, testing, performance, painting, packing, loading, safe delivery to ITER of the scope of work defined here below.

The Contractor is responsible to determine the detailed scope of supply that envelope the requirement of this section and to make sure that the equipment functional and operational requirements are met satisfactorily.

5.1 Scope of Supply

The scope of supply is composed by 8 Pumping Trains as defined here below:

a. Pumps, Motors and accessories to be installed on Main Skid (refer to section 5.1.1),
b. Electrical and Control Cabinets (refer to section 5.1.2),
c. Equipment installed off-skid or shipped loose (refer to section 5.1.3) and required spare parts and special tools (refer to section 5.1.4).

5.1.1 Equipment installed on Main Skid

Each of the 8 IBED PHTS Main Skids shall include:

a. One Horizontal API 610 Centrifugal Pump (preferred type: BB2), complete with bearings and required lubrication,
b. One Water Cooled Medium Voltage Electric Motor equipped with required power and instrumentation Junction Boxes and Cable Glands,
c. One Flexible Coupling with Spacer and Coupling Guard,
d. Two Pressurized Double Mechanical Seals,
e. Seal Flushing System complete with all required supports, piping, valves, filters, reservoirs, accumulators, heat exchangers, instrumentation and other accessories,
f. Anti-reverse rotation or back-stop device, if required,
g. Steel Baseplates covering all equipment installed on-skid with necessary lifting provision (refer to section 9.5.7 for required configuration of baseplates),
h. Baseplate anchoring system with levelling provision such as levelling screws and/or SS shim plates, counter-plates, bolting,
i. All required instrumentation for safe and reliable operation of the machine,
j. Instrumentation Junction Boxes with Cable Glands,
k. All additional auxiliary Electrical Motors and Electrical Equipment required in this specification,
l. One Power Terminal Boxes for each voltage level utilized,
m. Instrumentation Cables and Electrical Cables with cable/conduits or cable trays within the battery limits,
n. All interconnecting piping, including cooling arrangements (when required), valves and fittings up to skid edge,
o. Counter-flanges for all Terminal Points,
p. Isolation Valves for all Terminal Points,
q. Personnel protection for all hot surfaces,
r. Counter-flanges for suction and discharge nozzles and for all other terminal points along with gaskets, bolts, nuts and washers,
s. Removable Local Control Unit/ Emergency Push Buttons,
t. Two on-skid earthing lugs in opposite position. Internal grounding of components to baseplate shall be realized by Contractor,
u. Stainless steel name plates & labels,

v. Stainless Steel Cladding installed above heat/fire insulation,
w. Surface preparation, shop painting and corrosion protection up to final painting,
x. Painting material for touch-up painting at site,
y. Seaworthy long-term packing and preparation for Shipment (refer to section 13.4).

5.1.2 Electrical and Control Cabinets

The scope of supply of the IBED PHTS Main Pumps shall include dedicated Electrical and Control Cabinets installed in a separate area. The Cabinets shall be designed to allocate:

a. Variable Frequency Drive (VFD), (one per each Main Pump),
b. Vacuum Circuit Braker (VCB), (one per each Main Pump),
c. Control System (UCP): preferred configuration is 1 common and redundant UCP for the 8 Main Pumps and for the seal supporting systems,
d. Motor Control Center (MCC) for LV motors (common to all 8 Main Pumps),
e. Electronic transmitters for instrumentation installed on skid (when required),
f. Power and Instrumentation interconnecting cables between VFD, UCP, MCC and VCB shall be offered by Contractor with a separate quote.

Detailed requirements for this equipment are given in Technical Specification [d2].

5.1.3 Additional Equipment installed off-Main Skid or supplied loose

The Contractor shall include the following equipment installed off-skid or shipped loose:

a. Additional skid(s) required for Barrier Fluid Supply and Circulation System,
b. Any additional equipment required by the qualification strategy of the scope of supply (including all required sample equipment to be used in qualification testing, up to a complete test skid when required),
c. Flow Straightener or equivalent devices to cope with the process piping layout (refer to section 9.4.3) for each of the 8 IBED PHTS Main Pumps, when required. Flow Straighteners shall be supplied by Contractor together with the portion of process piping starting from pump flange and including the complete pipe length in which the device will be installed.
d. Spare Parts and Special Tools as per Section 5.1.4,

5.1.4 Spare Parts and Special Tools

a. Contractor shall include all the necessary Start-up spares and Essential/ Mandatory spares in his scope of supply, as described below.

i. Start-Up Spares are those spares which may be required during start-up and commissioning of units. All spares used until the units are finally commissioned shall come under this category. As a minimum, spares in Table 5 shall be provided. Contractor shall identify all additional start-up spares for selected models of equipment and supply them along with main supply. A final start-up spare list shall be submitted by Contractor,
ii. Essential/ Mandatory Spares are those spares which are considered necessary for two (2) years of normal plant operation. Minimum Essential spares, to be supplied by the Contractor as part of the base scope of supply, are listed in
iii. Table 6.

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Table 5 - Start-Up Spares

Spare-Parts Description	Unit for Spares	Total Quantity
Pump Gaskets	Sets	8
Complete Mechanical Seal Cartridge	Sets	2
Coupling Flexible Elements with bolts	Sets	2
Bearing Housing Seals	Sets	8
Set of Gasket for all flanged connections	Sets	24
Any additional Start-up/commissioning spare part defined by Contractor	Sets	TBD by Contractor

Table 6 - Mandatory Spares

Spare-Parts Description	Unit for Spares	Total Qty. of Spares
List of pump spares		
Impeller wear rings	Sets	4
Casing wear rings	Sets	4
Mechanical Seal Repair Kit (including as a minimum seal faces and o'rings)	Sets	8
Bearing Oil Seals	Sets	8
Pump Shaft Bearings (radial and thrust bearing)	Sets	2
Complete Coupling with Spacer	Sets	2
10% of Pump Unit Bolts and Screws (at least 1 per type)	Sets	Contractor to indicate
List of Motor Spares		
Complete motor bearing assembly for drive and non-drive end bearing	Sets	2
Space heaters	Sets	2
Shaft Insulating Sleeve	Nos	2
Motor seal and other materials that require periodic replacement	Sets	8
List of Instruments Spare		
Vibration Probes and Transmitters	Nos.	4 per type
Winding RTDs	Nos.	4 per type
Bearing RTDs	Nos.	4 per type
Other type of instruments	Nos.	2 per type
For Spare Parts required for VFD, UCP, VCB, MCC refer to Technical Specification [d2]		

Notes:

- *One set means quantity required for full replacement of the respective part of one IBED PHTS Main Pump. Total Quantities to be confirmed by Contractor.*
- *All spares supplied shall be physically and technically interchangeable with similar pump units being procured.*

b. Recommended Spares are the additional spares that Contractor considers necessary for two (2) years of normal operation of IBED PHTS Main Pumps and which are not included in Essential Spares specified by the IO. The Contractor shall furnish a list of recommended spare parts. The list shall be complete with quantities and unit prices. The IO shall have the option to increase or decrease the quantities of spare parts as required. The IO will provide separate order for recommended spares.

c. Capital Spares are parts that are normally not required during normal operation for their long life or reduced risk of failure, but that, in case of failure, would cause shutdown of equipment for a prolonged period because of the long lead time. The Contractor shall furnish a list of Capital Spares parts. The list shall be complete with quantities and unit prices. The IO shall have the option to increase or decrease the quantities of spare parts as required. Capital Spares are not included in the base scope of supply. The IO will provide separate order for the Capital Spares that might be selected.

d. Supplied spare part shall be furnished with same quality requirement and testing level of the main equipment. Dedicated Manufacturing and Inspection Plans shall be supplied.

e. The Contractor shall also furnish special tools required for handling, maintenance and repair of the components of IBED PHTS Main Pumps. The Contractor shall supply all tools and tackles clearly marked with its size and/or purpose. Special tools shall include as a minimum the items included in Table 7.

Table 7 – Special Tools

Special Tool Description	Unit	Total Quantity
Special Tools required to dismantle the pump rotor, including pull-out devices for coupling hubs (2 complete Kits required)	Sets	2
Cradles to remove the pump rotor from casing when required	Sets	2
Gas refilling kit for bladder accumulators	Sets	2
Skids Lifting Beams	Sets	1

5.2 Scope of Services

a. Meetings (including travel and accommodation expenses for Contractor personnel):
   i. Kick-off Meeting,
   ii. Pre-Inspection Meetings related to Manufacturing Readiness Review,
   iii. Engineering meetings,
   iv. Other Desing Review and Contract Reviews as required by Project Gates (refer to section17.2),
b. All Project Documentation as required in section 18,
c. Complete assembly of the scope of supply as per approved project drawings,

d. Installation of Heat Insulation/Heat Tracing/Fire Insulation/Personnel protection with cladding,
e. Safe delivery to ITER Site (DAP to ITER Site in Saint-Paul-lez-Durance, France),
f. All required NDTs with certificates as per approved MIP,
g. Services of Third Parties as required by applicable Laws and Codes,
h. Factory and Acceptance Test activities with certificates,
i. Qualification Documentations, Testing and Certificates,
j. All calculation notes and analysis required to certify the suitability of the machine to withstand operating and accidental conditions. Analysis Models shall also be submitted as per section 7.4 of [d1].
k. Assistance to Installation and Start-up, attendance to Site Acceptance Tests. This shall include personnel specialized on equipment supplied on Main Skid and Auxiliary Skids as well as on Electrical and Control Cabinets (refer to [d2]).

5.3 Exclusions

Are excluded from Contractor Scope of Supply:

a. Electrical cables from on-skid Junction Boxes to Power Supply and to VFD,
b. Instrumentation cables from on-skid Junction Boxes to UCPs,
c. Interconnecting piping between Main Pumps skid battery limit and mechanical seal supporting skids,
d. Piping to be welded to counter-flange of all Terminal points (except suction and discharge flanges (refer to 5.1.3),
e. Heat Insulation/Heat Tracing/Fire Insulation,
f. Radiation Shielding Wall Installed between Main Pump and Motor,
g. Fire Fighting System,
h. Civil Works and Concrete Foundations.

5.4 Contractor Quote request

The Contractor shall provide following separate quotes as indicated below:

Quote #1	Supply of 8 nos. Main Pump Units and their Auxiliaries (refer to sections 5.1.1, 5.1.3 and applicable part of 5.2),
Quote #2	Electrical Cabinet containing VFD, VCB, UCP, LV MCC (refer to sections 5.1.2 and applicable part of 5.2),
Quote #3	Spare Parts and Special Tools (refer to section 5.1.4),
Quote #4	Interconnecting wiring between VFD, VCB, UCP, LV MCC (refer to [d2]),
Quote #5	Assistance to Installation, Start-up, SATs (refer to section 5.2).

5.5 Delivery Time

Agreed Delivery Date will be included in the Purchase Order. Delivery shall occur within 5 years from contract signature. As long as the last unit is delivered within 5 years from contract signature, staggered delivery after Delivery Release by IO, shall be allowed by Contractor with no cost impact.

6 Location for Scope of Work Execution

List of Location where main manufacturing activities will be performed shall be indicated in the Contractor Proposal.

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This should include as a minimum the following activities:

a. IBED PHTS Main Pumps pressure casing manufacturing,
b. IBED PHTS Main Pumps Assembly and Testing,
c. Motor Manufacturing,
d. Skid Packaging,
e. Electrical and Control Cabinets Manufacturing,
f. Mechanical Seal and Seal Flushing System Manufacturing
g. Testing location.

The sub-Contractors and sub-Suppliers List, submitted for approval to ITER after the order, shall include the final location for work execution of each sub-Contractor.

Change of one of location above shall be timely notified to IO.

7 IO Documents & IO Free issue items

7.1 IO Documents:

No input document is expected from IO, except applicable documentation listed in sections 4.1.

7.2 Free issue items:

Fire insulation material will be supplied by ITER to Contractor for installation on the concerned equipment. Refer to section 9.6.7

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8 Equipment Classification

Table 8 - Equipment Classification

PIC/Safety Class	SIC-1 For Confinement Only
Quality Class	QC-1
PED Class	Request for Exclusion to be submitted by Contractor for Pump casing (Note d)
	PED applicable to all auxiliaries
ESPN Class	Main Process Pipe: Class N2
	Pump casing: Request for Exclusion to be submitted by Contractor
	Auxiliaries connected to casing including Seal Flushing Systems: Contractor shall apply French ESPN decree (refer to section 0) to determine applicability of ESPN and the related classification.
	Cooling Water to mechanical seal, pump bearings, VFDs and electric motor: NC
Seismic Class	SC-1(S)
Vacuum Class	N/A
Tritium Class	N/A
RH Class	N/A
Export Control	N/A
For detailed classification of Electrical and Cabinets (VFD, VCB, UCP, MCC), refer to [d2]	

NOTES:

a. SIC-1 identifies systems and component that are required to bring and maintain ITER in a safe state.

b. Quality Class QC-1: QC-1 is defined as per Quality Classification Determination, refer to [d3]. The requirements from application of quality Class 1 as per Appendix 2 of Quality Classification Determination [d3] applies.

c. Seismic Class SC1 (S): Structural stability maintained in the event of a SL-2 level earthquake, i.e. no rupture of piping, no collapse of structures or equipment, limited plastic strain, limited concrete cracking, structural support functions maintained. With this level of requirement, it is possible that a small level of deformation could occur. Consequently, it could be necessary to inspect equipment before re-using it. However, no radioactive water leak shall occur. Additionally, no shaft seizure shall occur to IBED PHTS Main pumps when exposed to an SL-2 Heartquake (Refer to section 9.3.3).

d. Seismic Class SC1 (SF): Structural stability and required functional seismic safety performance maintained in the event of an earthquake, the respect of this level of requirement guarantees the level of safety as throughout the normal operation of the equipment. Nevertheless, taking into account seismic load characteristics, fatigue is not taken into account.

e. Contractor can refer the “Guide to the implementation of directives based on the New approach and the global Approach” (see reference [s40]), or may hire consultant if required, to ensure that all applicable European directives and regulations are complied.

f. Contractor shall demonstrate applicability of Exclusion to PED Directive 2014/68/EU (and consequently to ESPN) for pump pressure casing, as allowed by Article 1 Section 2 (j) of the directive. In this section it is stated that is excluded from the range of applicability of the directive:

Equipment comprising casings or machinery where the dimensioning, choice of material and manufacturing rules are based primarily on requirements for sufficient strength, rigidity and stability to meet the static and dynamic operational effects or other operational characteristics and for which pressure is not a significant design factor. Such equipment may include:

• *Engines including turbines and internal combustion engines,*

• *Steam engines, gas steam turbines, turbo generators, compressors,*

• *Pumps and actuating devices.*

A demonstration of applicability of this clause shall be submitted to IO for approval.

Document in reference [d67] gives guidelines for the request of exclusion from French Regulation.

g. Nevertheless, all other auxiliary pressure equipment in Contractor scope shall follow the PED/ESPN classification as stated by the directive. Guidelines given in [d76] should be applied in the eventuality of application of ESPN directive to equipment included in the scope of supply.

h. Document in reference [d66] gives the guidelines for the application of Sound Engineering Practice usable by any manufacturer of Category 0 Pressure Equipment and Nuclear Pressure equipment to be installed in IO.

8.1 CE Markings

a. "CE" marking is required for units in the frame of Machinery Directive 2006/42/EC. A declaration of conformity, as per Annex II-1–A of Directive, shall be drawn up and signed certifying that the IBED PHTS Main Pumps comply with the "Directive of the European Parliament and the Council".
b. Declaration of conformity, the instruction and operational manuals and all other documentation required by applicable Directives, shall be provided in two languages – English and French.
c. Contractor shall include required certification to all other applicable European Directives and apply the CE marking to equipment installed on Main Skids, for Electrical and Control Cabinets and all the auxiliary equipment installed out of Main Skid or supplied loose, including spare parts and special tools.

9 Construction Requirements

9.1 General Requirements

a. The IBED PHTS Main Pumps shall be designed, fabricated, inspected and tested in accordance to API 610 - XII edition [s1], special purpose type, with supplemental requirements given in this Specification.
b. The IBED PHTS Main Pumps shall be designed for a commissioning period of 5 years and an operating life of 20 years under the operational requirements and the applicable loading conditions defined within this Specification and associated Appendices. This shall be demonstrated by Calculation notes and, when required, by testing.

c. Applicable loading conditions are listed in *Appendix C – Process Loading Conditions.*
d. The seismic loads applicable to the main skid and to the auxiliaries are defined in *Appendix E – Seismic Loads.*
e. Any deviation to required operational life shall be clearly stated by Contractor before Purchase Order.
f. Proposed Centrifugal Pumps hydraulic design shall be proved and referenced (reference list to be supplied by Contractor with the Proposal).

9.2 Reliability and Maintenance Requirements

g. Contractor shall clearly state in the Operation and Maintenance Manual the predictive maintenance schedule (including forecasted wear parts replacement) to be implemented to guarantee the required design life. Contractor shall clearly state in the Proposal any eventual capital spare required to reach these targets.
a. Secondary Equipment and subcomponents other than consumables, that are not demonstrated to achieve the required design life without replacement, shall be designed with a replacement interval of no less than 48 months.
b. IBED PHTS Main Pumps programmed maintenance intervals shall be of no less of 24 Months to be in line with plant planned maintenance intervals.
c. The IBED PHTS Main Pumps parts requiring adjustment, inspection, or repair shall be accessible and capable of convenient removal, cleaning, replacement, and repair. The required clearance for disassembly of the pump shall be clearly marked on the pump layout drawings and shall be agreed with IO considering plant layout.
d. The design of the IBED PHTS Main Pumps shall achieve the reliability values listed in Table 9 [r1]. These values are referred to the full scope of supply defined in this specification. Contractor shall submit a RAMI study to demonstrate compliance to these values. If these values cannot be achieved, an alternate value and basis for that value shall be provided to IO to determine the impact on the overall availability of the TCWS.
e. Contractor shall include in the RAMI analysis all provision required to meet the required Mean Time to Repair. This shall be in line with indications given in the Installation, Operation and Maintenance manual.

Table 9 – IBED PHTS Main Pumps Allowable Failure Rates

Failure Mode	Failure Rate	Mean time to Repair (hours)
Failure to start	1.08·E-3/day	22
Failure to Run	3.79·E-6/hour	145
Pump Pressure Boundary Leakage	2.91·E-7/hour	22

9.3 Operating Conditions

9.3.1 Process Configuration

a. The 8 IBED PHTS Main Pumps are capable to work in parallel and are identical in design and performance parameters (refer to *Appendix F – Simplified IBED PHTS PFD* and to [d4]).

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b. IBED PHTS Main Pumps are variable speed machines. Speed regulation is performed via Variable Frequency Drives (VFDs). VFDs are covered by the dedicated technical specification in reference [d2].
c. Process Fluid Parameters and Composition, including dispersed sources of radiations, are included in *Appendix A – IBED PHTS* Main Pump Datasheet.
d. No check valve and no regulation valve is present on the discharge line. Isolation valves only are available on the discharge line of each Main Pump. The closing time of the isolation valves at discharge has to be considered equal to 120 seconds.
e. There is no minimum flow line or turn around line for pump protection.
f. Main Pump regulation is performed via VFD only. A flow meter is available at suction of each pump. In the current configuration, a speed set point will be indicated from plant control system to pump control unit to deliver the required flow (final control arrangement will be agreed during detailed engineering phase).
g. A progressive and parallel start-up of the eight Main Pumps is required to limit backflow during startup and during switching from one operating mode to another. Contractor shall submit to IO approval a dedicate startup procedure for the complete set of pumps considering these restrictions.
h. The process condition with 7 Main Pumps running and 1 Main Pump stopped shall be considered in the design. Pump that is tripped will be subject to backflow with risk of reverse rotation. Contractor shall assess this case in his calculation reports defining the loads applied to the pump internals and on mechanical seals (including effect of reverse pressure). IBED PHTS Main Pumps shall allow reverse rotation up to 110% of the runaway speed calculated during backflow and at not less than 100% of their rated speed. If this is not achievable, Contractor shall include in the scope an anti-reverse rotation device.
i. No temporary or permanent strainer is foreseen in pumps inlet lines. A temporary strainer is present only upstream to the heat exchanger installed on pump suction line.
j. The Main Pump shall be able to run with no impact on its performance and its reliability with the solid particle parameters specified in *Appendix A – IBED PHTS* Main Pump Datasheet.
k. The load categories I, II, III and IV and the Service Levels A,B,C,D are defined in *Appendix C – Process Loading Conditions*.
l. *Appendix A – IBED PHTS* Main Pump Datasheet and *Appendix C – Process Loading Conditions* define the Applicable Environmental Conditions in normal and degraded (DEG) cases.
m. Available Utilities are indicated at page 7 of *Appendix A – IBED PHTS* Main Pump Datasheet. For cooling water consumption, the required flow rate shall be limited to values indicated in the page 7 of the Datasheet.
n. IBED PHTS Main Pumps are exposed to Environmental Radiations and Static Magnetic field during the normal operation. A shielding installed between Main Pump and Motor reduces the level of radiation on the Area of installation of the motor. Refer to *Appendix A – IBED PHTS* Main Pump Datasheet page 6 for expected level of radiations and magnetic field.

9.3.2 Performances in Load Condition Category I and II

a. The IBED PHTS Main Pumps shall deliver the performance required in following IBED PHTS system operating cases (refer to [d4]), corresponding to Service Level A):

   i. **Plasma Operation:** Operating point (flow rate/head) of Main Pumps is considered fixed during plasma operation and corresponds to the rated flow included in

Appendix A – IBED PHTS Main Pump Datasheet. Temperature is maintained at 70°C (+/-5°C). Suction Pressure if set to specified values by a Pressurizer on the suction line of the pump.

ii. **Stand-by mode:** is initiated just prior to enter a Plasma Operating State. The stand-by mode of operation is for intervals between periods of plasma operation. This mode includes:

- Short interval standby: the 8 Main Pumps will be operated at rated operating point.
- Long interval Standby: the 8 Main Pumps will be operated at lower speed to supply 22% of rated flow. This last is identified as the minimum flow in pump operating condition of the Datasheet. Pump speed can be increased where needed to accommodate the larger decay heat load. The fluid temperature will be kept at 70°C (+/-5°C) to allow a quick transition into plasma operating mode. The system pressure will be controlled with the Pressurizer.

b. Detailed Operating Parameters of each operating Case are defined in IBED PHTS Main Pumps Datasheet.

c. The preferred operating region of the IBED PHTS Main Pumps shall be as a minimum in the range from 70% to 120% of best efficiency flowrate. Preferred and allowable operating region shall be clearly identified on pump performance curve.

d. Rated flow should be within the region of 80–100% of best efficiency flowrate. Deviations to this requirement shall be submitted to IO for approval.

e. Variable speed curves with indication of all operating points and parallel operation curves shall be provided.

f. Maximum allowable working speed shall be at least 105% of synchronous speed with rated impeller diameter.

g. The IBED PHTS Main Pumps are VFD driven. Nevertheless, the project requires full capability to properly run them in parallel at motor synchronous speed:

i. Rated operating point shall be reached at motor synchronous speed,

ii. Requirements given by clause 6.1.13 of API 610 apply:

- head rise from rated point to shutoff shall be not less than 10%,
- the head curves shall be continuously rising to shutoff,
- the head values at any given flow within the preferred operating range shall be within 3 % of each other Main Pump. Installation of discharge orifices to meet this requirement is not allowed.

h. Discharge pressure at zero flow, maximum fluid density, maximum suction pressure and 105% of synchronous speed, shall be limited to piping design pressure. Maximum Shutoff head (including all test tolerances) shall be in line withthese requirements.

i. The pump rotor / bearing dynamic system shall be stable under all operating conditions. The pump design shall permit continuous operation at any point in the operating range from minimum stable flow to run-out flow.

j. Allowable Operating Region, Preferred Operating Region, Minimum Stable Continuous Flow shall be explicitly declared by Contractor and plotted on the multispeed performance curves.

k. The sound pressure level measured on all point at 1 m from the main skid shall be less 85 dBA (including test tolerances). This requirement applies to all skids and accessory equipment that will be supplied within the scope of this technical specification.

l. The Contractor shall provide the allowable number of starts of the Main Pump assemblies to IO for review during the design phase. The number of starts shall not

exceed the fatigue limit of the material and shall be in compliance with the number of cycles given in *Appendix C – Process Loading Conditions*.

m. Main Pump Pressure Boundary integrity shall be guaranteed to meet the IBED PHTS safety function, refer to section 9.5.1.
n. Leakage rates as defined in sections 9.5.1and 9.5.5 shall be guaranteed.
o. Stability, Integrity and Functionality of IBED PHTS Main Pumps and of all its auxiliaries shall be guaranteed when exposed to A/B Service level Nozzle Loads and Category I and II loading conditions.

9.3.3 Performances in Load Condition Category III and IV

a. Following service level applies to IBED PHTS Main Pumps and their accessories:
   iii. Service level C is required for Load Conditions Category III
   iv. Service level D is required for Load Conditions Category IV
b. The IBED PHTS Main Pumps shall be designed to meet all load combinations as specified in *Appendix C – Process Loading Conditions* and in *TCWS Load Specification* [d7] with consideration of guidelines on Allowable Values and Limits given in [d6].
c. The components of the Mechanical Seal and Seal Flushing System that contributes in short and medium term to the leak tightness of the IBED PHTS Main Pumps Pressure Boundary shall guarantee Service level B also for Load Conditions Category III, IV
d. Stability of the IBED PHTS Main Pumps and of all auxiliaries shall be guaranteed when exposed to C/D Service level Nozzle Loads and Category III and IV loading conditions.
e. Pump Pressure Boundary integrity shall be guaranteed to meet the IBED PHTS safety function (refer to section 9.5.1) when exposed to C/D Service level Nozzle Loads and Category III and IV loading conditions. Leakage rates included in sections 9.5.1and 9.5.5 shall be guaranteed.
f. The design shall include the equipment supports such as saddles and the anchoring system.
g. IBED PHTS Main Pumps shall be qualified to withstand a SL-2 seismic event, In line with Seismic Classification of the IBED PHTS Main Pumps (refer to section 8). The envelope SL-2 FRS with 3% damping factor for IBED PHTS Main Pumps location is given in *Appendix E – Seismic Loads.*
h. The Contractor shall demonstrate that shaft seizure will not occur in any of the load conditions given in *Appendix C – Process Loading Conditions*, including the case in which Main pumps are in operation when a seismic event up to Seismic Level 2 (SL-2) occurs. Pump seizure is also considered as initiating event in category III and IV to evaluate loads generated by the subsequent water hammer (refer to [r7] and [r8]).
i. The fire case is considered as a Category IV event (highly improbable situation): SL-2 seismic event followed by a fire event which is not concomitant shall be considered. The Maximum Historically Probable Earthquake (SMHV), as an aftershock, concomitant with the fire, is not considered for IBED PHTS Mains Pumps as per [r20].

9.4 Installation interfaces

9.4.1 General Installation Requirements

a. API RP 686 [s5] should be used as a guideline for the configuration of the installation of the IBED PHTS Main Pumps. All the additional requirements included in this specification apply.
b. Static and dynamic loads transmitted from the baseplate to the foundations shall be clearly indicated in the foundation drawings or in a dedicated calculation note.

c. A modal analysis of the vibration solicitations induced by IBED PHTS Main pumps operation on the foundations, in comparison with building modal analysis (to be provided by IO during detailed engineering phase), shall be submitted by Contractor to IO for approval. Contractor shall adapt the design of the skid to avoid any possible dynamic interaction with the civil works.
d. The design of supports for the installation of the insulation described in section 9.6.7 is included in the design and construction of the IBED PHTS Main Pumps. Contractor shall include the space reservation required for the installation of the insulation material. The attachments of the insulation material shall be designed to withstand all loading conditions defined in *Appendix C – Process Loading Conditions*.
e. The IBED PHTS Main Pumps and its heavy individual components shall be provided with handling/lifting lug(s) that shall be clearly identified and designed as per following requirements:
    i. Each handling/lifting lug shall be designed to support 125% of the dry weight of the IBED PHTS Main Pumps,
    ii. The IBED PHTS Main Pumps, the main sub-assemblies and all heavy-subcomponents shall not be lifted utilizing a single handling/lifting lug,
    iii. The material tracing requirement and the inspection level for the lifting lugs shall be equivalent to those of the pressure boundary materials.
f. Contractor shall indicate in the construction drawing the center of gravity of the entire skid, of the main sub-assemblies and of the heavy individual components.
g. An installation procedure that considers the specific installation zone and the presence of the radiation shielding between Main Pump and Motor (refer to sections 9.5.4 and 9.5.7) shall be submitted to IO for approval.

9.4.2 Space Reservation

a. Location of equipment included in this scope of supply is given in *Appendix D – Installation Data and Drawings.*
b. The dimensions and total weight of the IBED PHTS Main Pumps and of all required auxiliaries shall not exceed the values given in *Appendix D – Installation Data and Drawings*. Contractor shall state in the proposal the fulfilment of this requirement. In case the dimensions and/or total weight of the IBED PHTS Main Pumps are expected to exceed those values given, Contractor shall clearly indicate this information to IO in the bid phase.
c. Maintenance space have been foreseen to remove entire Main Pump skid and entire Motor skid (refer to 9.5.7). Any further maintenance space required to access the equipment or to dismantle minor components shall be compatible with installation area. This shall be included by Contractor in the general arrangement drawings and agreed with IO.
d. The proposal shall include the possibility to adapt Main Pump casing orientation to remove pump rotor from Drive-End or non-Drive-End side.
e. Refer to section 9.5.4 and 9.5.7 for interfaces requirement of the removable shielding with coupling and baseplates.
f. Loading, lifting and handling drawings/procedures shall be submitted to IO for approval.
g. Contractor shall include the proposal the footprint required to accommodate remote seal supply systems (e.g. plan 54 or refilling system).
h. Any deviation to agreed footprints shall be submitted to IO for approval as soon as possible and with sufficient notice before start of manufacturing.

9.4.3 *Piping interfaces*

a. Table 10 identifies the configuration of piping connections to terminal points. Applicable piping specifications codes are referred to *Equipment Specification for piping materials used in the design of process piping systems* [d8]. Piping installed within Contractor battery limits can follow Contractor piping classes, given that the applied design conditions are equal or higher than the design condition of the applicable piping classes. However, Contractor shall guarantee the full compatibility to IO piping classes at the interface.

b. Following requirement shall apply:
   i. Piping and piping connections shall be in accordance with ASME B31.3 [s12] Category M Fluid Service.
   ii. Flanges shall be in accordance with ASME B16.5 [s11].
   iii. The dimensions of all nozzles shall conform to ASME B36.19M [s13] metric dimensions.

c. Any deviation to the diameters and piping classes indicated in Table 10 or the request of additional terminal points, shall be submitted to IO for approval as soon as possible and before starting any manufacturing activity.

Table 10 - List of Terminal Points

Terminal Point (TP)	Nominal Diameter	Orientation	Piping Specification	Design Temp. [°C]	Design Pressure [MPa abs]
Main Pump Suction	DN400	TOP	4-S3S0600	150	5.0*
Main Pump Discharge	DN350	TOP	4-S3S0900	150	6.8*
Drains from Pump Casing and Mechanical Seals (to be collected in a single TP)	DN25 (TBC)	TBD	4-S3S0900	150	6.8
Vents from Pump Casing and Mechanical Seals (to be collected in a single TP)	DN25 (TBC)	TBD	4-S3S0900	270	6.8
Barrier Fluid refilling to Seal Flushing System	DN15 (TBC)	TBD	4-S3S0900	150	6.8
Cooling Water inlet to Motor and Bearing (to be collected in a single TP)	DN50	TBD	4-S3S0300	190	1.72
Cooling Water outlet to Motor and Bearing (to be	DN50	TBD	4-S3S0300	190	1.72

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Terminal Point (TP)	Nominal Diameter	Orientation	Piping Specification	Design Temp. [°C]	Design Pressure [MPa abs]
collected in a single TP)					
Cooling Water inlet to Seal System Heat Exchanger	DN25	TBD	4-S3S0600	150	5.0
Cooling Water outlet to Seal System Heat Exchanger	DN25	TBD	4-S3S0600	150	5.0
Baseplates Draining	TBD	TBD	TBD	TBD	TBD
	* discharge design pressure shall be applied to whole pump pressure casing				

d. All Internal pining shall be equipped with valved vents and drains to high and low points.
e. Utilities, Vent and Drains shall be collected at battery limits. All required intersection and valves shall be included in the scope of Contractor.
f. Isolation Valves shall be provided at each terminal point, included baseplates drains.
g. Main Pump casing drain and Seal drains shall be connected to a common terminal point.
h. For each flanged nozzle, the Contractor shall provide nozzle flange, counter-flange (closed with temporary end cap), bolts, nuts, washers and four gaskets (one installed and three spare). Each nozzle shall have its identification number, as specified, permanently marked on the outside cylinder.
i. Positioning and orientation of all nozzles shall be specified on the Contractor design drawings, which will require review and written approval by IO prior to start of manufacturing. Tolerances on indicated coordinates shall be clearly stated in the related drawings.
j. Main Pumps Inlet and Discharge nozzle positioning shall be as per *Appendix D – Installation Data and Drawings*.
k. Piping layout is not equal for each IBED PHTS Main Pump. The straight pipe length at pump suction and discharge before the first 90 degrees short radius bend is not equal for each pump. For some of the pumps no straight line at suction and/or discharge can be guaranteed. Contractor shall include in his scope all features required to cope with this layout. In case devices such as flow straighteners would be required to guarantee proper operation of the Main Pumps, Contractor shall supply the devices and spool of pipe (N2 ESPN class pipe) required to install the device. A CFD analysis shall be submitted to IO for all 8 IBED PHTS Main pumps to support the chosen configuration of suction and discharge piping before testing.
l. Nozzle reducers, if applicable, shall be included in Contractor scope.
m. Gaskets and hardware for all closed ports shall comply with EN 1591-1 [s24].
n. Gasketing material shall be compatible with the intended service of IBED PHTS Main Pumps.
o. All end flanges, if applicable, shall be checked for axial alignment and gasket face flatness after welding [s11].
p. Required inlet and discharge nozzle loads relative to each load combination shall be as per values included in *Appendix B – Nozzle Loads*. The relationship between load combination and process loading conditions is given in ref [r6] and in *Appendix C – Process Loading Conditions.*

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q. Contractor shall indicate in the General Arrangement the allowable nozzle loads for main nozzles and for auxiliary's nozzle for IO verification.

9.5 Mechanical Requirements

9.5.1 Machine Casing and Pressure Boundary

a. Main Pump Pressure boundary thickness shall be in accordance with API 610 requirements. Sufficient allowance will be added to the wall thickness to compensate for corrosion, erosion and abrasion over the design life of the Main Pumps. The pressure casing shall be designed to operate without leakage or internal contact between rotating and stationary components while subject simultaneously to the maximum allowable working pressure, the maximum operating temperature, the worst-case combination of the allowable nozzle loads to each nozzle, in all load conditions specified in *Appendix C – Process Loading Conditions.*

b. Allowable Stress values from ASME BPVC Section VIII, Division 2 [s9] shall be applied for all equipment. Contractor shall submit to IO for approval proposal to apply other recognized standards. When applicable codes specify multiple allowable stresses for the design of pressure parts, the lower value must be used.

c. Corrosion allowances, where needed to guarantee the design life with the requested heat duty, material choice, and water chemistry shall be included in the design.

d. Pump MAWP shall be calculated at maximum process fluid density and will consider the most conservative condition among:
   i. Maximum Impeller Diameter,
   ii. 110% of Shutoff head at Rated impeller diameter,
   iii. Operation up to 105% of rated speed with rated impeller diameter,
   iv. Discharge piping design pressure (6.8 MPa abs) and temperature (150 ºC), as per Appendix C – Process Loading Conditions.

e. All pressure boundaries shall be designed to withstand the design condition of the applicable piping classes (refer to 9.4.3).

f. Contractor shall consider in the design the cases in which equipment pressure boundary will be at lower pressure (-0.2 MPa) compared to environmental pressure (refer to *Appendix C – Process Loading Conditions*).

g. In the design of the pressure casing, Contractor shall consider the requirement on hydrotest as specified in section 11.4.2.

h. Threaded connections on pressure casing are not allowed. Any deviation to this requirement shall be submitted to IO for approval.

i. No repair of pressure castings (e.g. by welding) can be performed without IO approval.

j. The IBED PHTS Main Pumps design shall avoid unnecessary cavities where particles suspended in the process fluid can settle and/or collect (e.g., no socket welds, no spare connections). Surface finish for wetted surfaces is detailed in section 9.6.5.

k. The IBED PHTS Main Pumps shall be designed to allow complete draining (100% of contained liquid) and venting without any disassembly of the pump and of all other auxiliaries. Draining and venting can be accomplished through the inlet and discharge piping. If this is not possible, dedicated draining and/or venting connections shall be provided where necessary and connected to plant drain and vent system. The drain and/or vent piping shall be routed to the edge of the skids and collected to single terminal point with isolation valve.

l. Overpressure protection for the IBED PHTS Main Pumps is included in the system design and is out of the scope of this Specification.

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m. Leakage rates of Main Pump pressure casing non welded connections shall be L0.001 (specific leak rate ≤ 0.001 mg s-1 m-1) in all loading conditions. No leakage is allowed on welded connections.
n. Leakage rates of flanged piping connections in all loading conditions shall be limited to following values as per [d9] and [d10]:
    i. L0.01 (specific leak rate ≤ 0.01 mg s-1 m-1) for all inline connections (connections that will be exposed to piping interface loads and thermal expansion (e.g., pump suction and discharge flanges, process connections to heat exchangers),
    ii. L0.001 (specific leak rate ≤ 0.001 mg s-1 m-1) for non-inline connections (e.g., blind flanges, heat exchanger shell side opening, filters opening).

   Flanged connections shall be calculated according to EN 1591-1 [s24] to meet the required leak rate class in all loading conditions under the applicable nozzle loads. For mechanical seal leakages refer to section 9.5.5.
o. The Contractor shall provide the bolt torque and bolting sequence needed to fulfil leak rate requirement.
p. All fasteners within the pressure boundary shall be positively locked in place with safety wire or other suitable means.

9.5.2 Pump Internals

a. The IBED PHTS Main Pumps rotation direction shall be selected in order to meet inlet and discharge flange layout as indicated in *Appendix D – Installation Data and Drawings.*
b. Rated Flow and Head, as defined in the Datasheet, shall be achieved at motor synchronous speed.
c. Pump shaft, impellers and other internals shall be designed to withstand the backflow condition defined in section 9.3.1.
d. Design of shaft and other internals shall consider the most conservative condition between operation at Maximum allowable working speed with rated impeller diameter or to rated speed with maximum impeller diameter.
e. Selection shall be based on a nominal impeller diameter that is not less than 110% of the minimum diameter for the given hydraulics.
f. Selection should be based on a nominal impeller diameter that is not more than 90% of the maximum diameter for the given hydraulics. Considering that speed regulation with VFD is foreseen, higher selected diameters can be proposed to IO for approval.
g. Each IBED PHTS Main Pump rotor assembly shall be designed such that its first (dry) bending critical speed is at least 20 % above the maximum operating speed.
h. Contractor shall produce a lateral and torsional analysis report (dry and wet rotor, stationary and transient conditions).
i. Refer to section 9.7.2 for additional consideration on the influence of external magnetic field on pump performances.
j. Rotating parts shall be statically and dynamically balanced as per API 610 requirements. A balancing procedure shall be submitted to IO for approval. A 3.1 type certificate is required for each residual unbalance check.

9.5.3 Bearings and Lubrication

a. Hydrodynamic bearings with pressurized lubrication system shall be avoided. Natural lubrification shall be provided for Main Pump and Motor bearings. Any deviation to bearing selection criteria of API 610 (including and not limited to requirement of table 10) shall be submitted to IO for approval.

b. Vent to the atmosphere should be avoided. Closed loops oiling systems should be provided.
c. Contractor shall demonstrate that proposed bearings configuration is fully referenced with an history of safe and reliable operation in line with the requirements of this specification.
d. Quantity of oil shall be minimized and all skids shall be provided with a system to collect oil leak or spillage.
e. Water cooled bearing housing can be accepted when required (refer to *Appendix A – IBED PHTS Main Pump Datasheet* for cooling water parameters and availability).
f. Bearing life shall be in line with 6.10.1.11 of API 610 (L10h of about 40000 for each bearing and L10h of 25000h for each bearing assembly). A bearing life calculation report shall be provided.
g. Lubrication oil selection shall consider qualification to applicable environmental conditions (including radiation). Lubrication oil replacement interval shall be not less than 24 months.
h. A constant level oiler (or other equivalent oil top-up system) shall be provided on each bearing housing. The configuration of this device shall be duly agreed between IO and Contractor in the detailed design phase, considering the environmental and the maintenance interval constraints of the IBED PHTS Main pumps.
i. All lube oil shall have a flash point 10% higher than the maximum temperature (in Celsius degrees) as defined in *Appendix C – Process Loading Conditions*, except temperature achieved during fire event.
j. Bearing Seals suitable for the required all operating and environmental conditions shall be installed.
k. A remote system to detect low level in all bearing housing shall be supplied (refer to 9.8).

9.5.4 Coupling

a. PHTS IBED Main Pump Coupling shall be designed as per API 671 [s4].
b. All coupling shall be provided with a spacer sized for the removal of bearings and mechanical seals without the need to dismantle process piping or to remove the machines from the skid
c. A non-sparking removable coupling guard shall be provided on all shaft lines to avoid any risk of contact with rotating parts. Coupling guard shall be sufficiently rigid to withstand minimum 150 kg of dead load without any deflection.
d. A removable radiation shielding of maximum thickness of 700 mm will be installed between Main Pump and Driver to reduce radiation rates in motor area. Final positioning of the shield, penetrations, requirement for spacer dismantling and interfaces with coupling guards will be agreed between Contractor and IO during detailed design phase.
e. . Spacer length shall consider the thickness of the radiation shielding.
f. Couplings (complete with spacers) shall be balanced as per API 671 requirements and at as a minimum to grade 2.5 of ISO21940-11.

9.5.5 Mechanical Seal

a. Reference Standard for Mechanical Seals of IBED PHTS Main Pumps is API 682. [s2]. Requirement of this section applies even if they are higher than API 682 requirements.
b. The mechanical seal shall be of cartridge type and Arrangement 3 type (pressurized double mechanical seal) to prevent any leakage of the process fluid to the atmosphere.

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c. Requirement of Category 3 seals apply as a minimum. All additional engineering, testing and qualification activities to demonstrate suitability to the required operating conditions with the required performance level shall be included in the scope of supply.
d. Barrier Fluid is Demineralized Water (Refer to *Appendix A – IBED PHTS* Main Pump Datasheet for water parameters).
e. Barrier fluid leakage rates to atmosphere/drain and to process side shall be guaranteed by Contractor and demonstrated by testing. Expected refilling water flow is [d9]:
   i. < 100 ml/h per pump during operation
   ii. Equal to L0.01 criteria during standby.

   Any deviation to these values shall be submitted to IO for approval.
f. Contractor shall consider in the design maximum inlet pressure as defined in *Appendix C – Process Loading Conditions,* as well as backflow conditions defined in 9.3.1.
g. Mechanical seals are part of the containment barrier of the IBED PHTS Main Pumps. They shall demonstrate their capability to realize the containment function in all load conditions defined in *Appendix C – Process Loading Conditions*.
h. Behaviour of the mechanical seal and flushing system in case of failure of inboard seal, failure of outboard seal or loss of pressurization of barrier fluid shall be analysed. Contractor shall provide:
   i. Time during which the inboard seal or outboard seal can still provide the confinement function (no process flow leakage to the drain or atmosphere),
   ii. Expected Process Fluid Leakage rate when containment function will be lost.

   In case of failure of the inboard seal or loss of barrier fluid pressure, the outboard seal shall be still capable to ensure the containment function with leakage of process fluid limited to the L0.01 criteria. These values shall be demonstrated by testing. Alternative methodology can be proposed by Contractor to IO for approval.
i. Drain connection from outboard seal shall be collected and routed to battery limits. A method to detect abnormal leakage from outboard seal to the drain line shall be implemented by Contractor.
j. Throttling Bushing or Labyrinths should be implemented to reduce leakages to process (inboard seal failure) or to atmosphere/drain (outboard seal failure).
k. External retention seal should be implemented to avoid direct leakage to the atmosphere also in case of degraded operation of the seal.
l. Seal Material selection shall be compatible with radiation levels in the process fluid as given *Appendix A – IBED PHTS* Main Pump Datasheet.
m. Fire conditions at Main Pump discharge section, as per *Appendix C – Process Loading Conditions,* shall be considered as static design conditions (pump not running) also for the mechanical seal.

9.5.6 Seal Flushing Systems

a. Requirement of API 682 [s2] and API 614 [s3] apply to mechanical seal flushing systems of the IBED PHTS Main Pumps.
b. The reference seal plan for the IBED PHTS Main Pumps shall be Plan 53 B or Plan 53C. Accumulators, heat exchangers, instrumentation, piping, valves and all other required auxiliaries shall be included in the scope and shall be integrated on skid.
c. Contractor shall consider in the design maximum inlet pressure as defined in *Appendix C – Process Loading Conditions* as well as backflow conditions defined in 9.3.1.
d. Flushing System shall be designed to statically withstand discharge piping design condition (refer to section 9.4.3).

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e. Preferred installation Area of each mechanical seal flushing system should be the motor area to reduce radiation rate. Penetration to the shielding for the seal flushing piping will be agreed with IO during detailed design phase.
f. Contractor shall include in the scope of supply the electrical pumps required to refill the flushing system at required pressure. The supplied pumps shall be able to feed the complete set of flushing system of the 8 IBED PHTS Main Pumps.
g. Contractor shall confirm that in the given installation area, barrier fluid circulation can be achieved without the use of any circulation pump.
h. Alternative configuration with centralized circulation pumps/heat exchanger can be used (e.g. plan 54). The centralized system shall be supplied with all required equipment (baseplates, reservoir, electric pumps, heat exchangers, filters, relief valves, instrumentation, etc.) With this flushing system configuration, the refilling pumps indicated in point d should not be required. Nevertheless, each mechanical seal shall be equipped with dedicate check valves, remotely actuated isolation valves (when required) and accumulators installed on skid. This equipment has the scope to maintain, with the related IBED PHTS pump stopped, acceptable barrier fluid pressure to the seals and guarantee process leakage limits for 48 hours, also in case of mechanical seal failure or in case of lack of feed pressure.
i. The accumulator size of plan 53B or 53C shall allow to maintain the barrier function for at least 14 days without refill with the pump running or at standstill. In case of supply of a centralized supply system (e.g. plan 54) the centralized barrier fluid reservoir inventory shall be sufficient to maintain the barrier function for at least 28 days without refill with the pump running or at standstill.
j. Depending on the required operating conditions, additional seal flushing plans (e.g. plan 23, plan 32, etc) may be selected by the Contractor. The required equipment, including all fluid supply skids, with baseplates, reservoir, electric pumps, filters, relief valves, instrumentation, etc. shall be included in Contractor scope of supply.
k. Final seal flushing system configuration shall be included in the Proposal and shall be agreed with IO. Proposal shall clearly indicate required footprint and required utilities.
l. The components of Flushing System that are required to guarantee the containment of the process fluid shall be designed and shall demonstrate their capability to ensure this function in all conditions defined in *Appendix C – Process Loading Conditions*.
m. Installation location and piping routing distance from IBED PHTS Main pumps and refilling pumps (or alternatively remote seal flushing systems) is variable depending on the pump Item considered. It can vary from 10 meters (for the closest main pump) to 100 meters (for the farthest Main Pump). System design shall consider these range.
q. Extension of fire insulation required on flushing systems components will be agreed with IO in the detailed engineering phase. Insulation material will be supplied by IO. Contractor shall design all supporting features and include space reservation for the insulation.
n. Parameters of the cooling water are given in *Appendix A – IBED PHTS* Main Pump Datasheet.
o. In case of use of active equipment (e.g. electric pumps), they shall be redundant following N+1 criteria on all remote barrier fluid supply system and barrier fluid refilling system. Contractor shall demonstrate by testing that the switchover between the running equipment and the redundant equipment shall not reduce the barrier fluid pressure below acceptable limits for sealing function.
p. Flushing System are, with Mechanical seals, part of the containment barrier of the IBED PHTS Primary Pumps. Active and passive components of the flushing system contributing to containment shall follow the same safety classification of the Main Pump

pressure boundary. They shall also demonstrate their capability to realize the containment function in all load conditions defined in *Appendix C – Process Loading Conditions*.

9.5.7 Baseplate

a. Baseplate for the IBED PHTS Main Pumps shall be designed and manufactured in accordance with the API 610 and as per the additional requirements of this specification.
b. Considering the installation constraints and available footprints defined in 9.4 and in *Appendix D – Installation Data and Drawings*, baseplate shall be composed by:
    i. Common Baseplate or Main Skid installed on the foundations,
    ii. Baseplate for pumps and accessories with bolted and dismountable connection to the common baseplate,
    iii. Baseplate for motor and seal system with bolted and dismountable connection to the common baseplate,
    iv. Auxiliary skids for equipment remotely installed (e.g. mechanical seal barrier fluid support systems).

    Alternative design can be proposed by Contractor to IO approval.
c. The Radiation Shielding installed between pump and motor is out of the scope of Contractor. It will be dismountable and supported directly on foundation with no additional loading for the baseplate.
d. Main Pump baseplate, motor baseplate and all other auxiliaries skids shall be supplied with drip pan to collect any water leaking out of the pump. The drip pan shall be provided with drain connection in order to drain it, if necessary.
e. The installation configuration (footprint and building attachment locations) shall assume that the attachment points are rigid and have adequate capacity. No credit shall be taken for friction between support and foundation.
f. Baseplates shall be designed for non-grout construction.
g. Embedded Plates (EPs) are provided in the foundations. The size and position of the EPs or attachments on the steel platform, and orientation of the IBED PHTS Main Pumps against EPs are shown in *Appendix D – Installation Data and Drawings.*
h. Bolting between the baseplates that are part of the scope as well as the anchoring system to the foundation are included in the scope of the Contractor.
i. Contractor shall propose to IO approval the anchoring system of the common baseplate to the EPs. Steel Counter-plates to be welded to EPs, shim packs, bolting and levelling screws shall be included in the scope of Contractor. No removal of equipment shall be required for levelling.
j. Guidelines of API RP 686 (as amended by this specification) shall be followed. Anchoring System shall be designed to withstand nozzle loads defined in *Appendix C – Process Loading Conditions*. Additionally, the structural element that are not protected by the fire insulation, shall be able to withstand the conditions indicated in section 9.6.7. IO will communicate to Contractor during detailed engineering phase the need for provision for welding of secondary structural elements to the common baseplate (e.g. additional piping supports for fire extinguishing systems, platforms for personnel access).
k. Main Pump and motor supports shall be designed as rigid supports such that the vibration induced amplification on the pump and motor due to the flexibility of the supports is eliminated.
l. Pump shall be the fixed point for shaft alignment. No shimming is allowed between pump feet and pedestal.
m. Driver shall be provided with shim packs for vertical alignment and positioning screws for longitudinal and traverse horizontal alignment. The lugs holding these positioning

screws shall be attached to the base frame so that they do not interfere with the installation or removal of the drive element. Shaft alignment tolerances shall be clearly indicated in the General Arrangement Drawings.

n. Contractor shall include in the General Arrangement Drawing all tolerances related to skid anchoring.
o. Lifting lugs shall be integrated to skids as required in 9.4.1.

9.6 Materials, welding and fabrication requirements

9.6.1 Materials of construction

a. The base material for the IBED PHTS Main Pumps and accessories shall be austenitic stainless steel of either type 304L or 316L. Material Class A-7 or A-8 of API 610 applies. Other material can be proposed, subject to written approval by IO prior to Use.
b. All auxiliaries wetted by process fluid, lube oil, barrier fluid, cooling water fluid shall be in austenitic stainless steel. Other material can be proposed, subject to written approval by IO prior to Use.
c. The IBED PHTS Main Pumps pressure boundary material, including attachments to the pressure boundary and all welds, shall comply with the composition requirements for different steel product types per ASME Boiler and Pressure Vessel Code, Section II, Materials [s7] and ASME BPVC Section VIII, Division 2 [s9].
d. All Stainless Material that is part of the scope of supply shall comply with additional composition requirements per *Chemical Composition and Impurity Requirements for Materials* [d13] included here below for reference:
    i. Cobalt (Co) – max 0.05 wt.%,
    ii. Niobium (Nb) - max 0.10 wt.%,
    iii. Tantalum (Ta) - max 0.010 wt.%.

    These requirements apply also to welding filler material.
e. Structural elements can be supplied in Carbon Steel material. Requirement of [d13] on composition applies:
    i. Cobalt (Co)) - max 0.10 wt.%,
    ii. Nickel (Ni) – max 0.050 wt.%.

    These requirements apply also to welding filler material.
f. All other proposed materials shall follow requirement of [d13].
g. Gaskets and other elastomers shall be selected to withstand all required loading condition in associations with the limits on leakages defined in 9.5.1.
h. Selected material shall be qualified to environmental radiation levels defined in Pump Datasheet (refer to Appendix A – IBED PHTS Main Pump Datasheet) in combination with pressure, temperature and other environmental condition required by their installation zone.
i. Materials of all process wetted parts, including mechanical seals and flushing systems, shall be qualified to radiation levels in the process fluid defined in Datasheet (refer to *Appendix A – IBED PHTS* Main Pump Datasheet) in combination with pressure, temperature and other environmental condition required by the installation zone.
j. Expendable materials, defined as a non-permanent material that comes in contact with the IBED PHTS Main Pumps and any of its materials of construction, shall not cause degradation of the IBED PHTS Main Pumps (refer to 9.6.2). Use of expendable material shall be controlled by written procedure, which shall be approved by IO prior to use.
k. In case of use of junctions between dissimilar materials, Contractor shall include all required provision to prevent galvanic corrosion. Earthing of the components it is not a method to prevent the galvanic corrosion.

9.6.2 Prohibited Materials and Practices

a. Teflon and similar materials shall not be used.
b. Halogens are forbidden in all materials of construction, including gaskets and lubricants. Deviation to this statement shall be submitted to IO for approval indicating type and quantity (burnable and not burnable).
c. Mercury shall not be used in any manner, including during any construction of the assembly which can result in exposure of parts to the metal or its vapour.
d. The use of nitrided surfaces exposed to the process fluid is prohibited.
e. Care shall be taken to prevent contamination of material by red lead-graphite-mineral oil, molybdenum disulphide lubricants, halides, sulphur, copper, zinc and phosphorus.
f. The use of materials containing asbestos or PCBs and Antimony is not acceptable.
g. Direct contact between stainless and carbon steel/ galvanized/zinc coated steel is not permitted.
h. Direct contact between stainless steel and zinc lubrication fluids is not permitted.
i. Direct contact between stainless steel and copper or aluminium is not permitted. (Except that copper chills ad welding tips are permitted).
j. Contractor shall provide his personnel with necessary requirements and guidance to prevent the introduction of any foreign material in the scope of supply, refer Working Instruction for Foreign Material [d14] and to section 9.6.2.
k. Refer to Table 11 for applicable limit concentration of detrimental materials.

Table 11 - Limitations on Detrimental Materials

Detrimental Material	Affected Material	Maximum Concentration (PPM)	Possible Sources	Stage of Fabrication
Mercury	Nickel Base Alloys or Stainless Steel	10	Chemicals, instrumentation, mercury lighting	All
Lead	Nickel Base Alloys or Stainless Steel	10	Temperature indicating crayons, hammers, paint, temporary shielding used for maintenance, green polyethylene	All
Cadmium, Magnesium, Tin, Zinc, Antimony, Arsenic, Bismuth, Silver	Nickel Base Alloys or Stainless Steel	250	Hammers, fixtures, lubricants, cutting oils, paint, plating, wire brushes	Final cleaned surfaces or any surfaces prior to or during thermal treatment
Aluminum and Copper	Nickel Base Alloys or Stainless Steel	250	Soft pads or hammers, probes, tips (copper chill blocks & electrodes for welding are acceptable)	Final cleaned surfaces or any surfaces prior to or during thermal treatment
Sulphur	Nickel Base Alloys Stainless Steel		Furnace atmosphere, marking materials, lubricants and cutting oils, UT couplants, fluxes, final cleaned surfaces or any surfaces prior to or during thermal treatment	Final cleaned surfaces or any surfaces prior to or during thermal treatment or machining

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Detrimental Material	Affected Material	Maximum Concentration (PPM)	Possible Sources	Stage of Fabrication
Chlorides	Stainless Steel	250 ppm water leachable	Human perspiration, lubricants, cutting oils, fluxes, penetrant materials, water vapor atmospheres, protective materials, lagging, UT couplants	Final cleaned surfaces or any surfaces prior to or during thermal treatment or machining
Phosphorous	Nickel Base Alloys	250	marking materials, temperature indicating crayons, lubricants, UT couplants	Final cleaned surfaces or any surfaces prior to or during thermal treatment or machining

9.6.3 Weldings

a. All welding shall be performed in accordance with ASME BPVC Section IX [s10] or equivalent recognized standard (refer to [s1]).

b. The Contractor shall have all welding procedures and welders qualified in accordance with ASME Section IX Boiler and Pressure Vessel Code or equivalent recognized standard (refer to [s1]), prior to commencing any welding on the work.

c. For equipment falling inside the extent of PED or ESPN Order, depending on the pressure category and ESPN Level, the qualification of PQR, welders and NDT controllers shall be approved by the NB/ANB in charge of the conformity assessment of the equipment. These certifications shall be either established in accordance with EN Harmonized standards or according to ASME code plus additional requirements needed to meet the requirement defined by EN Harmonized code.

d. All Welding books, WPS, PQR shall be submitted to IO for approval.

e. Any procedure for the repair of defects in weldments shall be submitted to IO for his approval prior to any repair being done.

f. All pressure boundary welds shall be full penetration welds. They shall be subjected to 100% visual examination, 100% surface examination (Magnetic or Dye Penetrant Test) and 100% volumetric examination (Ultrasonic Test or Radiographies) in accordance with the applicable codes and standards as listed in this Specification.

g. Thermal arc gouging processes are prohibited.

h. Any heat treatments performed during fabrication or after welding shall also be duplicated on the qualification test coupon(s) and shall be included in the conformity assessment completed by the Contractor.

i. Each weld shall be identified with a unique weld identification number on the weld control record or equivalent. Weld numbers and weld location shall be shown on the Contractor’s drawings.

j. For pressure boundary parts, drawings that show fabrication by welding shall indicate the joints, together with the joint geometry and welding process and welding procedure(s).

k. Weld seams shall not intersect nozzle or access opening locations.

l. Tack welds to be incorporated into the final weld shall have a contour suitable for fusion with the root pass. Tack welds that become part of the finished weld shall be performed by a qualified welder, using a qualified procedure and filler material, and visually examined. Tack welds that have cracked or are defective shall be removed, and the area re-tacked prior to welding. Tack welds in grooves shall be kept to a minimum.

m. Temporary weld attachments to the pressure boundary shall be removed upon completion of their intended purpose. Removal shall be documented and included in the conformity assessment completed by the Contractor. If thermal cutting is used, the attachment shall be cut no closer than 8 mm from the surface to which it is attached, and the balance material shall be removed by mechanical means.

n. Weld joint preparation shall not be performed by thermal processes. The location, depth and area size of all weld repairs, regardless of the depth of the repair, shall be documented and included in the conformity assessment completed by the Contractor.

o. All additional requirements on welding on equipment subject to PED or ESPN directives (where applicable) shall be included in the scope.

9.6.4 Surface preparation and Cleaning

a. During cleaning, particular attention shall be given to the removal of weld spatter, debris and other foreign matter, particularly from the coolant passages and sealing surfaces. Final cleaning shall ensure effective cleaning without damage to the surface finish, material properties or metallurgical structure of the materials.
b. Unless otherwise specified, or instructed by IO, equipment shall be cleaned, primed, and finish painted in accordance with the Contractor's standard specification subject to IO approval.
c. The interior and exterior surfaces shall meet the requirements for ASME NQA-1 [s14] class B cleanness prior to packaging.
d. Pumps shall be free of mill scale. The inside surface shall be degreased and then flushed with clean filtered water (refer to point g of this section). It shall be visibly clean, free of sand, dirt and any other foreign matter.
e. Welded ends should be properly cleaned and treated with a suitable rust preventive other than grease and then securely fitted with plastic or wooden caps.
f. Grinding or lapping: Use only aluminium oxide, silicon carbide, zirconia or alumina grinding (or lapping) new wheels and in any case not previously used for on carbon or low alloy steel. Any type of grinding wheel bonded with a resin, rubber, or silicate must be submitted for review and written approval of chemical content by IO. Excessive pressure shall be avoided that may result in localized heating or smearing of the surface which can invalidate a subsequent liquid penetrant examination.
    i. Brushing: Use only stainless steel brushes not previously used on carbon or low alloy steel surfaces. Power wire brushing shall not be performed on surfaces that require a PT examination.
    ii. Blast cleaning: Use only new iron-free grit/sand. Steel iron grit/shot is not permitted. Glass beading or reconditioned grit/sand shall not be used unless followed by sandblasting with new grit/ sand.
    iii. Detergent (Alkaline cleaner) wash: Hot pressure washing with a detergent may be used. Detergent shall be allowed to flow along with demineralised water for rinsing and detergent shall not get dried on the surface.
    iv. Acid Cleaning: Pickling pastes or acid solutions, such as “Ox-out” may be used.
g. All water used for cleaning, hydraulic testing and performance testing shall meet the requirements in Table 12 in accordance with ASME NQA-1 [s14], Part II, Subpart 2.1,

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Section 304.1, Water for testing and Grade A water quality from RCC-M 2012 [s22] , Annex F-III for cleaning:

Table 12 - Water Quality for Cleaning and Testing

Parameter	**Requirement**	
	Cleaning	**Hydrotesting and Performance testing**
pH at 25°C	6.0 – 8.0(1)	6.5 – 8.0
Specific conductivity at 25°C, µS/cm	< 2	-
Chloride, ppm	<0.15	100 (2)
Fluoride, ppm	<0.15	<2
Sulfide, ppm	n/a	<1
Silica, ppm	<0.1	-
Total solids, ppm	<0.1	<500 (dissolved)
Corrosion Inhibitor (3)	-	-

(1)A drop in the minimum pH level to 5.5 is permissible on the condition that it can be shown that the drop in pH is effectively due to the carbonation of the water
(2)As per API 610 XII, clause 8.3.2.7.
(3) When a Corrosion Inhibitor is used it shall be declared by Contractor in the Related Procedure and it shall be approved by IO.

h. Inspection for cleanliness shall be performed for casings and internal parts prior to final closure. This in process cleanliness shall be documented on an inspection report and signed by IO.
i. Post hydro test dryness to be ensured in different ways like blowing warm air through the unit. Further, the equipment shall be cleaned and inspected before packing.
j. The Contractor shall submit to the IO the proposed cleaning procedure for approval/acceptance. The demonstration of meeting the above cleaning requirements represents a Hold Point (HP).

9.6.5 Surface finish

a. Internal wetted surfaces of the IBED PHTS Main Pumps, including welds, shall have a minimum acceptable surface finish smoother than 6.3 µm roughness (Ra). Feasibility to have a finishing smoother than 1.6 µm will discussed with contractor during detailed engineering phase.
b. Interior welds shall be ground flush to meet surface finish requirement.
c. Contractor shall specify finish recommendation for Gasket sealing surfaces to be applied to the scope of supply.
d. The external weld seams shall have a surface finish of 12.5 µm Ra or better. Surface finish shall extend a minimum distance from the edge of the weld to a distance whichever is the greater of twice the material thickness plus 100 mm or 150 mm.

e. All burrs and rough edges shall be removed.
f. All stainless-steel surfaces that are in contact with working fluid and with installation environment of the IBED PHTS Main Pumps shall be passivated in accordance with the ASTM A380/A380M [s35].

9.6.6 Coating and Painting

a. Stainless steel surfaces shall not be coated but shall be clean metal and free of weld spatter, oil, dirt, and grease.
b. Other steel surfaces shall be coated. Selection, qualification, application and testing of coatings shall be in accordance with as a minimum to requirement given in reference [d15] (Zone II level) and in reference [d73]. Contractor can propose to IO alternative painting specifications if it can demonstrate a level of protection equivalent or higher than procedures defined above.
c. Painting products and systems shall be free of halogens and shall be qualified for nuclear applications, taking into account the required level of radiations as per *Appendix A – IBED PHTS Main Pump Datasheet*.
d. Fire conditions included in section 9.6.7 apply (refer to [d73]).
e. Surface Preparation and Painting Specification, including painting product datasheets, shall be submitted to IO for approval.
f. Preliminary Colour shades are:
    i. Baseplates and Other Structural Steel: Green RAL6018
    ii. Motor Casing: Green RAL6018
    iii. Coupling Guard: Yellow RAL 1026

    Colour shades will be confirmed in the detailed engineering phase.

9.6.7 Fire Protection and Insulation

a. The outside of the Main Pumps and the inlet and discharge piping will be insulated as per materials given in [d16]. Insulation material will be supplied from IO to Contractor. The insulation thickness on pump casing will be of 60 mm (to be confirmed in detailed engineering phase). Insulation thickness on auxiliary piping, when required, will be also confirmed by IO in the detailed engineering phase.
b. Type of insulation and its technical requirements are included in reference [d16]. Insulation density is 350 kg/m3.
c. The design of the insulation material is out of the scope of this Specification. A metal temperature under the insulation shall be considered for the fire load as per case IV.T1 of *Appendix C – Process Loading Conditions*.
d. Even if insulation material itself is not part of this procurement, the design and installation of supports for installation of the insulation is included in the scope of Contractor, however,.
e. Insulation supports shall be designed to withstand all loading conditions included in *Appendix C – Process Loading Conditions* with additional requirements of point g of this section.
f. Contractor shall include in this scope the Stainless Steel cladding to be installed above insulation material.
g. The supports and skid are assumed to be not insulated and are deemed to be at a temperature of 400 °C during a fire event.
h. Personnel Protection shall be applied to all surfaces above 70 °C.

9.7 Electrical Requirements

9.7.1 General Requirements

a. Variable Frequency Driver (VFD), Vacum Circuit Breaker (VCB) and Auxiliary motor Low Voltage Motor Control Center (MCC) and Unit Control Panel (UCP) shall be included in Contractor Scope of Supply as defined by the Technical Specification [d2]. Refer to *Appendix G – Control Architecture* for the expected configuration of electrical and control panels.
b. LV MCC shall be included in Contractor scope for all LV motors that are part of the scope. This equipment shall be installed in same location of VFD, VCB and UCP. For specific environmental requirement, interfaces and space reservations, refer to Technical Specification [d2].
c. For general information on the ITER electrical system design, see *EDH Part 1: Introduction* [d17]. All electrical equipment and systems within the equipment boundary shall be in compliance with the *EDH Part 3: Codes and Standards and EDH [d19], Guide A: Electrical Installations for SSEN Client Systems[d51]*.
d. Auxiliaries may utilize a lower voltage connection (e.g., 230 VAC or 24 VDC). A 230 VAC single-phase power circuit shall be provided for the space heater circuit.
e. A 24 VDC power circuit will not be provided. However, the supplied equipment may generate its own 24 VDC power supply utilizing a transformer to obtain lower voltage levels for auxiliaries.
f. A separate terminal box shall be provided for each voltage level. Each terminal box except for the primary 6.6 kV circuit, shall have an adequately sized circuit breaker with an operating electrical disconnect lever or switch that can be locked in the off position without entering the terminal box.
g. All breakers shall have auxiliary contacts to indicate that the breaker is OPEN, CLOSED or TRIPPED. These contacts shall be wired to terminals in the terminal box for easy accessibility by field wiring.
h. All terminal boxes and enclosures shall be rated IP 66 per EDH Part 3: Codes and Standards [d19].
i. The electrical users list of the IBED PHTS Main Pump Control Cubicle and the auxiliary equipment shall be provided to IO for approval.
j. The power cables included in the scope shall be fire and radiation resistant and halogen-free and shall be chosen as per the IO Cable Catalogue [d22].
k. The Contractor shall provide properly sized power lugs in the terminal box to accommodate the incoming line side cable.
l. Stainless Steel cable glands shall be provided for all Junction Boxes cable entry.
m. The cables connecting the IBED Pump Control Cubicle to the junction boxes on the Main Skid are outside the scope of supply, however the sizing of the cables shall be provided to IO for approval.
n. Cable Terminals shall be identified and named in conformity to the project documentation.
o. Additional LV motors and users shall follow requirement of [d17], [d18], [d19], [d20], [d51] and shall be qualified to applicable environmental radiation and magnetic field. Effect of magnetic drag shall be considered in the sizing. Minimum required service factor shall be applied on the final calculated power rating. Motor bearing shall be electrically insulated at one end to eliminate shaft circulating current that may damage the bearings.
p. All LV electrical equipment shall follow the Low Voltage Directive 2014/35/EU and be CE marked.

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9.7.2 Main Electric Motor Driver

a. The IBED PHTS Main Pump Motor shall be rated for 6.6 kV, 3- phase, 50 Hz, 3-wire with earthing service. The IBED Single-line diagram is provided for information in [d23].
b. The motor neutral shall be isolated.
c. The IBED PHTS Pump Motor shall be water cooled and suitable to be driven by VFD. The detailed technical requirements for VFD are given in [d2].
d. Parameters of available cooling water are defined in *Appendix A – IBED PHTS* Main Pump Datasheet.
e. Main Motor shall be designed to be operated by applicable Solid-State Converter and must take into consideration all additional losses, including the ones related to harmonics and to the load.
f. Main Motor shall have a junction/terminal box(s) mounted on the motor for terminating electric power. Instrumentation connections shall be provided in separate Junction Boxes. The box shall be mounted in an easily accessible location.
g. Main Motor shall operate successfully under running conditions at rated load with the voltage variations and frequency variations required by section 9.3 and in *EDH Part 3: Codes and Standards and EDH Guide A [d51]*.
h. The Contractor shall provide the cable and terminations between the terminal box mounted on the motor and the junction boxes mentioned in 9.7.1. These connections shall be terminated on the load side of the provided circuit breaker.
i. The motor and the motor power terminal boxes shall be of the totally enclosed type with protection class IP55 (as a minimum) in accordance with the requirements of IEC 60034-5 [s28]. The motor shall be designed to operate as required by this Specification in the normal and abnormal (including seismic event) environments, including the water mist conditions given by saturated water.
j. The Main Motor shall have a safe stalled (locked rotor) time equal to or greater than the maximum acceleration time with the minimum starting voltage specified in *Appendix A – IBED PHTS Main Pump Datasheet.*
k. Bearings shall be suitable for continuous service under the conditions specified and shall be mounted in housings that are dust and lubricant tight. The type of bearing chosen shall be determined from the radial and axial thrust loads, speed of rotation, type of lubrication and load duty for which the motor is applied. Requirements given in 9.5.3 applies.
l. Motor bearing shall be electrically insulated at one end to eliminate shaft circulating current that may damage the bearings.
m. The IBED PHTS Main Pump Motor shall be supplied with a space heater for the windings with the required cables wired to the local terminal box. These connections shall be terminated on the load side of the provided circuit breaker. The heater shall be rated for the power supply 230 VAC, single phase, 50 Hz. A control circuit for the heater shall be provided. The ENABLE/OFF selector switch shall enable the circuit. Another contact shall energize the circuit. Auxiliary contacts on the heater circuit shall provide the status of the heater (STOPPED, RUNNING). The TRIPPED indication shall be provided by the auxiliary contact on the heater circuit breaker. All required wiring for enabling and the status of the heater circuit shall be provided.
n. After proper preparation, all interior metal parts and external hardware of the Main Motor that are not stainless steel shall be treated with a permanent protective coating to prevent corrosion and deterioration in accordance with section 9.6.6.
o. Deleted
p. The Contractor shall provide the surface temperature of the Main Motor (assuming no insulation) and the heat dissipated to the environment during the design stage.

q. The Main Motor shall have a premium quality of class F (155°C) insulation system with operating temperature by resistance at rated power, rated voltage, rated frequency and at the highest design cooling medium temperature limited to class B (130°C) in accordance with IEC 60085 [s41]. For voltage and frequency variations, paragraph 7.3 of IEC 60034-1 shall be applied and in the cases inside zone B, the temperature limits class F (155°C) shall not be exceeded.
r. Motor windings shall be suitably treated so that the insulation is moisture resistant and adequate for exposure to incidental/accidental environmental conditions (Appendix A, Section A.3.2). Motor shall have fully encapsulated winding system as described in IEC 60034-1 and IEC 60072 [s29].
s. Maximum operating and starting conditions (i.e., maximum load, minimum voltage, and maximum ambient temperature) shall be considered for the sizing and design in accordance with equipment classification and applicable standards.
t. The Contractor shall consider the impact of the applicable magnetic field on motor performances. Also, effects of magnetic drag on pump rotor shall be considered for the calculation of required brake-power to the motor. Torque instability related to presence of magnetic field shall be assessed and any interaction of torsional natural frequency shall be verified in the train torsional analysis.
u. The Main Motor shall have a minimum service factor of 1.15 on rated operating point and shall cover operation at maximum operating speed (refer to section 9.3.2). However, the motor shall be adequately sized without relying on a service factor greater than 1.0. This requirement will ensure adequate temperature profiles for the motor, adequate torque profiles for the driven load, and additional margin for overload conditions.
v. The requirements on motor instrumentation are included in section 9.8.
w. The Contractor shall provide the following information on the electrical motor during the bid stage:
    i. Nominal current and starting current,
    ii. Electric power, power factor and efficiency,
    iii. Insulation Class (sizing and installed),
    iv. Threshold for warning, alarm and trip on winding and bearing,
    v. Winding temperature increase (from ambient condition) from cold start.

    The Complete list of documentation required is included in section 18.

9.7.3 Grounding/Earthing

a. The IBED PHTS Main Pump and associated electrical equipment shall be grounded as per *the EDH part 5: Specification for Earthing and Lightning Protection* [d21] and *EDH Guide A: Electrical Installations for SSEN Client Systems* [d51]. Each skid shall be equipped with at least two earthing connection in opposite locations.
b. Motors earthing shall be provided through the screen (shield) of the power supply cable. In addition, each terminal box shall contain respective earthing terminal.
c. Main skids, Motor and all equipment skids shall include a minimum of two connection pads to be used for bonding and grounding with connection of a 4/0-AWG (or IEC equivalent) bare copper conductor to the building earth ground.

9.8 Instrumentation and Control requirements

a. Due to radiation dose rate exceeding 100 Gy in silicon and to presence of neutron flux, components on the Main Skid shall not have embedded electronics (refer to [d58] and [d68]). Electronics shall be deported and installed in the UCP cubicle that is part of this scope of supply and detailed in Technical Specification [d2].

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b. A Distance of at least 300 m between installation area of the Main Skids and UCP shall be considered. Contractor shall confirm that this distance is compatible with the selected equipment.
c. The UCP together with VFD and MCC, shall be able to manage and control all instrumentation, all electrical and electromechanical items included in this scope of supply. It shall be able to receive set points for each Main Pump from Plant Control System and to coordinate the simultaneous start-up the simultaneous operation of the Main Pumps. Refer to *Appendix G – Control* Architecture for the expected Control Scheme and to the Technical Specification [d2] for detailed description of the control system.
d. Supplier to propose the best suitable UCP architecture to control the full set of IBED PHTS Main Pumps. A common control unit for the 8 Main Pump and their accessories is the preferred solution. A redundant architecture installed in the same cubicle shall be provided.
e. This instrumentation shall be capable to safely work in all operating conditions defined in *Appendix C – Process Loading Conditions*
f. All terminal boxes and enclosures shall be rated IP 66 per EDH Part 3: Codes and Standards [d19].
g. A removable Local Control Panel (LCP) with START/STOP pushbuttons, a REMOTE/LOCAL selector switch and indicating lights (STOPPED, RUNNING, LOCAL, REMOTE, TRIPPED) shall be provided on the main skid for the primary 6.6 kV motor and all auxiliary LV motors. In addition, an ENABLE/OFF selector switch and status indicating lights (STOPPED, RUNNING, TRIPPED) for the space heater circuit shall also be provided on the LCP. All contacts provided with the LCP shall be wired to terminals inside the enclosure for easy accessibility by field wiring from the plant control system. All terminals shall be clearly identified. The pushbuttons and selector switches of the LCP shall be IEC-rated in compliance with the following standards: IEC/EN 60947-1, IEC/EN 60947-5-1, and IEC/EN 60947-5-5 [s34].The indicating lamps of the LCP shall be in accordance with Section 10.8 and Table 10 of the *Technical Specification of LV Electrical Cubicles for TCWS 1st Plasma* [d24]. Type of fast connector to LCP and fixing method to the equipment during use will be agreed with IO during detailed engineering phase.
h. A minimum of one (1) Emergency Stop (E-Stop) pushbutton shall be provided and mounted in a logical and easily accessible location on the Main Skid (on motor side) as well as near each other LV motors. E-Stops shall be of the push-pull type with a RED mushroom head and two (2) Form C contacts (Normally Open / Normally Closed). All contacts from each of the E-Stops shall be wired to terminals clearly identified inside the LCP.
i. The IBED PHTS Main Pump Control Cubicle shall interface with the plant UCP through Siemens Profinet and/or hardwired interface. Protocol converters such as Modbus to Profinet devices are acceptable. The Contractor shall provide all required hardware, software (including software development) and mapping required to facilitate this solution along with detailed documentation for installation and commissioning. List of signals to be hardwired shall be agreed between IO and Contractor during detailed design phase.
j. The expected interface with the control system shall include as a minimum a method to begin the automated pre-start process, indication that the pre-start process is complete and the pump starting process is ready to begin, a method to start the pump, control the speed of the pump, a method to stop the pump and return to the pre-start mode, and a method to stop the pre-start mode. Any indications to monitor and ensure proper operation of the pump such as oil flow rates, oil pressures, cooling water flow rates,

cooling water pressures, etc. shall be monitored by the IBED Pump Control Cubicle and an alarm shall be provided to the plant control systel to signify the event to the operator. The Contractor shall identify conditions which should be monitored and if any should provide a signal to stop the pump these shall be provided, along with a list of alarms, in writing to IO.

k. deleted
l. The cables connecting the IBED PHTS Main Pump Control Cubicle to the junction boxes on the main skid are outside the scope of supply, however the sizing of the cables shall be provided to IO for approval.
m. All instrumentation and control systems shall be in compliance with I&C Design criteria document for TCWS - IBED PHTS, NBI PHTS, CVCS [d65].
n. It is the responsibility of the Contractor to determine the number and location of the sensors required to protect the equipment. The process instrumentation for suction pressure, suction temperature, discharge pressure and flow rate are not part of the scope and will be provided by others.
o. For all medium voltage (MV) and low voltage (LV) motors defined in this Specification, two dual-element PT100 Class A 4-wire connection resistance temperature devices (RTD), platinum rated 100 ohms at 0°C, shall be installed in the motor for each phase. Alternatively, two single element PT-100 Class A 4-wire RTDs, platinum rated 100 Ohm's at 0°C, can be used in place of the dual-element RTDs. The protection against motor overheating will be also ensured by the detection of excessive starting time and locked rotor (Stalling time).
p. MV Motors shall be equipped by two speed sensors to measure the rotation speed. This information will be sent to the related VFD.
q. Contractor shall include in the scope provisions only for 4 additional speed sensors. Contractor shall declare the type and model of sensor suitable to be provided if needed.
r. Location of speed sensors will be preferentially on motor side, behind the radiation shielding.
s. All bearings of the IBED PHTS Main Pump assembly (Pump and motor) shall be equipped with a minimum of two (2) temperature detectors each. Detectors shall have different sensing point on the bearing. Each temperature detector will be either:
    i. one (1) dual-element PT100 Class A 4-wire connection RTD, platinum rated 100 ohms at 0°C,
    ii. two (2) single-element PT100 Class A 4-wire connection RTD, platinum rated 100 ohms at 0°C.

    When a separate thrust bearing is provided, this shall be considered as an additional bearing.
t. The elements shall be permanently installed as close as possible to bearing surfaces and shall be located preferably in the bottom half of the bearing housing. Where any bearing is insulated to prevent shaft current, RTD shall be ungrounded, and the metallic sheath insulated from the RTD head to prevent bypassing the bearing insulation. Contractor can propose alternative bearing temperature monitoring configurations, in writing, which will be subject to IO approval.
u. Each Main Pump shall be equipped with 4 Casing Skin Temperature Detectors with Thermowells directly welded to machine casing.
v. As a minimum the following vibration monitoring shall be provided:
    i. all bearings of the IBED PHTS Main Pumps assembly (Pump and Motor) shall be equipped with 2 vibration detectors installed at 90 degrees angular distance to detect radial vibration on two perpendicular planes.
    ii. Each Shaft line shall be equipped as a minimum with two Axial vibration probes.

    Contractor can propose other configuration for vibration monitoring to IO approval.

w. The vibration detectors shall be permanently installed and ground isolated with hermetically sealed cables. Sensitivity of the accelerometers shall be minimum ±5%. Vibration Velocity readings shall be provided to IO control System.
x. All bearing housing shall be equipped with at least two level switches each to remotely detect low oil level.
y. All instrumentation required for safe and reliable operation of Mechanical Seals and Flushing Systems shall be included in Contractor Scope of Supply. This includes, as a minimum, instrumentation required by API 682 and API 614 standards. A method to detect abnormal leakage on seal drain (leakage from outboard seal) shall be implemented.
z. All instruments shall be wired to and clearly identified in a dedicated stainless steel instrument terminal box on the skid equipped with stainless steel cable glands. Instrument cables shall be fire resistant and halogen-free and shall be chosen as per the IO Cable Catalogue [d22].
aa. All sensing lines on piping shall be equipped with isolation valves and block and bleed manifolds.
bb. All local indicators shall be installed on a gauge panel on skid limits. The location of the gauge panel shall be accessible to operator and guarantee a good reading. Final positioning will be mutually agreed between Contractor and IO during detailed design phase. These requirements apply also to auxiliary skids that are part of the scope.
cc. Temperature elements on piping shall be fitted in thermowells.
dd. Sensor wiring shall be protected from physical damage by conduits, armoured tubing, cable trays or other approved method.
ee. The cables from the terminal box from Main and auxiliary skids to the IBED PHTS Main Pump UCP and from the IBED PHTS Main Pump UCP to the plant control system are not part of the scope and shall be provided by others. The Contractor shall provide a detailed cable list, including also this interconnecting cabling, to IO for approval.
ff. Sub-Equipment, Instrumentation and Signal tagging shall follow ITER TTT codes list [d27] and ITER Numbering System for Components and Parts [d28].
gg. Instrumentation and control equipment with a safety function (if any) shall follow requirements given in [d77].

9.9 Nameplates

a. The IBED PHTS Main Pumps shall have a nameplate on the pump body, the motor, each auxiliary equipment, each terminal box, each cubicle. If desired, the nameplate may be multiple, provided the prescribed minimum information is included.
b. Instrumentation and Junction boxes nameplates shall be provided by Contractor. Cable Terminals shall be identified and named in conformity to the project documentation.
c. Each equipment, including instrumentation shall be marked with the unique identification number (tag number) agreed with IO (refer to section 9.8).
d. All nameplates shall be made of austenitic stainless-steel material and laser printed.
e. Pumps, motor and skids nameplates shall be at least 3 mm thick and shall be permanently attached to the equipment. The nameplates and attachments shall be such that removal shall require wilful destruction of the nameplate or its attachment system. The attachment method to the IBED PHTS Main Pumps shall not adversely affect the integrity of the IBED PHTS Main Pumps.
f. The nameplates shall include all information and marking as required by the design and construction codes, regulatory requirements and directives identified.
g. Direction of rotation of the Pump and motor shall be clearly marked or stamped on the machine. A Clear correspondence of sense of rotation with the supply voltage sequence of U-V-W shall be included in the Motor Terminal Box Nameplates.

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h. In addition to the nameplate contents specified here above, the nameplate of the Main Pump shall include the following minimum information:
   i. Equipment name and tag number,
   ii. PNI (refer to 13.2)
   iii. Equipment model and serial number,
   iv. Rated flow and head,
   v. Fluid service/type,
   vi. Casing hydrostatic test pressure,
   vii. Maximum allowable working pressure and temperature,
   viii. Rated speed and Maximum Allowable speed,
   ix. Lubricant type and lubrication instructions
   x. Weight (dry and full of process fluid),
   xi. Contractor name and address,
   xii. Manufacture date,
   xiii. CE Marking where applicable.

i. In addition to the nameplate contents specified here above, the nameplate for the motor shall include the following minimum information, unless included on the Main Pump nameplate:
   i. Catalogue or model number,
   ii. Equipment TAG
   iii. PNI (refer to 13.2)
   iv. Motor Contractor type and frame designation,
   v. Part number,
   vi. Power,
   vii. RPM at rated load,
   viii. Voltage,
   ix. Frequency range,
   x. Number of phases,
   xi. Temperature rise at service factor,
   xii. Insulation class,
   xiii. Time rating,
   xiv. Full load current,
   xv. Locked rotor current,
   xvi. Service factor,
   xvii. Power factor at 125%, 100%, 75%, and 50% Load,
   xviii. Total weight of motor,
   xix. Weight of rotor,
   xx. Max ambient temperature for which motor is designed,
   xxi. Contractor contact information,
   xxii. Manufacture date,
   xxiii. CE marking,
   xxiv. Lubricant type and lubrication instructions,
   xxv. Terminal arrangements,
   xxvi. Maximum permissible number of starts and the requirement cooling period when the motor is started under cold and hot motor conditions.

j. CE marking shall be provided also on main skid nameplate to indicate that the Contractor performed all required integration activities as required by applicable directives.

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10 Hazard and Risk Analysis

The Contractor shall submit Risk analysis report providing the comprehensive list of Hazards and provide adequate risk mitigation measures in detailed design. Contractor shall refer to the "HIRA Risk Assessment Table" [d29] to identify the potential risks associated with the equipment. Risk analysis shall be carried out.

Contractor participation to HAZOP meetings held by IO and corrective actions as required by HAZOP reports shall be included in the scope.

11 Inspection and Testing

a. The Contractor shall carry out inspection to establish and maintain quality of workmanship in his works and that of his sub-contractors to ensure the mechanical accuracy of components, compliance with drawings, identity and acceptability of all materials, parts and equipment. He shall conduct all tests required to ensure that the equipment and material furnished shall conform to the requirements of the applicable codes and of this Specification, including requirements of *Appendix A – IBED PHTS Main Pump Datasheet*. All test and test procedure proposed by the Contractor shall be notified well in advance of the fabrication and major shop test of the equipment for the purpose of making general inspections and for the progress report. The IO's representative shall be given full access to the shop in which the equipment is being manufactured or tested and all test records shall be made available to him.
b. Requirements for Equipment Qualification are included in section 15. All additional testing activities required for qualification shall be included in the scope of Contractor.
c. The equipment covered under this specification shall not be dispatched unless the same has been finally inspected and tested successfully and shipping release has been issued by IO.
d. All operations to be carried out by the Contractor shall be listed in the Manufacturing and Inspection Plan (MIP) which shall be submitted to the IO for approval. All inspection and testing shall be carried out as per MIP and test procedures, prepared and submitted by the Contractor and approved by IO.

11.1 Materials Certification

a. All base material shall comply with the requirements of this Specification and the requirements of EN 10204 [s23] and ASME BPVC Section II, Parts A and C [s7] as applicable. Certified Material Test Reports (CMTRs) shall document compliance with ASME BPVC Section VIII, Division 2 [s9], ASME BPVC Section II, Part A for all pressure boundary material, including attachments to the pressure boundary and all material utilized in the production of weld test coupons.
b. Wetted Parts and Pressure Retaining parts shall be manufactured with material traceable to EN 10204, Type 3.1 or 3.2 (when required by applicable regulation). This requirement applies also to weld filler material and Mechanical Seals and Flushing Systems. For all other parts 2.2 Certificates associated with PMI can be supplied. Exception to these requirements shall be submitted to IO approval.
c. Welding materials shall meet the requirements of the *Code of Construction,* as defined in Section 3.1.2. CMTRs shall document compliance with ASME BPVC Section VIII, Division 2, ASME BPVC Section II, Part A for all welding materials.
d. Material Certificates shall include all additional verification on chemical composition and impurity requirement listed in section 9.6.1.

11.2 Requirements on Castings

a. All casting materials shall conform to the relevant material specifications. All tests as called for in relevant material standards shall be carried out.

b. Test bars shall be cast for physical tests from the same ladle of metal as the castings they represent. Four copies of the ladle analysis shall be submitted to IO. Physical tests on test bars shall be carried out in the presence of the IO's representative if required by approved MIP.

c. The castings shall be sound, clean and free from porosity, blow holes, hard spots, cold shuts, distortion, sand inclusions and other harmful defects. Any projections in internal surfaces or on external surfaces shall be ground and smoothened for fine surface finish.

11.3 Non-Destructive Tests

a. Components shall be subject to non-destructive tests as specified in the Data Sheets, and in accordance with API 610 and other relevant Standards. All NDT procedures shall be approved by NDT level III as per ISO 9712 [s26] or SNT-TC-1A [s27] before submission to IO's approval. All NDT personnel who perform non-destructive testing shall be qualified to Level II as per ISO 9712 or SNT-TC-1A at least.

b. For Main Pumps, minimum requirements on NDTs are given in Table 15 of API 610. Additional requirements are given in the following paragraphs. In case of conflicts, the most stringent requirement shall be applied.

11.3.1 Magnetic Test:

a. Magnetic castings shall be examined by magnetic particle inspection as specified in the Data Sheets. The basis for acceptance shall be in accordance with Data Sheets. The requirements of ASME Section-VIII Div. 1 mandatory appendices shall be the minimum requirements.

b. Ferromagnetic forgings shall be subject to magnetic particle testing at the areas of fillet and change of section. The testing is to be carried out after the rough machining operation (3.17 micro meters (125 micro inches)). The acceptance standard shall be as per ASME Boiler and pressure vessels code-Section VIII Div. 1 Appendix VI.

11.3.2 Radiography:

a. 100% radiography test shall be conducted on castings as specified in the Data Sheets. The limit of acceptability shall be defined in approved MIP.

b. Extent of radiography on forging shall be as specified in Datasheet.

c. The requirements of ASME Section-VIII Div.1 mandatory appendices shall be the minimum requirements.

d. Pressure boundary of the Main Pumps, including mechanical seal pressure retaining part and portions of flushing system contributing to containment function, shall be 100% tested.

e. Lifting lugs and structural welds of the skids shall be 100% tested.

11.3.3 Dye Penetrant test:

a. All non-magnetic castings shall be examined by dye penetration test as specified in the Data Sheets. The requirements of ASME Section-VIII Div. 1 mandatory appendices shall be the minimum requirements.

b. The entire surface of the casing and impeller castings (approachable area only) shall be subjected to dye penetrant test as per ASTM Specification E-165 [s37] and ASME VIII division 1. Non-machined surface shall be ground before dye penetrant test. For other castings only machined surfaces shall be tested by dye penetrant test.
c. Pressure Boundary shall be re-tested after successful hydrotesting.
d. All Welds, including structural welds shall be 100% tested.
e. Lifting lugs and structural shall be 100% tested.
f. For Pressure retaining welds, all the root passes and final passes of the weldments shall be examined by Dye Penetrant Test in accordance with ASTM Specification E-165 and ASME VIII division 1.
g. Surface of the shaft shall be examined by dye penetrant tested.
h. Dye Penetrant Test Shall be performed prior to painting application.

11.3.4 Ultrasonic Examination:

a. Ultrasonic examination shall be performed in accordance with ASME BPVC Sec V [s8] for forgings, shafts, plates, and tubular products as specified in Data Sheet. If during the examination, ultrasonic indications are not interpretable due to, for example, grain size, the material shall be radiographed using the procedure requirements.
b. Shafts of 50 mm dia. and above shall be ultrasonically tested.

11.3.5 Visual Inspection

a. Equipment shall be available to IO visual inspection before shipment. Equipment shall not be painted before inspection. Where applicable, equipment shall be assembled with their spares and shown to be interchangeable. After inspection, test certificates shall be furnished.
b. Visual inspection shall be done in accordance with ASME sec. V article 9.
c. Acceptance criteria for castings shall be as per ASTM A802 or MSS SP-55.

11.3.6 Repair of Defects

Any defect that will not machine out during the final machining, will be gouged out fully, inspected by radiography and dye penetrant and/or magnetic particle inspection to ensure that the defect is fully removed and repaired using an approved repair procedure.

11.4 Factory Acceptance Test:

11.4.1 General Requirements

a. Factory acceptance tests shall be witnessed by IO. Detailed scope of witnessing will be agreed in the approved MIP and shall be considered as included in this scope of work without any cost and schedule impact.
b. Test Procedures shall be submitted to IO for Approval at least 2 months before the scheduled inspection.
a. Water used for cleaning, hydrotesting and performance testing shall meet the requirements given in 9.6.4.
b. For additional testing requirement refer to Datasheet in *Appendix A – IBED PHTS Main Pump Datasheet.*
c. After successful completion of each of the test categories included in section 11.4, equipment shall be drained and dried and immediately preserved from corrosion. Any

water that appears to have pooled or collected in the IBED PHTS Main Pumps shall be clearly indicated on the test report and reported to IO.

d. Purchased spare parts shall be submitted at the same level of testing required on main supply.
e. The performance test, the mechanical running test and the complete unit test shall be performed with inlet and discharge piping spools to reproduce the geometry of the portion of plant layout significant for the Main Pump performances (refer to 9.3.1and 9.4.3).

11.4.2 Main Pump Casing Hydrostatic Tests

a. Hydrostatic test shall be conducted for pressure containing parts at 1.5 times the design pressure and the duration of the test shall not be less than 30 minutes. Time duration will be establishing considering the leakage rate limits to be verified (refer to 9.5.1).
b. If the part tested will operate at a temperature at which the strength of a material is below the strength of that material at the testing temperature, the hydrostatic test pressure shall be multiplied by a factor obtained by dividing the allowable working stress for the material at the testing temperature by that at the rated operating temperature.
c. Hydrostatic Test Pressure for pump pressure boundary shall cover all loading cases included in *Appendix C – Process Loading Conditions* and shall be at least equal to values given in U.T1 of the same appendix.
d. When required to verify the leakage rate given in 9.5.1 a Helium leakage test shall be performed.

11.4.3 Rotor Balancing

a. The Main Pump rotor assembly including impeller, shaft etc. shall be statically and dynamically balanced by the Contractor as per API 610 requirements (requirements for between bearing pumps, section 9.2.4.2 of API 610, apply).
b. The coupling (complete with spacer) and Main Motor Rotor shall be balanced at the same grade of Main Pump rotor. Deviation to this requirement shall be submitted to IO for approval.

11.4.4 Mechanical Run Test

a. All IBED PHTS Main Pumps shall be run at nominal operating point for 4 hours after oil temperature stabilization:
    i. Time required for oil temperature stabilization shall be recorded.
    ii. Delivered flow, delivered head, bearings temperature and vibrations shall be continuously monitored and recorded.
b. All Main Pumps shall be stripped off to check for wear. Parts having close clearances shall be checked for any abnormal rubbing and wear. Wearing clearances shall be measured. Strip test to be performed after mechanical run and before performance test.

11.4.5 Performance Test

a. Performance testing shall be conducted in line with API 610, ISO9906 [s17] and as per the additional requirement listed in this specification.
b. Hydraulic performance test shall be conducted at rated speed with water and job motor to ascertain head, power, and efficiency against capacity. Speed variation shall not exceed ±3% of rated speed given on the approved Datasheet and Performance curves. The Contractor shall take test data, including head, flowrate, power, bearing temperatures and vibration at a sufficient number of points, to characterize the performance curve. The list

of operating points given in section 8.3.3.4.1 of API 610 shall be followed. Performance curves at test speed shall be converted to those at rated speed.

c. When Vibration is measured on non-rotating parts, requirements of ISO 10816 [s18]: apply.
d. A variable speed test shall be performed to cover all operating points included in the datasheet.
e. Tested Variable Speed Performance curve shall be added to the test report.
f. After acceptance by IO of test reports, a new revision of as-built performance curves and pump datasheet shall be issued.
g. NPSH required test shall be performed on all Main Pumps. NPSH required shall be measured in all operating points as per item b of this paragraph, except at pump shutoff. The NPSH required by the pump as measured must be lower than the NPSH available (NPSHa) in the DS over the whole pump operating range.
h. Disassembly of multistage pumps for any head adjustment (including less than 5 % diameter change) after test shall be cause for retest, unless otherwise agreed by IO.

11.4.6 Complete Unit Test

a. All of the 8 IBED PHTS Main Pumps complete units composed by:
    i. Pump,
    ii. Job coupling,
    iii. Job Motor,
    iv. Job Baseplates,
    v. Job instrumentation,
    vi. Job Mechanical Seal and Flushing Systems,

    shall be continuously run at the rated point for 8 hours with continuous recording of measurement of all instrumentation that is part of the scope of supply. All measured parameters shall be within the specified limits. Sound level test will be made according to ISO 3746 [s42] and shall be performed during complete unit tests.
b. Job VFD, UCP, MCC, VCB shall be included in the Complete Unit Testing of at least one of the 8 IBED PHTS Main Pumps.
c. Functionality of all electrical and control equipment shall be verified. This includes but it is not limited to:
    i. Verification of the functionality of the motor LCP START/STOP pushbuttons, REMOTE/LOCAL selector switch, E-stops and indicating lights (STOPPED, RUNNING, LOCAL, REMOTE, TRIPPED).
    ii. Verification of the operation of all breakers (disconnect switches) and the associated auxiliary contacts to indicate OPEN, CLOSED or TRIPPED status.
    iii. Operation of the space heater circuit, including functionality of the LCP ENABLE/OFF selector switch and the status-indicating lights (STOPPED, RUNNING, TRIPPED). The energizing contact may be jumpered out for this test. Verification of the instrumentation signals at the instrumentation box terminals (temperature and vibration readings).
    iv. Functionality of the job UCP and verification of interface signals with plant control room.
    v. Functionality of LV MCC, when this is equipment is part of the scope.
d. Additional testing, as reference test, endurance tests or repeated start/stop cycle test and other as per agreed qualification plan, shall be included in the scope when required to demonstrate reliability of pumps to the aging due to operation as per agreed qualification plan.
e. Exceptions to this complete unit test configuration shall be submitted to IO for approval.

11.4.7 Testing of Auxiliaries

a. Auxiliaries shall be submitted to all testing required by applicable standards and by the IO applicable documentation. Full scope of testing will be agreed in the project MIP.
b. All Auxiliaries exposed to pressure shall be hydrotested as per applicable standards. For equipment submitted to PED directive, requirement of directive will apply as a minimum.
c. A leakage test of mechanical seals in static and dynamic conditions shall be performed to verify the guaranteed values. All additional testing required by MIP shall be applied.
d. When remotely installed support skids are provided, a functional test of the system shall be performed. This will include as minimum:
    i. 4 hours Run Test of the units,
    ii. Switchover test from main to auxiliary pump and from auxiliary to main pump to demonstrate that barrier fluid pressure stays above minimum allowable pressure during the pressure,
    iii. Testing of capability of pumps to run at relief valve opening pressure,
    iv. Circulation pumps and Refilling pumps (when supplied) shall be performance tested. Requirements of applicable standards,
    v. Duplex filters switchover test.
e. Motor Testing - Complete tests shall be performed on the motor. Tests shall be as listed on IEC 60034-2-1 and EDH Part-3: Codes & Standards. Motor Routine Test, Type Test, Insulation Test shall be applied as per applicable Standards. Complete tests shall include end play measurements and dynamic balance to verify that the motor will accelerate the load within the time specified at the minimum starting voltage.
f. Testing of VFD, VCB, MCC and control units shall be in line with requirements of Technical Specification [d2]

11.4.8 Final Scope of supply check before packing

a. A pre-alignment of IBED PHTS Main Pump assembly shall be performed to confirm that acceptance criteria established by Contractor are fulfilled.
b. The IBED PHTS Main Pumps shall be subject to a load test of the handling/lifting lugs.
c. A nozzle load test shall be performed at least on 1 complete skid.
d. Final visual inspection prior to issuance of Contractor Release Note shall be completed to ensure the conformity of the IBED PHTS Main Pumps to all specified requirements.
e. A visual and dimensional check of full scope of supply shall be witnessed by IO.
f. For complete set of requirements prior to shipping refer to section 13

11.5 Site Acceptance Tests

a. Site Acceptance Test will include a performance check after complete installation to inspect the performance of IBED PHTS Main Pumps including duty points, noise level and vibration. Contractor shall submit to IO for approval a procedure to be followed for site test. The procedure shall include all required acceptance criteria. This test will be performed by IO with the assistance of the Contractor.
b. The same Vibration Levels of Factory Acceptance Test should apply to the Site Acceptance Test. Request of deviations to this clause shall be submitted from Contractor to IO for approval.

11.6 Final Acceptance

After the successful completion of Site Acceptance Tests, the equipment will be handed over to IO along with a certificate of final acceptance. The certificate of final acceptance shall be

signed by both the IO and Contractor, after the definitive acceptance of each component and its related documentation. The final acceptance does not relieve the Contractor from the obligations stated in the contract.

12 Guarantee

12.1 Performance Guarantee

a. The equipment and accessories supplied shall be guaranteed to meet the performance requirement called for in this specification & datasheet and regulations.
b. Guaranteed Point is the Rated Point indicated in *Appendix A – IBED PHTS* Main Pump Datasheet.
c. Performance Test Tolerances shall be as per table 16 of API 610 with the following additional requirement:
    i. Tolerance on rated head shall be -0/+3% (no negative tolerance allowed).
d. Vibration and Temperature measured on pump bearings shall be within limits allowed by API 610 of agreed instrumentation alarm thresholds.
e. Sound Pressure level shall be limited to 85 dBA, including test tolerances, for all locations at 1 meter from Main Skid and all auxiliary skids. For Electric Motor, requirements of IEC 60034-9 apply.
f. Allowable pump bearing vibration values shall be in line with table 8 of API 610.
g. Allowable pump bearing temperature values shall are defined in clause 6.10.2.7 of API 610. They shall be confirmed by Contractor in the detailed engineering phase.
h. All Other measured values shall be in line with applicable standards and code as well as with agreed alarms thresholds.
i. Contractor shall demonstrate by testing that leakage rates required in section 9.5.1 are fulfilled.
j. Barrier fluid leakage rate of mechanical seal and barrier fluid refilling time shall be as per requirements of section 9.5.5 and 9.5.6.
k. If Test Results deviate from the guaranteed values, the Contractor shall try to correct the deficiencies and if he fails, the Contractor shall replace the equipment with new one that meets the guaranteed value at no extra cost to IO.
l. The Contractor shall guarantee for safe preservation and safe loading of equipment specified in this specification.
m. Contractor shall clearly indicate in the project documentation all installation features required to fulfil the guaranteed performance on site.

12.2 Warrantee Period

a. The Contractor shall provide warranty covering repair or replacement of equipment up to 3 (three) years from the final acceptance as defined in section 11.6. If the subject equipment or any part is found defective during the stipulated warranty period, the Contractor shall replace the same at no extra cost to the IO. Warranty period of replaced parts or items shall be further extended for two years from end of main warrantee period.
b. The Contractor shall obtain similar warranty from each one of his Sub-Contractor. However, the overall responsibility of the warrantee shall lie with the Contractor.

13 Labelling, Cleaning, Packing, Handling, Shipment and Storage

13.1 Scope of application

The following generic requirements apply for the shipment of equipment from the manufacture site to the ITER site.

13.2 Labelling and Traceability

a. To be compliant with the MQP-Level-2 procedure [d30], section 5.2 and 5.1.5, before the MRR at Contractor level starts, the materials/items has to be catalogued in Smartplant Materials following the WI [d31] and shall be propagated to the nominated Contractor/ Contractor.
b. Prior to MRR, the materials/items are to be catalogued in Smartplant Materials and shall be propagated to the Contractor. The Contractor has the obligation to put ITER Ident Codes onto the materials itself.
c. All components and the main sub-components shall be clearly marked in a permanent way and in a visible place with the IO official numbering system according to the document ITER numbering system for components and parts", see ref [d28]. IO PNI shall be applied on all concerned items.
d. The separate / individual components of equipment shall be marked with suitable reference numbers or symbols which shall also be indicated on the assembly drawings to aid in their identification and assembly at site.
e. Mating parts of coupling of both Main Pump and motor shall be match marked before dispatch of the equipment to site.
f. The assembly shall be shipped with identification tags as required in section 13.4.
g. Requirements on equipment nameplates are given in section 9.9.

13.3 Spare Parts packing and availability

a. The Contractor shall also indicate the service expectancy period for the spare parts under normal operating conditions before replacement will be necessary. All spare parts shall be despatched along with the main scope.

b. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site, e.g. small items shall be packed in sealed transparent plastic bags with desiccator packs as necessary.

c. Each spare shall be clearly marked or labelled on the outside of its packing with its description and purpose. When more than one spare part is packed in a single case, a general description of the contents shall be shown on the outside of such a case and the detailed list enclosed. All cases, containers and other packages shall be suitably marked and numbered for the purposes of identification. A spare parts list with identification tag nos. for each spare part shall be furnished by Contractor.

d. All cases, containers or other packages are liable to be opened for such examination as the IO may reasonably require.

e. Contractor shall recommend additional packing recommendations for spares purchased by IO. A pressurized Nitrogen Container shall be supplied for main capital parts wetted by process (e.g. Main Pump Rotor) that could be purchased.

f. The Contractor shall guarantee the IO that before going out of production of spare parts, he shall give at least 12 months advance notice to the IO, so that the latter may order his requirement of spares in one lot, if he desires.

13.4 Packing and Handling

a. The equipment shall be prepared for shipment so that handling and unloading may be facilitated. Equipment shall not be shipped in a disorderly arrangement or situation of disarray so as to promote damage or hamper inspection of the scope of supply when received on the job site.
b. The packaging shall meet the minimum requirements of ASME NQA-1, Level “B” [s14] for overseas shipping and the additional requirements stated herein.
c. The scope of supply shall be packaged or crated to prevent deterioration, contamination, or physical damage during transit or storage. Any articles or material that may be otherwise lost shall be boxed or wired in bundles and marked for identification. The packing shall be sufficient to withstand, without limitation, rough handling during transit to their destination, as indicated in the Contract and exposure to extreme temperatures, salt and precipitation etc., during transport and open storage.
d. The IBED PHTS Main Pumps s internals shall be preserved by means of dry nitrogen gas purge and pressurization in accordance with ASME NQA-1, Part II, Subpart 2.2, Section 304.2, Inert Gas Blankets. Proper instrumentation shall be provided for periodic checks of nitrogen conditions.
e. The Contractor shall design and supply appropriate packaging to prevent damage during shipping, lifting and handling operations. Shock absorbing material,adequate cushioning, blocking, bracing, skidding, hoisting and tie-down provisions shall be used. The Contractor shall include specific provisions in order to check, guarantee and provide evidence that scope of supply is not exposed to extreme accelerations which could lead to unforeseen impairment of functionality. These provisions may include accelerometers or recording devices and shall be agreed with IO prior to shipment.
f. A method of moisture control shall be provided for the interior of the shipping packages, using silica desiccant gel firmly attached to the inner surface of the cover. The desiccant shall be non-corrosive and shall not liquefy under saturated conditions.
g. All packages shall be clearly, legibly, and durably marked with uniform block letters (preferably with waterproof paint) on at least three sides with:
    i. Equipment name and tag number,
    ii. IO identification and destination address,
    iii. Purchase Order/Contract Number and Date,
    iv. Contractor’s/Contractor's or Sub-Contractor’s/Sub-Contractor's Name,
    v. Consignment Serial Number,
    vi. Overall Dimensions,
    vii. Net and gross weights,
    viii. Sign showing 'side up',
    ix. Sign showing 'fragile' marks in case of delicate equipment,
    x. Sign showing slinging and sling position,
    xi. Any handling and unpacking instructions, if considered necessary,
    xii. Identification markings relating to the appropriate shipping documents,
    xiii. In case of spare parts, each spare part shall be clearly marked and labelled on the outside of its packing with its description and catalogue/ part number and item number of main equipment to which it relates.
h. Packing Procedure shall be submitted to IO for approval.

i. Flanged nozzles shall be fitted with their counter-flange and gasket fully assembled for transportation. Main and auxiliary's flanges/counterflanges shall be always equipped with preservation caps/covers.
j. Packing case size and weights shall be take into consideration, wherever appropriate, the remoteness of the 'goods' final destination and absence of heavy mechanized handling facilities, at all points in transit.
k. Contractor to provide instruction for handling at site. If any assembly is required to perform at site, then method of assembly should be properly documented and accordingly all components shall be marked for identification. Guidelines for lifting and handling are provided in Procedure_CMA_Lifting Contract - Lifting and Handling, see reference [d33].
l. The IO may require inspecting and approving of the performed packing before the items are dispatched. However, the Contractor shall be entirely responsible for ensuring that the packing is suitable for the mode of shipment and such inspection will not exonerate the Contractor from any loss or damage due to faulty packing.

13.5 Shipment, Transportation and Delivery

a. The transport of the scope of supply shall be the responsibility of Contractor. The selection of the transport company shall be at the Contractor's discretion. No materials shall be dispatched without prior consent (acceptance certificate) of the IO. The scope of supply must be transported up to the place of installation or storage only by an experienced and qualified carrier.
b. In order to proceed with shipment, the Contractor shall present Contractor Release Note in accordance with "Requirements for Producing Contractor Release Note", see ref [d34]. The CRN represents a Hold Point.
c. Each shipment shall be accompanied by a Delivery Report (as per template [d36]) prepared by the Contractor, that shall be signed by a representative of the IO. The signature by the IO of the Delivery Report prior to shipment represents a Hold Point (HP).
d. A Package & Packing List Template, see ref [d35] and the equipment storage and preservation requirements form Template - Equipment Storage & Preservation Requirements Form (see ref [d37]) shall be submitted to IO Logistic team at least 15 working days prior to the planned shipment date.
e. For export, Regulation in force in the country of destination shall be applied, in particular with respect to the type of packaging authorized.
f. Upon receipt of the package, the IO shall open the package and make a visual inspection of its content.
g. In the case of anomalies, the IO will make any additional relevant remark on the inspection.
h. A final decision on acceptance of the delivery of the components will be made by the IO. If the components are in an acceptable condition, the IO will sign the Delivery Report. The signature of the Delivery Report is an IO Hold Point. The original of the Delivery Report shall be kept by the IO and a copy of it shall be kept by the Contractor.

13.6 Preservation after shipment

Contractor shall clearly indicate the activities that must be performed for preservation during the equipment storage (long and short term). The packing shall be designed to allow all required interventions without compromising the required storage time. The Contractor shall also indicate the required preservation activities after equipment installation in its final location in the plant.

14 Quality Assurance

The Quality class under this contract is QC-1. GM3S [d1] section 8 applies in line with the defined Quality Class.

a. Quality Requirements shall be in accordance with the "ITER Procurement Quality Requirements" [d42] and with Quality Classification Determination [d3]. The ITER Quality Assurance Program shall be applied to all the work under this Contract. The ITER QA Program is based on IAEA Safety Standard GS-R-2 and on conventional QA principles and integrates the requirements of the "INB Order dated 7 February 2012" [d46] on the quality of design, construction and operation in Basic Nuclear Installation. For this purpose, the Contractor and Sub-Contractors shall be in compliance with the requirements given by the relevant ITER QA classification and shall have an IO an ISO 9001 accredited quality system, in compliance with the above mentioned requirements.
b. All requirements of this Technical Specification and subsequent changes proposed by the Contractor during the course of execution of this Contract shall be in line with deviation request and non-conformity management procedures described in see ref [d47] and [d48].
c. Documentation developed as the result of this Contract shall be retained by the Contractor for a minimum of 5 years and then may be discarded with the approval of 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 Procedure,* see ref [d43].
d. Prior to commencement of any work under this contract, a "Quality Plan" (QP), describing how the ITER procurement quality requirements will be implemented (see ref [d44]), shall be produced by the Contractor, sub-Contractors and sub-Suppliers, The QP shall be submitted to the IO for approval,

14.1 Responsibilities

a. Sub-Contracting shall be managed in line with requirement of section 6.4 of [d1]. The Acceptance form required in 6.4.1 of [d1] can be replaced by the list of Sub-Contractors and Sub-Suppliers to be submitted to IO for approval.
b. The Contractor shall be fully responsible for quality with respect to all services, materials, manufacturing, testing, etc.
c. Contractor shall be responsible for imposing all contractual technical and quality requirements, as applicable, to all sub-Contractors and sub-Suppliers furnishing hardware or services.
d. QA and QC activities by IO shall not relieve the Contractor and their sub-Contractors from responsibility to perform all inspections and tests required by the contract and governing codes and standards.
e. The services required to Third Parties (Notified Body or Agreed Notified Body), as required by the applicable laws and standards shall be included in the scope of Contractor.
f. Any deviation to the specification requirements or IO applicable documents shall be submitted to the IO for review and acceptance, in writing, prior to proceeding.

14.2 Testing Equipment Calibration

a. All the instruments used for the specified shop tests shall be calibrated and calibration certificates shall be furnished from laboratories accredited for the applicable standards. The laboratory shall be certified in accordance with ISO 17025 [s43].The calibration shall have been carried out not more than six months prior to the testing date. Certificates of Calibration must be submitted to IO.
b. Pressures gauges shall be calibrated before and also after tests.

c. All measurements used in testing shall have an evaluation of the total measurement uncertainty following ASME PTC-19.1. An equivalent standard can be used subject to prior acceptance in writing by IO. The calculation of the measurement uncertainty shall be documented in a report and added to the final test report. Requirements on testing accuracy given by API 610 apply.

14.3 Manufacturing and Inspection Plan (MIP)

a. Prior to commencement of any manufacturing, a *Manufacturing and Inspection Plan* (MIP) shall be produced by the Contractor and Sub-Contractors and approved by the IO, who will mark up any intended intervention point. MIPs are used to monitor Quality Control and acceptance tests during the execution of the Contract. It shall meet the requirements of given in reference [d52]. It should be noted that interventions additional to those required in this Technical Specification may be included on the MIP by the IO. Control Points are defined in section 8.4 of [d1].
b. In case of witness point, Contractor shall notify IO at least 2 weeks to the selected test step.
c. The MIP shall explicitly identify PIAs. Contractor may refer to a non-exhaustive list of PIAs for the design, manufacture and transportation of the components as provided in reference [d53] and ITER-defined list of PIAs given in reference [d50].
d. The right of the IO listed above shall apply in relation to any sub-Contractor and in this case the IO will operate through the Contractor. The overseeing of the quality control operation by the IO shall not release the Contractor from his responsibility in meeting any aspect of this Technical Specification.
e. The IO approved MIP is a prerequisite to the Contractor proceeding with the work contained. It is permissible for the IO to indicate partial approval to authorize operations that would be constrained due to issues with subsequent operations.

15 Qualification requirements

a. The primary objective of qualification is to demonstrate with reasonable assurance that, the design of an equipment, for which a qualified life or condition has been established, will perform its function without experiencing failures before, during and after applicable events.
b. Equipment required to ensure primary fluid containment function shall demonstrate their capability to properly perform this function in all loading conditions defined in Appendix C – Process Loading Conditions.
c. The Guidelines given in reference *Collection of Input Data to support Qualification Plan in charge of TCWS electro-mechanical equipment Contractor* [d10] apply to the scope of this specification.
d. One of the qualification schemas for mechanical components from ASME QME-1 [s44] or RCC-M [s22] shall be applied (vol Q of RCC-M can be applied for active mechanical equipment).
e. Electrical and Instrumentation components, including the equipment listed in [d2], shall be qualified as per RCC-E K2 level [s21]. This is required to demonstrate the capability of the equipment to withstand the environmental condition (e.g. radiations and static magnetic field) required during category I and II conditions. Furthermore, instrumentation and electrical devices (if any) required to ensure primary fluid containment function shall demonstrate their capability to properly perform this function also in category III and IV events. For the safety classification applicable to Electrical and Control Cabinets, refer to [d2].

f. The scope of supply shall be qualified to the following main conditions:
   i. Seismic Loads,
   ii. Magnetic field,
   iii. Electromagnetic compatibility,
   iv. Equipment Aging,
   v. Irradiation
   vi. Fire.

g. Additional qualification activities, as required in [d10] shall be added in the qualification plan when required to demonstrate the ability of the pump unit to perform its safety functions.
h. Qualification requirements are further discussed in the below sections:
   The Contractor shall be compliant with the guidelines provided in Qualification guidelines, see ref [d54].

15.1 Qualification Strategy and Approach

a. Qualification method by analysis or by testing shall be selected by Contractor considering the required qualification parameters and the applicable standards and codes.
b. The Contractor shall select software tools qualified and approved by IO as indicated in reference document Software Qualification Policy, see ref [d55] for analytical qualification. Also, Contractor shall implement procedure for analysis and calculations in compliance with ITER reference document [d55].
c. The Contractor shall prepare and execute corresponding Qualification Strategy or Methodology to fulfil the qualification requirement of the supplied equipment.
d. For Seismic Qualification, when functionality is required also after the seismic or accidental condition, qualification should be through be both analytical evaluations and shake table test. Eventual request of exemption from shake table test shall be fully demonstrated by Contractor and approved by IO.

15.2 Qualification Plan

a. A Qualification Plan shall be submitted to the IO, for review and acceptance, before any qualification activity is undertaken.
b. The Qualification Plan shall follow guidelines given in reference [d54].
c. The qualification plan shall include provisions for test inspections at pre-determined points of the test sequence.
d. Any of the qualification reports prepared as part of this program shall be available for review by the IO and shall be included in the final report. The final report shall be prepared and submitted to the IO for review and acceptance.

15.2.1 Inspection Plan for Qualification Tests

a. The qualification testing Inspection Plan shall be provided by the Contractor and agreed with IO prior to the start of the qualification plan. The proposal shall include Hold Points and/ or witness points.
b. In case of witness point, Contractor shall notify IO at least 2 weeks to the selected test step.
c. These procedures, coupled with the qualification plan, shall form a complete picture of the program to be conducted and activities to be performed.

15.3 Seismic Qualification

a. The SL-1 earthquake is considered a category II event (refer to *Appendix C – Process Loading Conditions*). Contractor shall demonstrate that IBED PHTS Main Pumps are able to withstand this type of event with no impact on their structural integrity and functionality.
b. IBED PHTS Main Pumps are classified SC-1 (S). They shall be qualified to guarantee integrity and process fluid confinement during an SL-2 seismic event. Additional Requirements related to Electrical and Control cabinets are included in [d2].. The floor response spectra related to SL-2 are provided in *Appendix E – Seismic Loads*. The complete methodology of active component for seismic qualification can be obtained from ASME QME-1 non-Mandatory Appendix QR-A, and the requirements shall be as per "Equipment Qualification Program"[d56].
c. Contractor shall demonstrate that, after a SL-2 Earthquake, no rupture of piping, no collapse of structures or equipment, limited plastic strain, limited concrete cracking, structural support functions maintained, and process fluid leakages remain within the levels required in this specification. With these requirements, it is possible that a small level of deformation could occur. Additionally, it is required that IBED PHTS Main Pumps will not suffer any shaft seizure during and after the SL-2 event.
d. Components of the mechanical seal and of the flushing system that contribute to IBED PHTS Main Pump Containment function shall demonstrate their capability to fulfil their function in case of a SL-2 event.
e. When demonstration by analysis is selected, requirements given in [d70] and [d71] apply.
f. A typical test sequence is described below, to be applied when demonstration cannot be performed only by analysis. It is strongly recommended to record the below steps through photographs or video.
    i. Pre- Test: The test shall be performed to identify the following parameters:
        - Material and Assembly condition,
        - Operability Status (Verify the operability before testing, if required),
        - Leak tightness and Mounting,
        - Location, attachment, orientation and operability of seismic test instruments like accelerometers,
        - Verification of shake table input parameters and assure that instrumentation is properly calibrated.
    ii. Test: Shake table testing, with or without functionality checks during tests, as specified by Contractor in the test specification.
    iii. Post Test: Repeat the pre-test checks and confirm the operability as specified by designer in the test specification.
g. The qualification procedures shall be submitted to the IO, for review and acceptance, before any qualification activities is undertaken.
h. Acceptance Criteria shall be provided by Contractor and approved by IO.

15.4 Static Magnetic Field

a. Static Magnetic field to which components are exposed is included *in Appendix A – IBED PHTS Main Pump Datasheet* (refer to [d2] for values applicable to Electrical and Control Cabinets). The equipment qualification shall address the exposure of the equipment to this environmental condition.
b. For the qualification to static magnetic field, testing has to be performed with a field strength that is 1.4 times the current field values and as per the magnetic field

compatibility tests specified in “Test Method for ITER Equipment for Static (D.C) Magnetic Fields” Chapter 5 [d57].

15.5 Electro-Magnetic Compatibility

a. Qualification should ensure that the electromagnetic emissions from equipment stay within acceptable limits through the qualified life and during incidental or accidental events, otherwise they may affect the other equipment. This qualification ensures also the immunity of the supplied equipment to external electromagnetic fields that can present in the installation environment.
b. Electromagnetic compatibility shall follow the EMC 2014/30/EU and EDH Part 4 [d20]:
c. Electromagnetic Compatibility Testing shall be performed as required by applicable standards mentioned in [d20] and as per additional requirements of IEC 61000 - 2019.

15.6 Irradiation

a. In regard to this chapter, it should be noted that TCWS equipment is submitted to “irradiation” during “Normal Operating Condition” (Category I event).
b. Contractor shall demonstrate the compatibility of the supplied equipment to work when exposed to the expected radiation dose in the installation Area. For IBED PHTS Main Pump expected doses in the environment and in the process fluid are given in *Appendix A – IBED PHTS* Main Pump Datasheet. Radiation doses for Electrical and Control Cabinets are given in [d2].
c. For Electrical, Electro-mechanical and Electronic components, additional guidelines give in reference [d58] apply.
d. References for effects of irradiation by neutrons is given in [d10] as amended by [d68].
e. Process Piping is classified N2 as per ESPN codification (refer to [d12]). Supplier can submit a request of exclusion of pump pressure casing from PED directive and consequently from ESPN (refer to section 8). However, PED is applicable to auxiliaries. For auxiliary equipment connected to pump pressure casing, including seal flushing system, supplier shall refer to the French ESPN decree to determine its applicability and the related classification.

15.7 Aging

a. Effect of Aging during equipment life shall always be taken into account, considering that the equipment shall be capable to guarantee the required safety function during all its operating life. When qualification by analysis is proposed by Contractor, it shall be supported with experimental data available on similar equipment. Extrapolation of existing data shall be limited and shall be submitted to IO approval. When existing data cannot satisfy the qualification requirement, testing shall be performed.
b. Effects of vibrations and cycling have to be considered (refer to [d10]). Vibrations can affect the life of the equipment as well as their normal performances. Dedicate qualification activities shall be performed to consider both these conditions.
c. The Contractor shall integrate in his maintenance plan all preventive activity required for the replacement of wear parts and other equipment exposed to aging. An interval of 24 Months for preventive maintenance shall be considered.

15.8 Fire

a. Contractor shall demonstrate the capability of the equipment to guarantee the integrity and containment function during and after a fire event.

b. The applicable loading condition related to a fire event are included in section 9.6.7 and in *Appendix C – Process Loading Conditions*.

15.9 Electrical Conditions

Contractor shall demonstrate capability of supplied equipment to operate successfully under running conditions at rated load with the voltage variations and frequency variations required by section 9.3, in *EDH Part 3: Codes and Standards and EDH Guide A: Electrical Installations for SSEN Client Systems* [d51] and in reference [d10].

15.10 Qualification Reports

a. Qualification report shall be prepared by the Contractor. The report shall provide the level of information required in [d54] and [d72].
b. Any of the qualification reports prepared as part of this program shall be available for review by the IO and shall be included in the final test report. A final report shall be prepared and submitted to the IO, for review and acceptance that provides evidence of the qualification of the subject equipment and shall cite any precautions, restrictions, or limitations which must be accounted for by the IO in order to maintain the qualified status of the subject equipment (refer to 15.11).
c. When applicable, a separate complete report for shake table test shall be prepared after completion of the shake table test.

15.11 Preservation of Equipment Qualification

a. Qualification Preservation Sheet shall also be completed at the end of the qualification process to provide to the operator, as well as to the other Contractors and installers/assemblers, the requirements to ensure that the qualification is preserved over time during installation, assembly and operation phases.
b. Maintenance strategy shall be conceived in order to guarantee the preservation of the qualification.
c. Reference files as defined in RCC-E [s21] should be provided at the end of the qualification process. Alternative methods of identification and storage of technical and qualification features of the supplied equipment can be proposed by Contractor to IO for approval.

16 Safety requirements

a. Safety Classification of the equipment in this scope of supply is defined in section 8.
b. The IBED PHTS Main Pumps Units shall fulfil design requirement of SIC /PIC classified equipment, in line with the INB order [d46] considering that:
    i. The order 7th February 2012 applies to all the components important for the protection (PIC) and all the activities important for the protection (PIA),
    ii. The compliance with INB order must be demonstrated in the chain of external Contractors,
    iii. In application of article II 2.5.4 of the order 7th February 2012, contracted activities for supervision purposes are also subject to supervision done by the nuclear operator.
c. The scope under this contract covers for PIC and PIA. GM3S [d1] section 5.3 applies.

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16.1 Propagation of Safety Requirements

a. ITER is a nuclear facility (an “INB”, for Installation nucléaire de base, “Basic nuclear installation” in French regulation) identified in France by the number “INB no.174” [d46].
b. The Contractor must comply with all requirements expressed in see ref [d45]. For each requirement, the external intervener must explain in its quality system the dispositions taken to implement the requirements stipulated in[d45]..
c. Safety Important Class (SIC) describes a classification scheme for structures, systems and components (SSC) of ITER that perform a safety function and contribute towards meeting the General Safety Objectives at ITER during incident/accident situations. Components classified SIC are divided into:
    i. SIC-1 are those required to bring to and to maintain ITER in a safe state,
    ii. SIC-2 are those used to prevent, detect or mitigate incidents or accidents, but not SIC-1
d. PICs require control and guaranty, during the design, manufacturing and transportation phase, to ensure its safety functions can be maintained in all postulated situations. This is accomplished through the guidelines provided for in the Management of Propagation of Nuclear Safety Requirements in the Contractor Chain, see reference [d49].
e. In every contract involving PIA and PIC, it must be clearly stated that defined requirements on PIC and PIA have to be fulfilled. For PIC and their defined requirement, the procedure [d49] applies. For PIA and their defined requirement reference [d50] applies. The classification corresponding to the graduated approach of PIC is specified in document in see ref [d59].
f. In the contracts passed down to the sub-Contractors, in addition to technical requirements and defined requirements on PIC, IO shall ensure the surveillance of the Protection Important Activities (PIA). The Contractor shall ensure the technical control. The sub-Contractor must possess a quality system in agreement with the importance of the products being delivered and for the follow-up of the PIA corresponding to the PIC to be provided under the contract. The Contractor shall provide documented information on how to perform the technical control (each protection-important activity undergoes technical monitoring), to ensure that the activity is carried out in compliance with the requirements defined for the activity and, if necessary, for the protection-important components concerned and that the appropriate corrective and preventive actions have been defined and implemented. This system shall be included in the MIP or Quality Plan.

17 Specific General Management requirements

a. Requirement of GM3S [d1] section 6 applies completed/amended with the below specific requirements.
b. The Contractor shall designate a Project Manager, who will be responsible for the overall design, documentation, qualification, manufacturing, inspection, testing, packing, safe delivery to site, schedule, cost control and resolution of disputes and discrepancies. The Contractor shall also identify specific individuals responsible for each aspect of the Work.
c. The Contractor shall provide a schedule identifying the submittals to and approvals from IO of the Contractor's and Sub Contractors' specifications, drawings, analysis reports, procedures, and other types of documents as appropriate.
d. As a minimum the schedule shall include task descriptions with start and finish dates for each task. Separate detailed task breakdowns shall be provided for design,

documentation, procurement, manufacturing, testing phases and end with a Scheduled Site Delivery Date.

e. The schedule shall be in a Critical Path Method style with logic ties that identify each activity and is capable of tracking percentage complete for verification of progress. The schedule is subject to IO's approval.

f. The schedule shall include all work activities identified within the Specification. The schedule shall include milestones for design, documentation, manufacturing, inspection, shop testing and delivery to allow for IO to monitor the progress of the work and to schedule its interface activities with the Contractor. The schedule shall include all documents and deliverables listed in the Specification as minimum.

g. The Contractor shall participate in a Project Kick-off Meeting and subsequent status meetings as agreed and requested by IO.

17.1 Responsibilities

The responsibilities between the IO and Contractor are defined in the below Table 13and is further detailed in the following sections.

Table 13 - Summary of Responsibilities between the IO and the Contractor

Activity	IO	Contractor
Phase 1 Design & Documents	A	R
Phase 2 Qualification		
Qualification Plan	A	R
Qualification Tests	A	R
Phase 3 Manufacture, Assembly, FAT and Delivery		
Manufacturing Readiness Review	A	R
Manufacturing	A	R
Inspection	A	R
Factory acceptance Testing	A	R
Delivery Readiness Review Packing, Shipping and Safe Delivery to the ITER site	A	R
Phase 4 Site Acceptance Test (SAT)	R	A

R = Responsible for organizing, performing and for the content

A = Review/Comment/Accept

17.2 Contract Gates

a. Main Contract Gates are (refer to [d1]):
   - T0: Contract Signature,
   - T1 : Kick-off Meeting,
   - T2 : IO approval Of the Delivery Schedule, Quality Plan And Procurement Strategy,
   - T3: Manufacturing Readiness Review /Start of manufacturing,
   - T4: FAT Readiness Review/Start of Testing,
   - T5: Delivery Readiness Review,
   - T6: Delivery to ITER Site,
   - T7: Final acceptance after SAT and contract Close-Out.

   The Gates shall be represented in the contract schedule submitted by Contractor.

b. Forecasted Schedule of Contract Gates together with the List of Deliverable associated to each gate are included in section 18.

17.3 Data Management

a. The data generated during the execution of the contract shall be handled electronically and entered into the ITER database (refer to section 6.2 of [d1]). Contractor shall use this database to store information related to the contract. All data entered in the database will be kept strictly confidential by the IO and, under no circumstances, will be communicated or made accessible to other Contractors or the DAs (Domestic Agency).
b. Data consistency checks shall be implemented to facilitate IO oversight. Relevant data shall be made available by the Contractor to the IO through ITER database each time a control point is requested, or a deviation request, a non-conformance report or any other document which is part of the contract deliverables is issued by the Contractor, in accordance with the document “Procedure on procurement documentation Exchange between IO, DA and Contractors”, see ref. [d59]. The requirement does not apply for other documents through specialised CAD software (e.g. CATIA, see System design and others) and so undergo other requirements in separate documents.

17.4 Reviews

a. The Contractor shall organise Design review, Status reviews, Quality control reviews and Manufacturing Readiness Reviews. These may be focussed on particular areas of production. The IO may also decide to organise reviews, in which case the IO will appoint the review group and define its terms of reference.
b. Contractor shall submit at least the below list of approved documents for Manufacturing Readiness review (other document can be required as per section 18). MRR shall be conducted as per [d61]:
   i. General Arrangement of the Supplied Equipment and Auxiliaries,
   ii. Performance curve and Datasheet,
   iii. P&ID of the Scope of Supply,
   iv. Mechanical design calculation,
   v. Qualification plan,
   vi. Quality plan,
   vii. Manufacturing and Inspection Plans,
   viii. All test procedures,
   ix. Procedure for Surface preparation and painting,
   x. Packing and Shipping procedure and details.

The IO may decide to put a hold point on them.

c. Safety Reviews will be organised at each stage of production, as required by the IO.

17.5 Monitoring and Access Rights

a. Refer to section 6.1 of [d1] for required contract monitoring.

b. IO reserves the right to perform unscheduled inspection in accordance with para 3.10 of the “ITER procurement Quality requirements”, see ref [d42]. Planned and documented audits will be performed by the IO, and regulators body representatives in France, to verify compliance with the technical and quality requirements of the contract. Moreover, the IO reserves the right to take photographs of the ITER equipment during the contract life.

18 Project and Deliverables Schedule

a. The Contractor shall provide IO with the documents and data required in the application of this technical specification, the GM3S Ref [d1] and any other requirement derived from the application of the contract.

b. Documentation is intended to be individual for each IBED PHTS Main Pump. When information is identical, documentation can be common for all IBED PHTS Main Pumps. IO reserve the right to ask for dedicated documentation for each train when required for project needs.

c. Test Certificates, End of Manufacturing Report, as built drawings shall be individually submitted for each IBED PHTS Main Pump with no exception.

d. Contractor shall prepare a document schedule based on the above and using the template available in the GM3S Ref [d1] appendix II.

e. Contractor shall include IO document code, when available, in all submitted documents and shall mention the relative IO code when a project deliverable is referenced in any other document.

f. Any additional document required by the scope of work defined in this specification and in [d2] shall be considered as part of the contract and shall be provided by Contractor.

g. When requested by IO, Native format of documents listed in Table 14 shall be supplied by Contractor.

h. Forecasted dates of Project Gates are presented in Table 14 together with a minimum list of documents, required within the expected timing.

i. This document list included in this section covers also the Electrical and Control Cabinets defined in [d2].

Table 14 - List of Deliverables with Contract Gates

D#	Deliverable Details	Type and Quantity	Due Date	A	B	C	D	E
Documentation Required during the Bid Stage								
a.	Project Schedule	1E	with the Bid					
b.	Datasheets of Main Equipment	1E	with the Bid					
c.	Datasheet or selection sheet of auxiliaries (mechanical seals, flushing systems, Electric Motors, VFD, UCP, VBC, MCC, etc.)	1E	with the Bid					
d.	Performance Curves (pump head at min/rated/max impeller diameter, efficiency, power consumption, NPSH, variable speed curves, combined curve for parallel operation)	1E	with the Bid					
e.	General Arrangement drawing of main skid, Auxiliaries skids (if any) and Electrical and Control Cabinet, including foundation details and stating and dynamic weights (Preliminary)	1E	with the Bid					

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D#	Deliverable Details	Type and Quantity	Due Date	A	B	C	D	E
f.	Pump Cross Sectional Drawing (Typical)	1E	with the Bid					
g.	P&ID of the scope of supply (Preliminary)	1E	with the Bid					
h.	Sub-Contractor List	1E	with the Bid					
i.	Instrument List and Datasheets (Preliminary)	1E	with the Bid					
j.	Electrical and Instrumentation wiring Diagram (Preliminary)	1E	with the Bid					
k.	List of deviation from applicable Specifications, if any	1E	with the Bid					
l.	Quality Plan	1E	with the Bid					
m.	Qualification plan including seismic analysis (Preliminary)	1E	with the Bid					
n.	Manufacturing and Inspection Plan (Preliminary)	1E	with the Bid					
o.	List of References	1E	with the Bid					
p.	List of Deviations (if any)	1E	with the Bid					
T0 – Contract signature								
T1 – KoM			**Within 2 weeks from T0**					
1.	MoM of the Kick-off meeting	1E	T1		X			
2.	MOM of Technical Clarification meetings (if applicable)	1E	Weekly during 2 weeks from T1		X			
3.	Final version of delivery schedule	1E	T1 + 2 weeks		X			
4.	Quality Plan (Final)	1E	T1 + 2 weeks		X			
5.	Contractor Catalogues (if applicable)	1E	T1					
6.	Sub-Contractor and sub-supplier List, Sub-contractor acceptance forms and Procurement Strategy	1E	T1 + 2 weeks		X			
T2 – IO approval of the Delivery Schedule, Quality Plan and Procurement Strategy			**T1 + 6 weeks**					
7.	Complete P&ID for Pump Unit	1E	T2+2 weeks	X				
8.	Control Logic of Pump Unit	1E	4 weeks prior to manufacturing	X				
9.	Bills of Material for all material included in the scope of supply: Main Skid, Electrical and Control Cabinets, Auxiliary equipment	1E	4 weeks prior to manufacturing		X			
10.	Final Datasheets of Supplied Equipment: Main pumps, Motor, Mechanical Seal and Flushing Systems, VFD, MCC, UCP, VCB, etc (ITER Format, when available, or format given by applicable standards)	1E	T2+2 weeks	X				
11.	Final Pump Performance Curve (pump head at min/rated/max impeller diameter, efficiency, power consumption, NPSH, variable speed curves if applicable, combined curve if parallel operation is required)	1E	T2+2 weeks	X				
12.	Interface Document including electrical loads list and utilities list	1E	T2+6 weeks	X				
13.	General Arrangement Drawing of IBED PHTS Main Skids and auxiliary skids, including foundation details, anchor bolts details, stating and dynamic weights and allowable flange loads (Final)	1E	T2+4 weeks	X				
14.	Control and Instrumentation Cabinets General Arrangements including grounding locations, mounting method and accessory's location, etc.	1E	T2+4 weeks	X				
15.	3D models of the whole scope of supply	1E	4 weeks prior to manufacturing	X				
16.	Cross Sectional Drawing of Pump, Motor and auxiliaries	1E	4 weeks prior to manufacturing	X				
17.	Base Frame Drawing	1E	T2+4 weeks	X				
18.	Mechanical Seal and Flush Plan Drawing with part list	1E	4 weeks prior to manufacturing	X				
19.	Coupling Drawing	1E	4 weeks prior to manufacturing	X				
20.	Motor Datasheet and GA Drawing (including terminal boxes details)	1E	T2+8 weeks	X				
21.	Motor Characteristic Curve i. Speed -Torque curve at rated & minimum starting voltage. ii. Current Vs Speed Curve. iii. Current Vs Time Curve iv. Thermal withstand characteristic for Motors - Hot and Cold.	1E	T2+8 weeks	X				
22.	All other Electric Motor Drawing	IE	T2+8 weeks	X				
23.	Cable diagrams for instruments, electrical components of Pump Unit, Control Unit, Local Control Station, VFD, VCB, MCC	1E	T2+8 weeks	X				
24.	Electrical Block Diagrams	1E	T2+8 weeks	X				

SUPPLY

D#	Deliverable Details	Type and Quantity	Due Date	A	B	C	D	E
25.	Instrumentation Hook-up drawings	1E	T2+8 weeks		X			
26.	Internal and Interconnecting Wiring Diagram for Instrumentation, and Power Junction Box, Electrical Cabinets, Control Cabinets in SEE Electrical Expert Software	1E	4 weeks prior to manufacturing	X				
27.	Instruments Datasheet and Documents	1E	4 weeks prior to manufacturing	X				
28.	Instrumentation input/output list including alarm and trip list	1E	4 weeks prior to manufacturing	X				
29.	Valves, Instrumentation Manifolds and other accessories Datasheet	1E	T2+8 weeks	X				
30.	Lateral and Torsional analysis	1E	4 weeks prior to manufacturing	X				
31.	Skid Modal Analysis with evaluation of interaction with installation structure	1E	4 weeks prior to manufacturing	X				
32.	Static and Dynamic Foundation load calculation note with verification of selected anchoring system (applicable for all equipment and including Electrical and Control Cabinets)	1E	T2+12 weeks					
33.	CFD study for impact of suction and discharge piping layout to pump performances	1E	4 weeks prior to manufacturing	X				
34.	Bearing Life Calculation Report	1E	4 weeks prior to manufacturing	X				
35.	Mechanical Seal Leakages analysis (normal operation and degraded conditions)	1E	T2+8 weeks	X				
36.	Electrical calculation notes for selection of cable earthing and protective devices	1E	4 weeks prior to manufacturing	X				
37.	Seismic Analytical Analysis Report	1E	T2+8 weeks	X				
38.	Qualification plan including seismic analysis and other qualification Required for the complete scope of supply.	1E	T2+4 weeks	X				
39.	Hazard and Risk Assessment Report	1E	T2+8 weeks		X			
40.	Design calculation for insulation and heat tracing	1E	T2+12 weeks		X			
41.	Manufacturing Inspection Plan	1E	T2+4 weeks		X			X
42.	Welding book, WPS, PQR including weld repair procedures (if required)	1E	T2+8 weeks		X			
43.	Piping Classes (if different piping classes is applied respect to IO applicable piping classes)	1E	T2+8 weeks	X				
44.	Shake Table Test Procedure (if applicable)	1E	T2+8 weeks		X			
45.	NDE Procedures	1E	T2+8 weeks	X				
46.	Hydrostatic test procedures	1E	T2+8 weeks		X			
47.	Procedure for Performance Tests	1E	T2+8 weeks		X			
48.	Procedure for surface preparation and painting	1E	T2+8 weeks		X			
49.	Mechanical Seal and Flushing Systems Test Procedures	1E	T2+8 weeks		X			
50.	Installation Procedure	1E	T2+16 weeks		X			
51.	Any document/drawing/procedure that needs prior approval by the IO as mentioned elsewhere in this specification.	1E	T2+8 weeks		X			
52.	Any additional Calculation and Analysis report as required by this specification and by applicable documents, standards and codes	1E	T2+8 weeks	X				
53.	Reliability, Maintainability, Availability Analysis	1E	T2+8 weeks	X				
54.	Calculation Software Model	1E	T2+8 weeks		X			
55.	Calculation software verification note	1E	T2+4 weeks		X			
56.	Request of exclusion from PED of pump pressure casing	1E	T2 + 4 weeks	X				
57.	Design Reviews Reports	1E	Schedule to be agreed		X			
58.	Manufacturing Readiness Review Report	1E	T2 + 20 weeks	X				
T3 – Start of Manufacturing			**Date to be agreed**					
59.	Certified Material Test Reports	1E	4 weeks prior to manufacturing		X			X
60.	Welder's Qualification certificates/reports (if required)	1E	4 weeks prior to manufacturing		X			
61.	FAT Readiness Review Report	1E	T1 + 38 weeks		X			
T4 – Start of Testing			**Date to be agreed**					
62.	Shake Table Test Report (if applicable)	1E	4 weeks prior to shipment			X		X
63.	Qualification Test Reports, Qualification Summary Report, Qualification Preservation Sheets, Reference Files for entire skid and installed components	1E	4 weeks prior to shipment			X		X
64.	NDE Reports	1E	4 weeks prior to shipment			X		X

SUPPLY

D#	Deliverable Details	Type and Quantity	Due Date	A	B	C	D	E
65.	Hydrostatic test reports	1E	4 weeks prior to shipment			X		X
66.	Dimensional reports	1E	4 weeks prior to shipment			X		X
67.	Performance Test Reports	1E	4 weeks prior to shipment			X		X
68.	Quality Assurance Data Package (QADP) (Manufacturing Dossier)	2H+1E	4 weeks prior to shipment			X		
69.	Preservation, Storage and Handling Procedures	1E	4 weeks prior to shipment			X		
70.	Spare Parts List (Commissioning and Startup, 2 Years, Capital) for the complete scope of supply including Electrical and Control Cabinets	1E	4 weeks prior to shipment			X		
71.	Special Tools List	1E	4 weeks prior to shipment			X		
72.	Limits and Precautions	1E	4 weeks prior to shipment			X		
73.	Packaging and Shipping Details	1E	4 weeks prior to shipment		X			X
74.	Customized Start-up Procedure for IBED loop	1E	4 weeks prior to shipment		X			
75.	Operation and Maintenance Manual	2H+1E	4 weeks prior to shipment			X		
76.	Complete software documentation linked to UCP Control system, VFD parametrization, VCB protections parameters (including native codes)	1E	4 weeks prior to shipment			X		
77.	All other Certified Test Report(s) as per agreed MIP	1E	4 weeks prior to shipment			X		X
78.	Certificate of Cleanliness	1E	2 weeks prior to shipment			X		X
79.	CE -Declaration of Conformity	1E	4 weeks prior to shipment			X		X
80.	Certificate of Conformance to Purchase Order Requirements	1E	2 weeks prior to shipment			X		X
81.	Engineering Dossier with all approved and As-Built Drawings	1E	2 weeks prior to shipment			X		X
82.	Approved MIP's (signed and completed)	1E	2 weeks prior to shipment			X		X
83.	Approved Test Procedures	1E	2 weeks prior to shipment			X		X
84.	All design concession reports if any	1E	1 weeks prior to shipment			X		X
85.	Guarantee and compliance certificates	1E	1 weeks prior to shipment			X		X
86.	Packing inspection reports along with photographs before and after packing for identification	1E	1 weeks prior to shipment			X		
T5 - Delivery Readiness Review			**Agreed Delivery Date – 1 week**					
87.	Delivery Readiness Review Minute of Meeting	1E	1 weeks prior to shipment			X		
88.	Contractor Shipping Release Note and Delivery report	1E	1 weeks prior to shipment			X		
T6- Delivery DAP Cadarache			**Agreed Delivery Date**					
89.	Report on Commissioning Activities Performed by Contractor	1E	prior to Equipment Acceptance		X			
90.	Report on Electrical and Control Cabinets Parameter Configuration	1E	prior to Equipment Acceptance		X			
T7- Equipment Acceptance after SAT and contract Close-Out			**Date to be agreed**					

Note:

- Column A – IO acceptance required prior to manufacturing.
- Column B – IO acceptance required prior to use.
- Column C – IO acceptance required prior to shipment.
- Column D – Retained in Contractor's shop and available for IO review.
- Column E – Document included in QA Data Package (QADP), QADP approval prior to shipment.

E – Electronic File (PDF or other accepted format and native file format, for drawings. CD for instruction materials).

H – Hard Copy

SUPPLY

Appendix A – IBED PHTS Main Pump Datasheet

IBED PHTS MAIN PUMP DATA SHEET
PROCESS AND PERFORMANCE DATA

APPLICABLE TO: **PROPOSAL** | APPLICABLE NTL/INTNTL STANDARD: **API-610 XII Edition** | Rev

PBS **26** | SYSTEM **IBED PHTS** | NO. REQ **8**

TAG **26PHBDPL-1910 to 1980** | FUNCTION **Main Pumps**

Information provided by

△ I/O | ☐ Vendor | ⧋ I/O and Vendor

LOCATION: Building **11** | Level **L3 Mezzanine** | Room **05 for Motors / 03E for Pumps**

Installation ● **Indoor** ○ **Outdoor**

☐ **PUMP IDENTIFICATION** | PUMP SIZE | TYPE | No. STAGES

MANUFACTURER | MODEL | SERIAL NO.

△ LIQUID CHARACTERISTICS

	Units	Maximum	Minimum	Note
LIQUID TYPE OR NAME :	Demineralized Water with Hydrazine			Max & min values refer
VAPOR PRESSURE :	bar a	0.250	0.386	only to the property
RELATIVE DENSITY :		0.981	0.975	listed
SPECIFIC HEAT :	kJ/(kg-K)	4.19	4.19	
VISCOSITY :	cP	0.433	0.377	

△ LIQUID PARAMETERS (2823A2)

Conductivity @ 25 °C (µS/cm)	≤0.2
pH :	7.0-9.0
Sodium (ppb)	≤5
Chlorides (ppb)	≤5
Hydrogen (ppb)	≤350
Catalyzed Hydrazine (ppb)	≤30
Ammonia (ppb)	≤1000
Oxygen (ppb)	≤10
ORP@25 °C	(-400) - (-100)
Iron (ppb)	≤10
Copper (ppb)	≤10
PARTICULATE SIZE (µm)	200
PARTICULATE CONCENTRATION (ppb)	TBD

△ OPERATING CONDITIONS

	Units	Maximum	Rated	Normal	Minimum
NPSHa Datum:			C.L. Impeller		
PUMPING TEMPERATURE (2) :	°C	75	70		65
FLOW :	m³/h		2311		505.3
DISCHARGE PRESSURE :	bar a		50.9		
SUCTION PRESSURE :	bar a	19.0	14.6		13.7
DIFFERENTIAL PRESSURE :	bar		36.3		
DIFFERENTIAL HEAD :	m	380	377		
$NPSH_A$:	m		154		
HYDRAULIC POWER :	kW		2330.26		

△ RADIOACTIVITY IN PUMPED FLUID (UXKBZL) (1)

Source	GBq/m3
Total Tritium (T)	1800
14C	1.00E+00
Activated Corrosion Products	7.80E+00
17N	1.03E+02
16N	9.74E+05

△ SERVICE

TYPE OF SERVICE : **CONTINUOUS**

• IF INTERMITTENT NO. OF STARTS :

PUMPS OPERATE IN: **PARALLEL**

☐ PERFORMANCE

PROPOSAL CURVE NO.		RPM	
As Tested Curve No.			
IMPELLER DIA.: RATED	MAX.	MIN.	mm
RATED POWER	kW	EFFICIENCY >75	(%)
RATED CURVE BEP FLOW (at rated impeller dia)			m³/h
MIN FLOW : THERMAL	m³/h	STABLE	m³/h
PREFERRED OPERATING REGION		to	m³/h
ALLOWABLE OPERATING REGION		to	m³/h
MAX HEAD @ RATED IMPELLER			m
MAX POWER @ RATED IMPELLER			kW
NPSH3 AT RATED FLOW :			m
CL PUMP TO U/S BASEPLATE			m
NPSH MARGIN AT RATED FLOW :			m
SPECIFIC SPEED		m3/h, rpm, m	
SUCTION SPECIFIC SPEED LIMIT			
SUCTION SPECIFIC SPEED		m3/h, rpm, m	
MAX. ALLOW. SOUND PRESS. LEVEL REQD			(dBA)
EST MAX SOUND PRESS. LEVEL			(dBA)
MAX. SOUND POWER LEVEL REQ'D			
EST MAX SOUND POWER LEVEL			

⧋ DRIVER

Driver Type	**MOTOR**
GEAR	**NO**
VARIABLE SPEED REQUIRED	**YES**
SOURCE OF VARIABLE SPEED	**Motor**
OTHER	
MANUFACTURER	
NAMEPLATE POWER	kW
Nominal RPM	
RATED LOAD RPM	
FRAME OR MODEL	
ORIENTATION	
LUBE	
BEARING TYPE:	
RADIAL	/
THRUST	/
STARTING METHOD	**Open Valve (Fully-Loaded)**
MINIMUM EFFICIENCY AT RATED FLOW	**95%**

REMARKS

(1) Detailed Sources of Radiation have been given to the scope of wetted material qualification. Radiation doses given in page 6 include irradia process fluid.

(2) These temperature are related to category I and II Operation. Temperature up to 150 °C can be required in category III events.

Refer to Annex C of Technical Specification.

DATA SHEET No. | Rev: | SHEET 1 of 10

SUPPLY

IBED PHTS MAIN PUMP DATA SHEET
CONSTRUCTION DATA

CONSTRUCTION

API PUMP TYPE: BB2
PUMP DESIGN LIFE: 25 years

NOZZLE CONNECTIONS:

	Size	Facing	Rating	Position
SUCTION	400	RF	900	TOP
DISCHARGE	350	RF	600	TOP

PRESSURE CASING AUX. CONNECTIONS:

	No.	Size	Type	Facing	Rating	Posn.
BALANCE/LEAK OFF			Refer to Technical Specification ITER_D_9396JP. Detailed list of connections to be added in the General Arrangment Drawing			
DRAIN						
VENT						
PRESSURE GAGE						
TEMP GAGE						
WARM-UP LINE						

Required Finishing level of internals: 12.5 µm
Drain Valve Supplied By: PURCHASER
DRAINS MANIFOLDED: YES
VENT Valve Supplied By:
VENTS MANIFOLDED: YES
THREADED CONS FOR PIPELINE SERVICE & < 50°C:
SPECIAL FITTINGS FOR TRANSITIONING:
CYLINDRICAL THREADS REQUIRED: TAPERED
GUSSET SUPPORT REQUIRED:
MACHINED AND STUDDED CONNECTIONS:
DRAIN TO SKID EDGE: YES

MATERIAL

APPENDIX H CLASS: A-7 or A-8
MIN DESIGN METAL TEMP: °C
REDUCED-HARDNESS MATERIALS REQ'D:
Applicable Hardness Standard:
BARREL :
CASE : Austenitic SS or superior
DIFFUSERS: Austenitic SS or superior
IMPELLER : Austenitic SS or superior
IMPELLER WEAR RING : Hardfaced Aust SS or sup.
CASE WEAR RING : Hardfaced Aust SS or sup.
SHAFT: Austenitic SS or superior
Bowl (if VS-type)
Inspection Class: Level 3

BEARINGS AND LUBRICATION

BEARING (TYPE / NUMBER):
RADIAL /
THRUST /
REVIEW AND APPROVE THRUST BEARING SIZE :

LUBRICATION : OIL MIST
PRESSURE LUBE SYSTEM TO ISO 10438-
ISO 10438 DATA SHEETS ATTACHED
Pressurized Lube Oil System mtd on pump baseplate
Location of Pressurized Lube Oil System mounted on baseplate :

INTERCONNECTING PIPING PROVIDED BY:
OIL VISC. ISO GRADE: VG
CONSTANT LEVEL OILER : REQUIRED

CASING MOUNTING: CENTERLINE
CASING TYPE:
OH3 BACKPULLOUT LIFTING DEVICE REQD.

CASE PRESSURE RATING: '(1)
MAWP : 6.80 bar g @ 150 °C
HYDROTEST : bar g @ °C

HYDROTEST OH PUMP AS ASSEMBLY
SUCT'N PRESS. REGIONS DESIGNED FOR MAWP: YES
ROTATION: (VIEWED FROM COUPLING END)
- IMPELLERS INDIVIDUALLY SECURED : YES
- BOLT OH 3/4/5 PUMP TO PAD / FOUNDATION :
- PROVIDE SOLEPLATE FOR OH 3/4/5 PUMPS

ROTOR:
SHAFT FLEXIBILITY INDEX (SFI)
First Critical Speed Dry: >20%of max working speed
COMPONENT BALANCE TO ISO 1940 G1.0: NO
SHRINK FIT -LIMITED MOVEMENT IMPELLERS: YES

COUPLING:
MANUFACTURER
MODEL: API 671
RATING (POWER/100 RPM)
SPACER LENGTH mm
SERVICE FACTOR
RIGID: NO
COUPLING WITH HYDRAULIC FIT
COUPLING BALANCED TO ISO 1940-1 G 2.5: YES
COUPLING WITH PROPRIETARY CLAMPING DEVICE
COUPLING IN COMPLIANCE WITH: API 671
COUPLING GUARD STANDARD PER
Window on Coupling Guard

BASEPLATE

API BASEPLATE NUMBER :
BASEPLATE CONSTRUCTION: FULL TOP DECKING
BASEPLATE DRAINAGE: Entire Baseplate Drain Rim
MOUNTING : BOLTED ON STEEL WORK
NON-GROUT CONSTRUCTION : REQUIRED
VERTICAL LEVELING SCREWS : REQUIRED
LONGITUDINAL DRIVER POSITIONING SCREWS : REQUIRED
SUPPLIED WITH : ● GROUT AND VENT HOLES
● DRAIN CONNECTION: YES
MOUNTING PADS SIZED FOR BASEPLATE LEVELING: YES
MOUNTING PADS TO BE MACHINED: YES
PROVIDE SPACER PLATE UNDER ALL EQUIPMENT FEET: YES
OTHER
Required baseplates configuration is described in Technical Specificatior
Mounting is performed on Embedded Steel Plates on Concrete foundatio
Supplier and IO shall agree in detailed design phase the baseplates anchoring configuration

REMARKS

(1) Design conditions for process piping. Minimum values to be fulfilled.
Fire Exposure : Pumps and mechanical seals shall be able to statically withstand fire condition

DATA SHEET No. Rev: SHEET 2 of 10

SUPPLY

IBED PHTS MAIN PUMP DATA SHEET
AUXILIARY EQUIPEMENT

Note	INSTRUMENTATION	
	SEE ATTACHED API-670 DATA SHEET	
	ACCELEROMETER	
	Number of Accelerometers	
	Mounting Location of Accelerometers	
	PROVISION FOR MTG ONLY	
	Number of Accelerometers	
	Mounting Location of Accelerometers	
	FLAT SURFACE REQUIRED	
	Number of Accelerometers	
	Mounting Location of Accelerometers	
	VIBRATION PROBES	
	VIBRATION PROBES REQUIRED	YES
	NUMBER PER RADIAL BEARING	2
	NUMBER PER AXIAL BEARING	2
	MONITORS AND CABLES SUPPLIED BY	VENDOR
	TEMPERATURE	
	PROVISIONS FOR TEMP PROBES	
	RADIAL BEARING TEMP.	YES
	NUMBER PER RADIAL BEARING	2
	THRUST BEARING TEMP.	YES
	NUMBER PER THRUST BEARING ACTIVE SIDE	1
	NUMBER PER THRUST BEARING INACTIVE SIDE	1
	TEMP. GAUGES (WITH THERMOWELLS)	
	PRESSURE GAUGE TYPE	
	OTHER INSTRUMENTATION	
	Two speed sensor for closed loop control with VFD	
	3x2 Winding RTDs (2xphase)	
	Oil Level Switches on Bearing Housing	
	4 Skin Temperature sensors	
	Provision for addition 4 speed sensors	
	All Instrumentation required for Seal Flushing	
	All additional instrumentation requried by technical	
	specification ITER_D_9396JP	
	LOCAL CONTROL STATION REQUIRED (Removable)	YES
	INSTRUMENTATION CABLES	YES
	JUNCTION BOXES	YES

REMARKS

Scope of required Electrical and Control Cabinets is defined in Techical Specification ITER_D_ALWTJX

MECHANICAL SEAL AND SEAL SUPPORTING SYSTEMS	
SEE ATTACHED ISO 21049/API 682 DATA SHEET	
CARTRIDGE TYPE REQUIRED	YES
SEAL CONFIGURATION	Dual Pressurized
SEAL FLUSHING PLAN	plan 53B/C preferred
HEATING JACKET REQ'D.	NO
INTERCONNECTING PIPING	Supplier
INTERCONNECTING PIPING TYPE	PIPE
SEAL SYSTEM MOUNTED ON PUMP SKID	YES
MATERIALS:	
Mechanical Seal Sleeve/Gland	SS
Mechanical Seal Faces	TBD
Flushing Systems	SS

HEATING AND COOLING	
COOLING REQ'D	
COOLING WATER PIPING PLAN	
COOLING WATER PIPING	PIPE
FITTINGS	
COOLING WATER PIPING MATERIALS	STAINLESS STEEL

PIPING & APPARTENANCES	
CUSTOMER PIPING CLASS TO BE FOLLOWED	YES
MANIFOLD PIPING FOR PURCHASER CONNECTION:	
VENT	YES
DRAIN	YES
COOLING WATER	YES
TAG ALL ORIFICES	
TYPE OF CONNECTION ON SEAL GLAND:	
SOCKED WELDED	TBA
THREADED	TBA
COUNTEFLANGES REQUIRED FOR:	
INLET/DISCHARGE FLANGES	YES
AUXILIARY FLANGES	YES

REMARKS

WINTERIZATION & TROPICALIZATION	
WINTERIZATION REQUIRED	NO
COLD INSTULATION	
HEAT TRACING	
CABINET	
CANOPY	
Other	
TROPICALIZATION REQUIRED	YES
HOT INSULATION	
CABINET	
CANOPY	
Other	Fire/hot Insultation material by IO Personnel protection for Surfaces > 70°C

REMARKS

DATA SHEET No. _____ Rev: _____ SHEET 3 of 10

SUPPLY

IBED PHTS MAIN PUMP DATA SHEET
QUALITY AND TESTING REQUIREMENT

Note	SURFACE PREPARATION AND PAINT		TEST			Rev
	MANUFACTURER'S STANDARD		SHOP INSPECTION		YES	
	OTHER (SEE BELOW)		PERFORMANCE CURVE			
	SPECIFICATION NO. Supplier to propose a nuclear and fire qualified		& DATA APPROVAL PRIOR TO SHIPMENT.		YES	
	system. Refer to Technica Specification ITER_D_9396JP		TEST WITH SUBSTITUTE SEAL			
	PUMP:		MATERIAL CERTIFICATION REQUIRED	CASING	YES	
	PUMP SURFACE PREPARATION			IMPELLER	YES	
	PRIMER			SHAFT	YES	
	FINISH COAT			OTHER all wetted parts		
			CASTING REPAIR WELD PROCEDURE APPR REQD		YES	
	BASEPLATE:					
	BASEPLATE SURFACE PREPARATION		INSPECTION REQUIRED FOR CONNECTION WELDS			
	PRIMER:			MAG PARTICLE		
	FINISH COAT			RADIOGRAPHY	YES	
	DETAILS OF LIFTING DEVICES			LIQUID PENETRANT	YES	
				ULTRASONIC		
	SHIPMENT:		INSPECTION REQUIRED FOR CASTINGS			
	EXPORT BOXING REQUIRED			MAG PARTICLE		
	OUTDOOR STORAGE MORE THAN 6 MONTHS			RADIOGRAPHY	YES	
				LIQUID PENETRANT	YES	
	SPARE ROTOR ASSEMBLY PACKAGED FOR:			ULTRASONIC		
	ROTOR STORAGE ORIENTATION		HARDNESS TEST REQUIRED			
	SHIPPING & STORAGE CONTAINER FOR VERT STORAGE		ADDNL EXAMINATION			
			UTs on shaft			
	N2 PURGE					
	SPARE PARTS		PMI TESTING REQUIRED			
	START-UP	YES	COMPONENTS TO BE TESTED			
	NORMAL MAINTENANCE	YES	All equipment not supplied with 3.1 certificates			
			RESIDUAL UNBALANCE TEST		YES	
	AVAILABLE FOOTPRINT		NOTIFICATION OF SUCCESSFUL SHOP			
			PERFORMANCE TEST			
			BASEPLATE TEST			
			HYDROSTATIC		WIT	
	Refer to appendix D of Pump Technical Specification ITER_D_9396JP		HYDROSTATIC TEST OF BOWLS & COLUMN			
			PERFORMANCE TEST		WIT	
			TEST IN COMPLIANCE WITH			
			TEST DATA POINTS TO			
			TEST TOLERANCES TO			
	OTHER PURCHASER REQUIREMENTS		NPSH		WIT	
	COORDINATION MEETING REQUIRED		NPSH-1ST STG ONLY			
	MAXIMUM DISCHARGE PRESSURE TO INCLUDE		NPSH TESTING TO HI 1.6 OR ISO 9906			
	MAX RELATIVE DENSITY	YES	TEST NPSHA LIMITED TO 110% SITE NPSHA			
	OPERATION TO TRIP SPEED	YES	RETEST ON SEAL LEAKAGE		WIT	
	MAX DIA. IMPELLERS AND/OR NO OF STAGES	YES	RETEST REQUIRED AFTER FINAL HEAD ADJ		WIT	
	CONNECTION DESIGN APPROVAL		COMPLETE UNIT TEST		WIT	
	TORSIONAL ANALYSIS / REPORT	YES	SOUND LEVEL TEST		WIT	
	PROGRESS REPORTS		CLEANLINESS PRIOR TO FINAL ASSEMBLY		WIT	
	OUTLINE OF PROC FOR OPTIONAL TESTS		LOCATION OF CLEANLINESS INSPECTION			
	ADDITIONNAL DATA REQUIRING 20 YEARS RETENTION		NOZZLE LOAD TEST			
		YES	CHECK FOR CO-PLANAR MOUNTING PAD SURFACES		WIT	
	LATERAL ANALYSIS REQUIRED	YES	MECHANICAL RUN TEST UNTIL OIL TEMP STABLE			
	MODAL ANALYSIS REQUIRED	YES	4 HR. MECH RUN AFTER OIL TEMP STABLE		WIT	
	DYNAMIC BALANCE ROTOR	YES	4 HR. MECH RUN TEST			
	INSTALLATION LIST IN PROPOSAL					
	VFD STEADY STATE DAMPED RESPONSE ANALYSIS		BRG HSG RESONANCE TEST			
		YES	STRUCTURAL RESONANCE TEST		WIT	
	TRANSIENT TORSIONAL RESPONSE		REMOVE / INSPECT HYDRODYNAMIC BEARINGS AFTER TEST			
	BEARING LIFE CALCULATIONS REQUIRED	YES			WIT	
	IGNITION HAZARD ASSMT TO EN 13463-1		AUXILIARY EQUIPMENT TEST		WIT	
	CASING RETIREMENT THICKNESS DRAWING		EQUIPMENT TO BE INCLUDED IN AUXILIARY TESTS			
	FLANGES RQD IN PLACE OF SKT WELD UNIONS		Mechanical Seal, Flushing System, Motor,VCB, VFD,			
	INCLUDE PLOTTED VIBRATION SPECTRA	YES	LOCATION OF AUXILIARY EQUIPENT TEST			
	CONNECTION BOLTING					
	CADMIUM PLATED BOLTS PROHIBITED		IMPACT TEST	PER EN 13445		
	VENDOR TO KEEP REPAIR AND HT RCDS	YES		PER ASME SECTION VIII		
	VENDOR SUBMIT TEST PROCEDURES	YES	REMOVE CASING AFTER TEST		WIT	
	SUBMIT INSPECTION CHECK LIST	YES				

REMARKS

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SUPPLY

IBED PHTS MAIN PUMP DATA SHEET
REGULATION AND NDTs

Note		Rev
	PRESSURE VESSEL DESIGN	
	CASTING FACTORS USED IN DESIGN	
	SOURCE OF MATERIAL PROPERTIES	
	WELDING AND REPAIRS	
	ALTERNATE WELDING CODES AND STANDARDS — **REFER TO TECHNICAL SPECIFICATION ITER_D_9396JP**	
	WELDING REQUIREMENT (APPLICABLE CODE OR STANDARD)	
	WELDER/OPERATOR QUALIFICATION	
	WELDING PROCEDURE QUALIFICATION	
	NON-PRESSURE RETAINING STRUCTURAL WELDING SUCH AS BASEPLATES OR SUPPORTS	
	MAGNETIC PARTICLE OR LIQUID PENETRANT EXAMINATION OF PLATE EDGES	
	POSTWELD HEAT TREATMENT	
	POSTWELD HEAT TREATMENT OF CASING FABRICATION WELDS	
	MATERIAL INSPECTION	
	THESE REFERENCES MUST BE LISTED BY THE PURCHASER — DEFAULT TO TABLE 14 API 610	
	ALTERNATIVE MATERIAL INSPECTIONS AND ACCEPTANCE CRITERIA	

TYPE OF INSPECTION	METHOD	ACCEPTANCE	FOR CASTINGS	FABRICATION
REFER TO TECHNICAL SPECIFICATION ITER_D_9396JP				

Equipment Classification

Safety Class (2)	Quality Class	HCC	PED class (1)	ESPN cl. (1)	Seismic class	Vacuum class		Tritium Class		RH class
SIC-1	QC-1	NO	TBD	N2	SC1 (S)	N/A		N/A		N/A

REGULATION

MACHINE DIRECTIVE 2006/42/CE	Appendix II-1-A
LOW VOLTAGE DIRECTIVE 2014/35/EU	
ELECTROMAGNETIC COMPATIBILITY DIRECTIVE 2014/30/EU	YES
ATEX DIRECTIVE 2014/34/EU	NO
PED DIRECTIVE 2014/68/EU	For Auxiliairies only

REMARKS

(1) Manufacturer shall present a request of Exclusion for PED and ESPN to be applied to pump pressure boundary. PED/ESPN class will be ap
case by case depending on the auxiliary component. N2 ESPN class is the classification of piping connected to inlet and discharge nozzle
(2) SIC-1 For Confinement Only. Please refer to technical specification ITER_D_ALWTJX for the required classification and Electrical and Control Cabinets

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SUPPLY

IBED PHTS MAIN PUMP DATA SHEET
ENVIRONMENTAL CONDITIONS

ENVIRONMENTAL CONDITIONS (1)

Range of Ambient Conditions (2,7)	Normal Conditions (8)		Degradated Conditions		Storage		Fire (6)	
	MIN	MAX	Category II	Category IV	Indoor	Outdoor (3)	Insulated	non-insul
RANGE OF AMBIENT TEMPS [°C]	5	35	5-100	5-130	-8 to 45	-25 to +45	284	400
RELATIVE HUMIDITY [%]	0	60	0 to 100		0 to 100			
ATMOSPHERIC PRESSURE[KPa abs.]	95	200	95 to 200		atm (8)		105	105

Room Specific Radiation and Static Magnetic Field	Radiatons		
	Integrated Dose 20 Years [kGy] (4)	Average Dose Rate over 4700 hrs [kGy/hr] (4)	Static Magnetic Field Max Modulus [mT] (5)
Pumps Area	4100	8.72E-01	55
Motor Area	120	2.55E-02	40
Seal Flushing Support Systems L4-04	10	2.13E-03	45
Seal Flushing Support Systems L3-02S	3300	7.02E-01	20
Electrical and Control Cabinets	(7)		

REMARKS

(1) Source of references:
Radiation environment for equipment during operations - ITER_D_3FM52L.
IBED PHTS System Process Loading Condition - ITER_D_YQCUY5.
(2)Refer to Appendix C of Technical Specification ITER_D_9396JP for related Loading Conditions.
(3) Additional conditions for ourdoor storage : extreme winds up to 166 km/h, maximum mass of snow 150 daN/m2.
(4) Integrated Radiation dose is referred to silicon dose. Installation life is 20 years, but total irradiation time is 4700 h.
Irradation by Neutron Flux shall be considered for Electronic Devices.
(5) Qualification testing shall to be performed with a field strength that is 1.4 times these current field values .
Values of static magnetic field Modulus have been calculated using Tool in reference 53KMVD
For detailed composition of magnetic field, refer to maps in references QQGFU6 (L3), QUDEGC (L4), R35C6B (R1).
(6) This fire temperatures shall be considered as a static condition for the Main pumps (pumps not running).
This two temperature values are referred to the maximum temperature under fire insulation (insulated) and maximum
temperature of surfaces not covered by fire insulation (non-insul).
(7) For environmental conditions, Radiation and Magnetic Field applicable to electrical and control cabinets,
refer to technical specification ITER_D_ALWTJX
(8) Indoor Storage Condition to be applied also for the storage during installation phase. Normal condition to be applied also to activities and
storage time after installation during commissioning.

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SUPPLY

IBED PHTS MAIN PUMP DATA SHEET
PLANT UTILITIES

UTILITIES (1)

Utilities specification :

Cooling water to mechanical Seals Heat Exchanger:

Type : **Cooling Water from CCWS-1 system**

	Min	Normal	Max	Design	
Inlet temperature :			31		°C
Outlet temperature :			40		°C
Inlet pressure :				50	bara
Outlet pressure :					bara
Allowable ΔP :				1	bar
Allowable ΔT :					°C
Allowable flow:			TBC		kg/s
Required flow:					kg/s

Fouling factor : TBC m².Kw

Cooling water to Pump Bearings and Electric Motors

Type : **Cooling Water from CCWS-1 system**

	Min	Normal	Max	Design	
Inlet temperature :			31	190	°C
Outlet temperature :			40		°C
Inlet pressure :				17.2	bara
Outlet pressure :					bara
Allowable ΔP :				1	bar
Allowable ΔT :					°C
Allowable flow:			6.25		kg/s
Required flow:					kg/s

Fouling factor : TBC m².Kw

Barrier Fluid for Mechanical Seals

Type : **Demineralized water from PBS 65**

	Min	Normal	Max	Design	
Inlet temperature :				270	°C
Outlet temperature :					°C
Inlet pressure :	6			68	bara
Outlet pressure :					bara
Allowable ΔP :					bar
Allowable ΔT :					°C
Water consumption:			TBC		kg/s

Fouling factor : kcal/h/m²/°C m².Kw

Fluid Pameters

	Barrier Fluid	Cooling Water (All)
Conductivity @ 25 °C (µS/cm)	0.1	50
pH :	6.5-7.5	6.5-9.5
Hardness (Ca, Mg, etc) (µg/kg)	≤1	
Chlorides and/or Fluorides (µg/kg)	≤3	100
Sulphates (µg/kg)	≤3	
Copper (µg/kg)	≤2	nil
Iron (µg/kg)	≤2	100
Total Organic Content (µg/kg)	≤100	nil
Dissolved Oxygen (µg/kg)	≤50	nil
Silica (µg/kg)	nil	nil
Sodium (µg/kg)	nil	nil
PARTICULATE SIZE (µm)	≤25	nil*
PARTICULATE CONCENTRATION (ppb)	TBC	TBC

During commissioning stage, the coolers shall be capable to operate with suspended solid particle size up to 1 mm

ELECTRICAL POWER SUPPLY

	Voltage	Frequency	Phase	Neutral
	V	Hz		
Power driver	**6600**	**50**	**3**	**TN-S**
Auxiliairy driver	**400**	**50**	**3**	**TN-S**
Heating	**230**	**50**	**1**	
Tracing	**NA**	**NA**	**NA**	**NA**
Control	**24 V DC**			
Instrumentation	**24 V DC**			
UPS	**400 (230)**	**50**	**3**	**TN-S**

REMARKS

(1) Corrosion allowances and fouling factors needed for the requested heat duty, material choice, and water chemistry will be clearly justified in the Manufacturer's design for the design life of this technology.

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SUPPLY

IBED PHTS MAIN PUMP DATA SHEET
PUMP PERFORMANCE CURVE

	Note		Rev

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IBED PHTS MAIN PUMP DATA SHEET
PID

Note		Rev

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IBED PHTS MAIN PUMP DATA SHEET
PART NUMBER IDENTIFICATION

Note | Rev

PNI	TAG	Description

REMARKS

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SUPPLY

Appendix B – Nozzle Loads

a. The required nozzle loads for the 8 IBED PHTS Main Pumps provided in this appendix are derived from [r3].
b. This nozzle loads are considered at the pump flanges N1 (suction) and N2 (discharge). These loads are calculated considering piping designed as per applicable piping class up to main pump flanges.
c. The nozzle coordinate system for forces and moments is provided in API 610 XII ed, Figure 23.
d. IBED PHTS Main pumps shall be designed as a minimum for the nozzle loads given in Table 15.
e. IBED PHTS Main Pumps shall also be designed to withstand the additional nozzle load combinations included in the Table 16.
f. The allowable nozzle loads shall be supplied by Contractor during the design phase and shall envelop the values given in this Appendix.
g. Loads on Auxiliaries Nozzles will be shared by IO in the detailed engineering phase.
h. Water hammer cases have been developed using methodology included in [r7]. Detailed calculation results are included in [r8].
i. Refer to *Appendix C – Process Loading Conditions* for the definition of the load cases included in Table 16.

Table 15 - Minimum Required Nozzle Loads

Minimum Required Nozzle Loads											
Nozzle	**DN [mm]**	**Service Level**	**ratio to API 610 loads**	**FX [N]**	**FY [N]**	**FZ [N]**	**FR [N]**	**MX [Nm]**	**MY [Nm]**	**MZ [Nm]**	**MR [Nm]**
N1	400	A/B	4	33800	26680	40920	59400	29280	14640	21680	39280
		C/D	6	50700	40020	61380	89100	43920	21960	32520	58920
N2	350	A/B	4	28480	23120	35600	51120	25480	12480	19000	34160
		C/D	6	42720	34680	53400	76680	38220	18720	28500	51240

Table 16 - Additional Nozzle Load Combinations Coming from Piping Stress Analysis

Pump	Nozzle	FX	FY	FZ	FR	MX	MY	MZ	MR
Level A/B - Load Ratios compared to 4xAPI loads									
PL-1960	N1	0.267	0.875	0.416	0.510	0.422	1.157	0.590	0.625
	N2	0.080	0.237	0.455	0.338	0.235	0.583	0.186	0.294
PL-1970	N1	0.460	0.326	0.229	0.339	0.218	1.269	0.253	0.519
	N2	0.213	0.125	0.619	0.451	0.146	0.669	0.112	0.275
Level C –– Case III.T5 - Load Ratios compared to 6xAPI loads									
PL-1970	N1	0.465	0.283	0.298	0.358	0.205	1.402	0.216	0.557
	N2	0.156	0.098	0.479	0.348	0.103	0.453	0.084	0.189
Level D – Case IV.T6 – Water Hammer related to Pump seizure - Load Ratios compared to 6xAPI loads									
PL-1910	N1	1.818	1.799	1.109	1.519	0.895	2.193	1.462	1.328
	N2	1.156	0.654	0.482	0.784	0.288	1.332	0.243	0.549
PL-1920	N1	1.613	1.117	0.443	1.090	0.656	1.852	1.177	1.067
	N2	0.947	1.233	0.487	0.839	0.711	1.095	0.913	0.836
PL-1930	N1	0.612	3.678	0.996	1.822	3.678	1.843	0.291	2.831
	N2	1.134	0.380	0.485	0.737	0.374	1.290	0.331	0.578
PL-1940	N1	1.410	0.722	0.959	1.088	0.828	3.414	0.849	1.490
	N2	1.272	2.287	0.677	1.340	1.267	1.419	2.137	1.605

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Pump	Nozzle	FX	FY	FZ	FR	MX	MY	MZ	MR
	N1	0.593	0.494	0.395	0.487	0.215	0.958	0.741	0.566
PL-1950	N2	0.771	1.300	1.152	1.084	1.334	1.688	0.598	1.217
	N1	0.705	2.095	0.916	1.202	1.803	1.924	0.981	1.617
PL-1960	N2	1.189	1.524	0.989	1.178	0.695	1.401	0.942	0.898
	N1	0.999	0.331	0.411	0.652	0.277	1.597	0.366	0.661
PL-1970	N2	0.769	0.130	1.375	1.050	0.198	2.062	0.130	0.771
	N1	0.377	1.386	0.482	0.738	1.233	0.693	0.670	1.024
PL-1980	N2	0.595	0.789	0.543	0.616	0.503	0.856	0.527	0.569
Level D - Case IV.T6 - SL-2 -Load Ratios compared to 6xAPI loads									
	N1	0.272	0.750	0.402	0.463	0.572	1.036	0.478	0.632
PL-1960	N2	0.074	0.202	0.428	0.314	0.258	0.624	0.153	0.310
	N1	0.574	0.329	0.399	0.452	0.246	1.787	0.249	0.704
PL-1970	N2	0.167	0.108	0.525	0.380	0.107	0.473	0.091	0.197
Level D – FIRE (case IV.T1) +SMHV - Load Ratios compared to 6xAPI loads									
	N1	0.334	0.425	0.186	0.298	0.198	0.392	1.331	0.763
PL-1920	N2	0.306	0.313	0.458	0.388	1.163	0.664	0.312	0.917
	N1	0.368	0.773	0.747	0.655	0.087	1.314	1.042	0.758
PL-1950	N2	0.508	0.202	0.264	0.350	0.148	1.190	0.195	0.462
	N1	0.418	1.245	0.348	0.653	0.538	1.566	0.844	0.848
PL-1960	N2	0.092	0.595	0.354	0.368	0.350	1.101	0.523	0.561
	N1	0.647	0.500	0.341	0.491	0.279	1.774	0.094	0.695
PL-1970	N2	0.357	0.124	0.219	0.257	0.168	0.655	0.192	0.290
	N1	0.305	0.814	0.237	0.436	0.829	0.636	0.461	0.709
PL-1980	N2	0.707	0.543	0.371	0.531	1.093	0.161	0.302	0.834

SUPPLY

Appendix C – Process Loading Conditions

a. The ITER loading conditions are categorized, into four classes based on the expectation of occurrence (ref. [r4] and [d6]):
    i. Category I: Operational Loading Conditions
    ii. Category II: Likely Loading Conditions
    iii. Category III: Unlikely Loading Conditions
    iv. Category IV: Extremely Unlikely Loading Conditions

b. Service Level Definition [r5]:
    - A: Normal Operation. All structures, systems, and components are functional.
    - B: Same service level as for Criteria Level A but with lower margin.
    - C: May be significant local distortion. May need to inspect, call for repair or replacement of faulty components.
    - D: May be large general distortion and investment loss. Repair may not be considered economic. Safety functions shall be maintained.

c. The relation between load conditions and service levels is established in ref.[r6]. The specific loading conditions related to IBED PHTS Main Pumps are given in the table here below.
d. Allowable values and limits in service level C and D for ITER mechanical components are fixed in [d6].
e. Water hammer cases have been developed using methodology included in [r7]. Detailed calculation results are included in [r8].
f. Loading conditions included with strikethrough font in Table 17 are not applicable to IBED PHTS Main Pumps.

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Table 17 - Process Load Conditions for IBED PHTS Main Pumps

	Loading Conditions	Cycles	IBED PHTS Main Pumps Discharge	IBED PHTS Main Pumps Suction	Comment	Main pump is in operation in the loading case?
Service Level A						
I.S0	Design Conditions	-	6.8 MPa 150 °C	5.0 MPa 150 °C		yes
I.S1	Standby Mode (Low Flow)	-	2.2 MPa 70 °C	2.2 MPa 70 °C		yes
I.S2	Water Baking Operation at 240 °C	-	1.9 MPa Tamb	1.9 MPa Tamb		no
I.S3	Idle Mode	-	0.1 MPa Tamb	0.1 MPa Tamb		no
I.S4	Off Mode	-	0.6 MPa Tamb	0.6 MPa Tamb		no
I.S5	Maintenance Mode	-	0.1 MPa Tamb	0.1 MPa Tamb		no
I.S6	Standby Mode (Nominal Flow)	-	4.8 MPa 70 °C	1.36 MPa 70 °C		yes
I.S7	Gas Baking Operation at 390 °C	-	1.9 MPa Tamb	1.9 MPa Tamb		no
I.S8	Water Baking Operation at 18 °C	-	1.9 MPa Tamb	1.9 MPa Tamb		no
I.S9	First Plasma Gas Baking Operation at 240 °C	-	0.1 MPa Tamb	0.1 MPa Tamb		no
I.T1	Plasma Operation	30000	4.8 MPa 70 °C	1.36 MPa 70 °C		yes
I.T2	Standby Mode (Low Flow) to Water Baking Operation	500	[1.9, 2.2] MPa [18, 70] °C	[1.9, 2.2] MPa [18, 70] °C		yes
I.T14	Idle Mode to Water Baking Operation		0.1 MPa Tamb	0.1 MPa Tamb		no
I.T3	Water Baking Operation to Standby Mode (Low Flow)	500	[1.9, 2.2] MPa [18, 70] °C	[1.9, 2.2] MPa [18, 70] °C		yes

SUPPLY

	Loading Conditions	Cycles	IBED PHTS Main Pumps Discharge	IBED PHTS Main Pumps Suction	Comment	Main pump is in operation in the loading case?
I.T15	Water Baking Operation to Idle Mode		0.1 MPa Tamb	0.1 MPa Tamb		no
I.T4	Standby Mode (Low Flow) to Idle Mode	500	[0.1, 2.2] MPa [10, 70] °C	[0.1, 2.2] MPa [10, 70] °C	0.1 [Mpa] is before the heaters in the pressurizers are on.	yes
I.T5	Idle Mode to Standby Mode (Low Flow)	500				yes
I.T6	Off Mode to Maintenance Mode	500	[0.1, 0.6] MPa T_{amb}	[0.1, 0.6] MPa T_{amb}		no
I.T7	Maintenance Mode to Off Mode	500				no
I.T8	Off Mode to Idle Mode	500	[0.1, 0.6] MPa T_{amb}	[0.1, 0.6] MPa T_{amb}		no
I.T9	Idle Mode to Off Mode	500				no
I.T10	Clients Dryout during Maintenance Mode	50	0.1 MPa Tamb	0.1 MPa Tamb		no
I.T11	Clients Blowout during Maintenance Mode	**See comment**	0.1 MPa Tamb	0.1 MPa Tamb	**These 50 cycles are decomposed in 900 sub-cycles for PT5 (18groups of 3 x divertor cassettes), 1800 sub-cycles for PT6 (36 x half a FW/BLK sector), & 1200 sub-cycles for PT7 (24 EQ port clients).**	no
I.T12	Maintenance Mode to Gas Baking Operation	15	[0.1, 0.6] MPa Tamb	[0.1, 0.6] MPa Tamb		no
I.T13	Gas Baking Operation to Maintenance Mode	15				no
I.T16	Standby Mode (Low Flow) to Standby Mode (Nominal Flow)	4000	[2.2, 4.8] MPa 70 °C	[1.9, 1.36] MPa 70 °C		yes
I.T17	Standby Mode (Nom. Flow) to Standby Mode (Low Flow)	4000				yes
~~I.T18~~	~~MD Category I~~	~~2600~~	~~N/A~~	-	~~This loading condition is only applicable to IBED PHTS divertor piping inside cryostat.~~	yes

SUPPLY

	Loading Conditions	Cycles	IBED PHTS Main Pumps Discharge	IBED PHTS Main Pumps Suction	Comment	Main pump is in operation in the loading case?
I.T19	Maintenance Mode to First Plasma Gas Baking Operation	18	0.1 MPa Tamb	0.1 MPa Tamb		no
T.T20	First Plasma Gas Baking Operation to Maintenance Mode	18				no
Service Level A						
II.S1	DEG1 Degraded Environmental Conditions	-	Environmental pressure: [95, 200] kPa Environmental temperature: [5, 100] °C Environmental air humidity: [0, 100] %			yes
II.T1	Short-Term LOOP	50	[4.8, 5.0] MPa [10,141] °C	[1.36, 5.0] MPa [10, 141] °C	Pumps stops as soon as LOOP happens. Before the re-start an interlock function in the suction pressure should be implemented.	The pump will trip
II.T2	Cat. II Break within In-Vessel LOCA Boundaries	50	[4.8, 6.8] MPa [10,141] °C	[1.36, 5.0] MPa [10, 141] °C	5.0 MPa at the pump suction are experienced only when the pump is already stopped.	yes, possible SIC trip to be considered
II.T4	Loss of HVAC Incident	50	[-0.2 Mpa] 18 → 100 → 18	[-0.2 Mpa] 18 → 100 → 18	System is under vacuum, outside pressure 0.2 Mpa. A differential pressure of -0.2 Mpa is experienced by the pump. Starting temperature is at 18 (Psat) at 2.1 kPa. Environmental temperature goes from 18 to 100 (+50C/h), remain at 100C for 1h and go back to 18 (-10/h)	no
II.T5	SL-1 Seismic Event	50	4.8 MPa 70 °C	1.36 MPa 70 °C	SL-1 is cumulated to this bounding case. If needed, it is possible to use 2 couples of highest operational conditions for PT5: (3.2 MPa, 390 °C) and (4.6 MPa, 240 °C).	yes
N.A	Combination I.T18 + II.T5 = SL-1 + MD I		N/A		This loading condition is only applicable to IBED PHTS divertor piping inside cryostat.	
II.T6	WH Pump Trip	50	Primary pumps: I.T1 + PL-19x0 common trip (3S3YGB) [2.1, 4.8] Mpa	Primary pumps: I.T1 + PL-19x0 common trip (3S3YGB) [1.3, 2.2] Mpa		no
II.T7	~~CrICE Category II~~	~~15~~	~~N/A~~		~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	

SUPPLY

	Loading Conditions	Cycles	IBED PHTS Main Pumps Discharge	IBED PHTS Main Pumps Suction	Comment	Main pump is in operation in the loading case?
II.T8	~~VDE Category II~~	~~300~~	~~N/A~~		~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	
II.T9	WH Spurious LOCA Isolation Valve Closure (all of them)	5	For ex-vessel LOCA valves: During plasma: I.T1 + simultaneous closure of ex-vessel LOCA isolation valves (3S3YGB) [4.8, 6.1] Mpa	For ex-vessel LOCA valves: During plasma: I.T1 + simultaneous closure of ex-vessel LOCA isolation valves (3S3YGB) [1.3, 2.0] Mpa		yes
~~II.WH~~	~~Bounding Case for Category II Water Hammer Events (II.T6 & II.T9)~~	~~55~~	~~[4.8, 6.8] MPa 70 °C~~	~~[4.3, 5.0] MPa 141 °C~~	~~100% design pressure is never exceeded for category II water hammer events (II.T6 & II.T9). Their initial operating conditions are based on I.S2 & I.T1. A bounding case is thus defined based on sudden pressure variation from lowest operating pressure to design pressure at constant highest operational temperature, and vice-versa.~~	-
II.T11	OPP Category II (Plasma)		[4.8, 6.8] MPa 150 °C	[1.36, 5.0] MPa 150 °C	pump trip will occur before reaching max pressure in the suction	
II.T12	HX Tube Leakage	1	4.8 MPa [70 - 141 °C]	1.36 MPa 70 -141 °C		yes
Service Level C for Main Pump Service Level B for mechanical Seals and Components of the flushing Systems that contributes in short and medium term to the leak tightness of the IBED PHTS Main Pumps Pressure Boundary.						
III.S1	DEG2 Highly Degraded Environmental Conditions	-	Environmental pressure: [95, 200] kPa Environmental temperature: [5, 130] °C Environmental air humidity: [0, 100] %			(yes)
III.T1	Long-Term LOOP + Failure of DHR Operation	1	4.8 → 6.8 → 4.8 MPa 70 → 10 → 190 → 10 °C	1.36 → 5.0→ 1.36 MPa 70 → 10 → 190 → 10 °C	Pumps stops as soon as LOOP happens. Before the re-start an interlock function in the suction pressure should be implemented.	no
~~III.T2~~	~~Short-Term LOOP + Loss of HVAC Incident~~	~~1~~	II.T1 → II.T1 + II.S1 → II.T1		This loading condition is covered by the bounding case suggested for loss of HVAC incident (II.T4), and the bounding case for short-term LOOP (II.T1).	no

SUPPLY

	Loading Conditions	Cycles	IBED PHTS Main Pumps Discharge	IBED PHTS Main Pumps Suction	Comment	Main pump is in operation in the loading case?
III.T3	LOCA Outside Cryostat	1	[-0.2] MPa 18 → 130 → 18 °C	[-0.2] MPa 18 → 130 → 18 °C	Environmental conditions. -0.2 Mpa of differential pressure between room and inside of piping.	no
III.T4	WH Pump Seizure	1	Primary pumps: I.T1 + PL-19x0 WH pump seizure (I3S3YGB) [5.0, 3.2] Mpa	Primary pumps: I.T1 + PL-19x0 WH pump seizure (I3S3YGB) [1.36, 2.2] Mpa		no
III.T5	SMHV Seismic Event	1	4.8 MPa 70 °C	1.36 MPa 70 °C	SMHV is cumulated to this bounding case.	yes
III.T6	~~CrICE Category III~~	~~1~~	~~During plasma: I.T1 → I.T1 + CrICE III → I.T1 With guard external pressure from 1E-7 to 140 kPa in 1 ms and guard temperature from 66 to -63 °C in 1 s~~ ~~During water baking: I.S8 → I.S8 + CrICE III → I.S8 With guard external pressure from 1E-7 to 140 kPa in 1 ms and guard temperature from 221 to -48 °C in 1 s~~		~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	
III.T7	~~VDE Category III~~	~~1~~	~~I.T1 → I.T1 + VDE III → I.T1~~		~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	
III.T8	~~Helium Leak in CSR~~	~~1~~	~~This loading condition is not considered for IBED PHTS guard pipes in CSR as they are insulated with 50 mm of Microtherm or equivalent. But it must be considered for supports (if any). See SZE5MR v2.6 Section 10.5 for further details.~~		~~This loading condition is only applicable to IBED PHTS supports in CSR (= interspace between cryostat and bioshield).~~	
III.T9	WH Break Propagation	1	BreakForces3.1 - LOCA Upstream VG-2101 - Cooling Train DN400 PI-2101 excel sheet			
III.T10	OPP Category III	1	4.8 → 7.5 MPa 150 °C	1.36 → 5.5 MPa 150 °C	pump trip will occur before reaching max pressure in the suction	yes

SUPPLY

	Loading Conditions	Cycles	IBED PHTS Main Pumps Discharge	IBED PHTS Main Pumps Suction	Comment	Main pump is in operation in the loading case?
III.T11	WH Spurious & Simultaneous LOCA Isolation Valves Closure with a Single Failure	1	I.T1 + simultaneous closure of all LOCA isolation valves except one (X9AZZL) [4.8, 6.5] Mpa	I.T1 + simultaneous closure of all LOCA isolation valves except one (X9AZZL) [1.36, 2.2] Mpa		no because SIC trip of the pump
~~III.WH~~	~~Bounding Case for Category III Water Hammer Events (III.T4 & III.T11)~~	~~1~~	~~4.8 → 7.5 → 4.8 MPa 70 °C~~	~~4.3 → 5.5 → 4.3 MPa 141 °C~~	~~110% design pressure is never exceeded for category III water hammer events (III.T4 & III.T11).~~ ~~Their initial operating conditions are based on I.S2 & I.T1.~~ ~~A bounding case is thus defined based on sudden pressure variation from lowest operating pressure to design pressure at constant highest operational temperature, and vice-versa.~~	yes
III.T12	Cat. III Pipe Break within In-Vessel LOCA Boundaries	1	4.8 → 7.5 → 4.8 MPa 10, 141	1.36 → 5.5 → 1.36 MPa 10, 141	In case of category III pipe break, significant hydraulic loads may be generated outside of the in-vessel LOCA boundaries of the affected client. The in-vessel LOCA boundaries of the affected client consist of 2 redundant inlet in-vessel LOCA isolation valves and 2 redundant outlet in-vessel LOCA check-valves. In-vessel LOCA isolation valves and in-vessel LOCA check-valves must be able to close. Additional data required for sizing must be specified by valve supplier and provided by IO TCWS.	yes
III.T13	~~Helium Leak in Galleries~~	~~1~~	~~N/A~~		~~This loading condition is only applicable to IBED PHTS supports in galleries.~~	
N.A	~~Combination II.T5 + II.T8 = SL-1 + VDE Category II~~	~~1~~	~~N/A~~		~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	
N.A	~~Combination III.T5 + III.T6 = SMHV + CrICE Category III~~	~~1~~	~~N/A~~		~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	

SUPPLY

	Loading Conditions	Cycles	IBED PHTS Main Pumps Discharge	IBED PHTS Main Pumps Suction	Comment	Main pump is in operation in the loading case?
N.A	~~Combination III.T5 + III.T8 / III.T13 = SMHV + Helium Leak in CSR or Galleries~~	~~1~~	~~N/A~~		~~This loading condition is only applicable to IBED PHTS supports in CSR and in galleries.~~	
~~III.AD~~	~~Combination III.WH + III.T5 = SMHV + WH Cat. II or III~~	~~1~~	~~4.8 → 7.5 → 4.8 MPa 70 °C~~	~~1.36 → 5.5 → 1.36 MPa 141 °C~~	~~SMHV is cumulated to bounding case III.WH. Note that this covers any combination of category II / III water hammer events with SMHV.~~	
Service Level D for Main Pump Service Level B for mechanical Seals and Components of the flushing Systems that contributes in short and medium term to the leak tightness of the IBED PHTS Main Pumps Pressure Boundary.						
IV.S1	Fire Design Basis	1	The fire design basis event is based on Eurocode 1 EN 1991-1-2:2002. Environmental temperature increases up to 1049 °C for a fire duration of 2 hr. IBED PHTS fire insulation is sized to ensure that the maximum process temperature in case of fire never exceeds the saturation temperature at design pressure.			no
IV.T1	Fire Exposure	1	0.6 → 6.0 → 0.6 MPa 18 → 275.5 → 18 °C	0.6 → 6.0 → 0.6 MPa 18 → 275.5 → 18 °C		no
IV.T2	SL-2 Seismic Event	1	4.8 MPa 70 °C	1.36 MPa 70 °C	SL-2 is cumulated to this bounding case.	yes
IV.T3	~~CrICE Category IV~~	~~1~~	~~During plasma: I.T1 → I.T1 + CrICE IV → I.T1 With guard external pressure from 1E-7 to 200 kPa in 1 ms and guard temperature from 66 to -64 °C in 1 s~~ ~~During water baking: I.S8 → I.S8 + CrICE IV → I.S8 With guard external pressure from 1E-7 to 200 kPa in 1 ms and guard temperature from 221 to -51 °C in 1 s~~		~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	
IV.T4	~~VDE Category IV~~	~~1~~	~~I.T1 → I.T1 + VDE IV → I.T1~~		~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	

SUPPLY

	Loading Conditions	Cycles	IBED PHTS Main Pumps Discharge	IBED PHTS Main Pumps Suction	Comment	Main pump is in operation in the loading case?
IV.T5	Cat. IV Pipe Break within In-Vessel LOCA Boundaries	1	4.8 → 6.8 → 4.8 MPa 10, 141	1.36 → 6.0 → 1.36 MPa 10, 141	pump trip will occur before reaching max pressure in the suction	yes
IV.T6	WH Severe Pump Seizure	1	Primary pumps: I.T1 + PL-19x0 WH pump seizure (I3S3YGB) [4.8, 5.5] MPa	Primary pumps: I.T1 + PL-19x0 WH pump seizure (3S3YGB) [1.36, 2.6] MPa		
~~IV.WH~~	~~Bounding Case for WH Severe Pump Seizure (IV.T6)~~	~~1~~	~~4.8 → 8.2 → 4.8 MPa 70 °C~~	~~1.36 → 6.0 → 1.36 MPa 141 °C~~	~~120% design pressure is never exceeded for WH severe pump seizures (IV.T6).~~ ~~Their initial operating conditions are based on I.S2.~~ ~~A bounding case is thus defined based on sudden pressure variation from lowest operating pressure to design pressure at constant highest operational temperature, and vice-versa.~~	no
N.A	~~Combination IV.T3 + IV.T2 = SL-2 + CrICE Category IV~~	~~1~~	~~N/A~~		~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	
N.A	~~Combination IV.T2 + III.T8 / III.T13 = SL-2 + Helium Leak in CSR or Galleries~~	~~1~~	~~N/A~~		~~This loading condition is only applicable to IBED PHTS supports in CSR and in galleries.~~	
~~IV.AD~~	~~Combination IV.WH + IV.T2 = SL-2 + WH Cat. II, III, or IV~~	~~1~~	~~4.8 → 8.2 → 4.8 MPa 70 °C~~	~~1.36 → 6.0 → 1.36 MPa 141 °C~~	~~SL-2 is cumulated to bounding case IV.WH.~~ ~~Note that this covers any combination of category II / III / IV water hammer events with SL-2.~~	

SUPPLY

	Loading Conditions	Cycles	IBED PHTS Main Pumps Discharge	IBED PHTS Main Pumps Suction	Comment	Main pump is in operation in the loading case?
Service Level A						
U.S1	Storage Env. Conditions	-	OUTDOORS Environmental pressure: atmospheric Environmental temperature: [-25, 45] °C Environmental air humidity: 30 g/kg (=> 100% at 32 °C and 50% at 45 °C) Extreme winds up to 166 km/hr Maximum mass of snow: 150 daN/m2 INDOORS Environmental pressure: atmospheric Environmental temperature: [-8, 45] °C Environmental air humidity: 30 g/kg (=> 100% at 32 °C and 50% at 45 °C)			
U.T1	Hydrostatic Pressure Test	10	0.1 → 10.8 → 0.1 MPa [5, 45] °C	0.1 → 7.9 → 0.1 MPa [5, 45] °C		
U.T2	Containment Leak-Tightness Test	10	Environmental pressure: [95, 200] kPa Environmental temperature: [18, 35] °C Environmental air humidity: [0, 60] %			

Appendix D – Installation Data and Drawings

Installation Data					
	Installation Area	Length [mm]	Width [mm]	Height [mm]	Weight [kg]
Complete Skid	Building 11-Level 3 - Zone 03E	6750	2600	2600	30000
Pump Skid*	Building 11-Level 3 - Zone 03E	2450**	2600	2250	
Motor Skid	Building 11-Level 3 - Zone 05 behind Shielding	3200**	2600	2180	
Seal Flushing Support Systems	Building 11 – Level 4 – Zone 04 (on steel platform) and/or Building 11 – Level 3 – Zone 02S***	3000 5000	2500 3500	3000 3000	TBC TBC
Electrical and Control Cabinets	Building 11 – Level 4 – Zone 01S (6 Cabinets) and Building 11 – Roof 1 – Zone 01E (2 Cabinets) For Available footprint refer to Specification [d2]				
*Suction and discharge flanges positions shall be respected as much as reasonably possible. **Dimensions that consider shaft length up to coupling hub. ***Zone exposed to higher environmental radiation compared to L4 – 04, refer to *Appendix A – IBED PHTS* Main Pump Datasheet.					

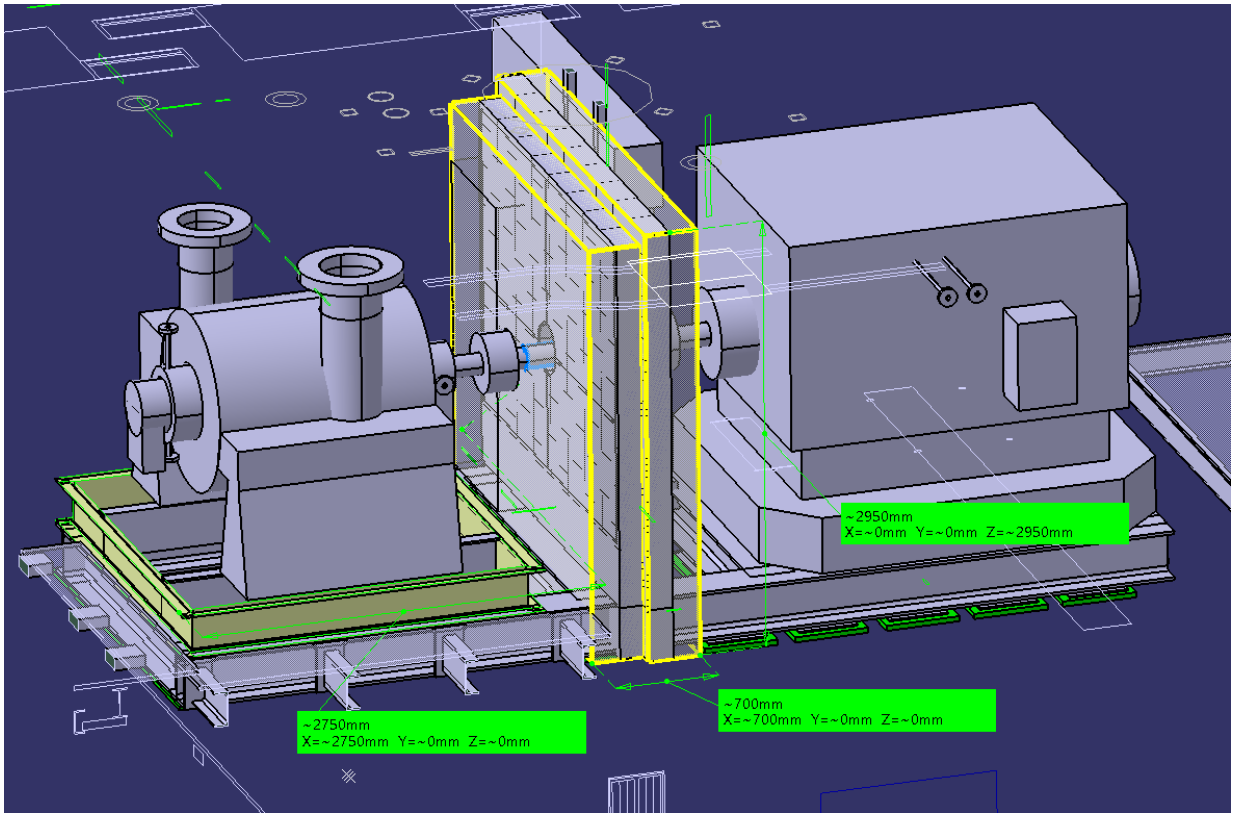


Figure D.1

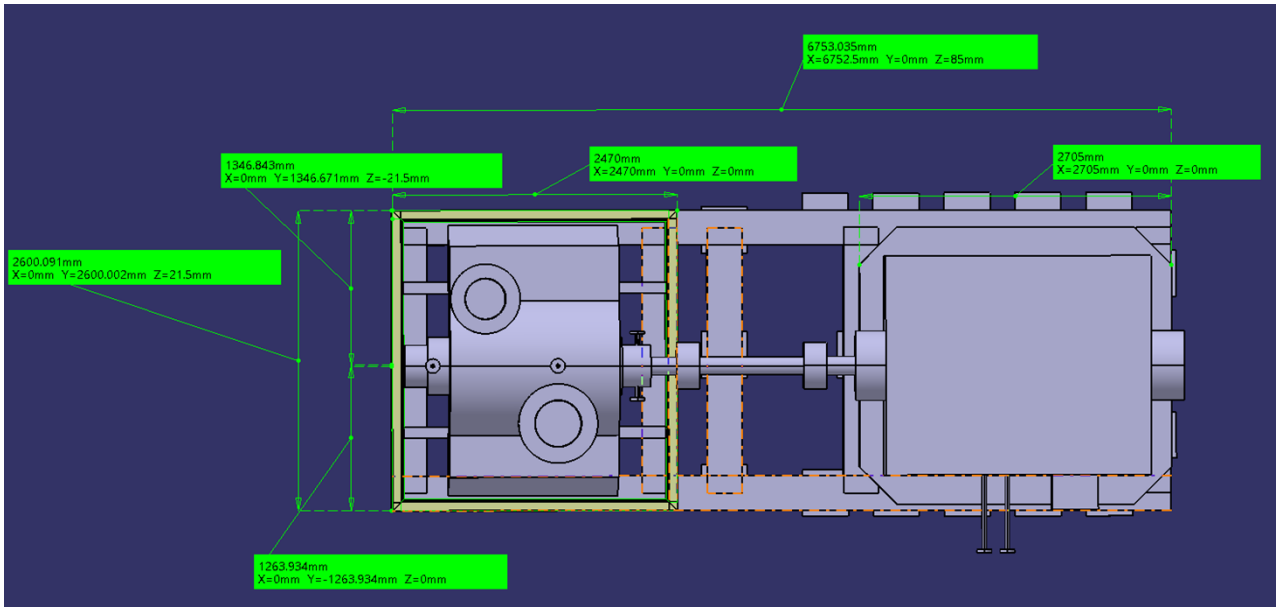


Figure D.2

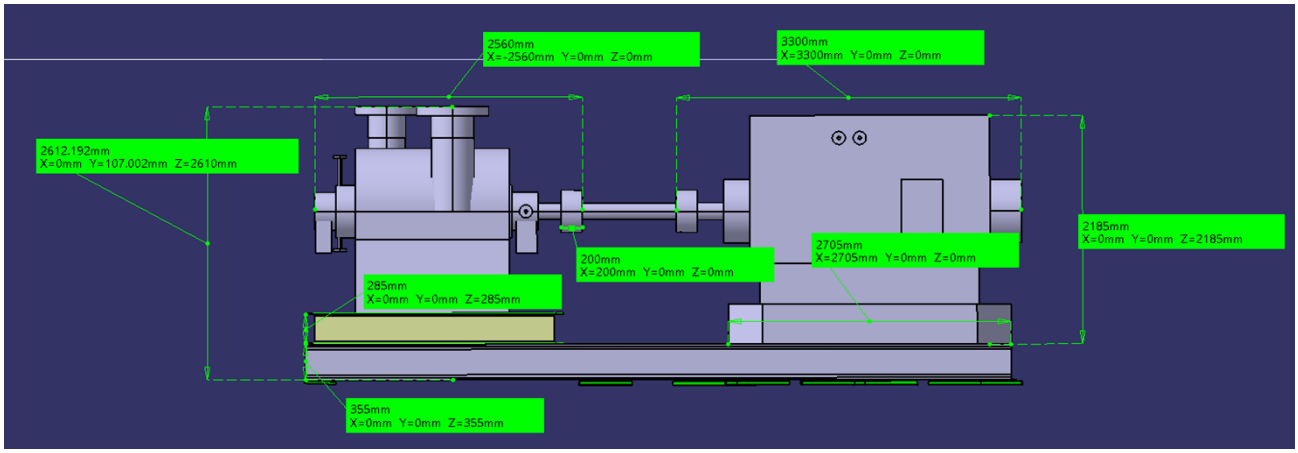


Figure D.3

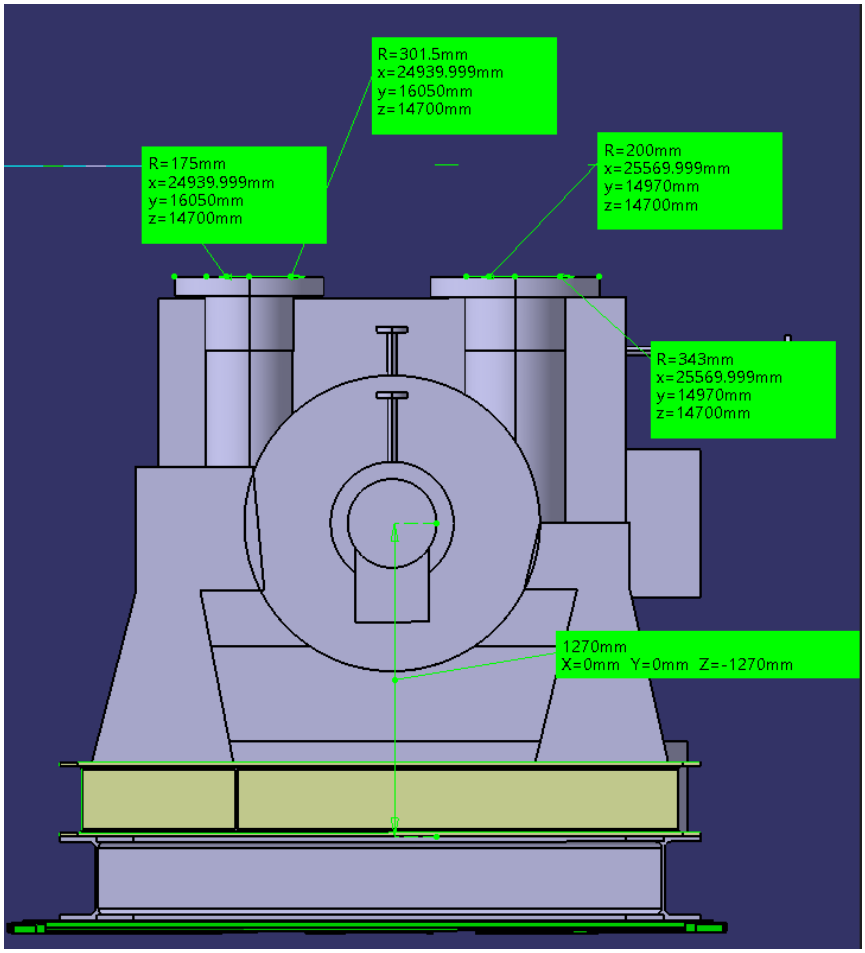


Figure D.4

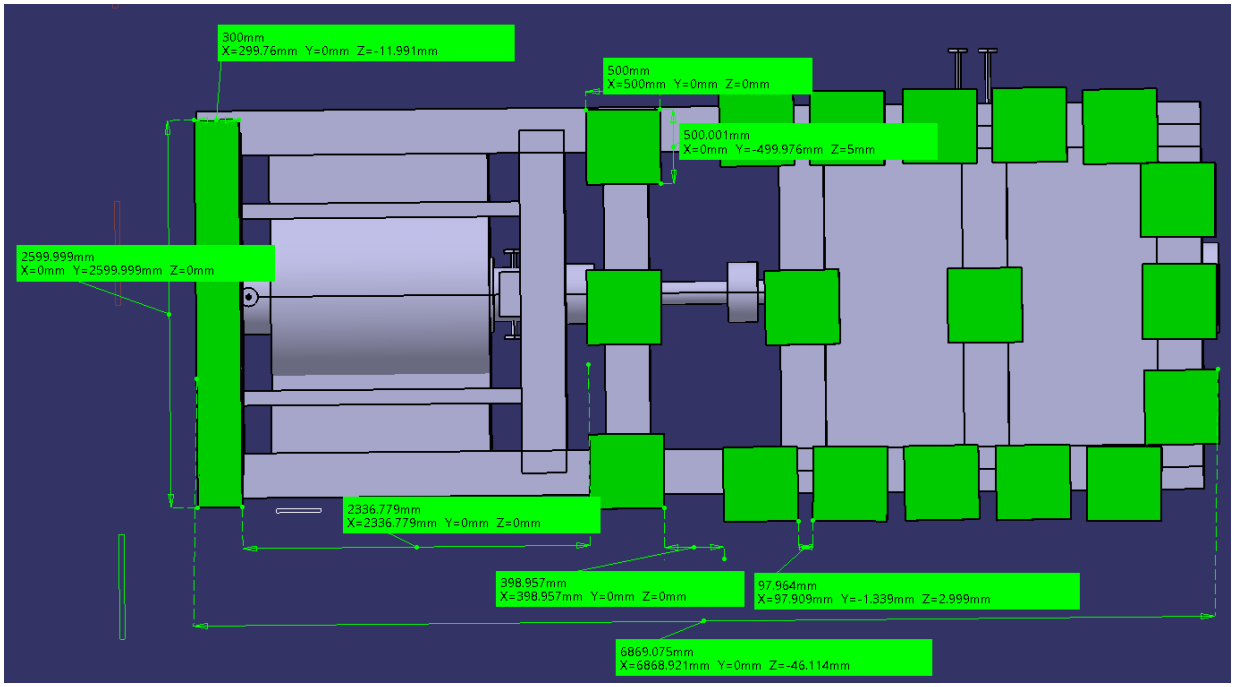


Figure D.5

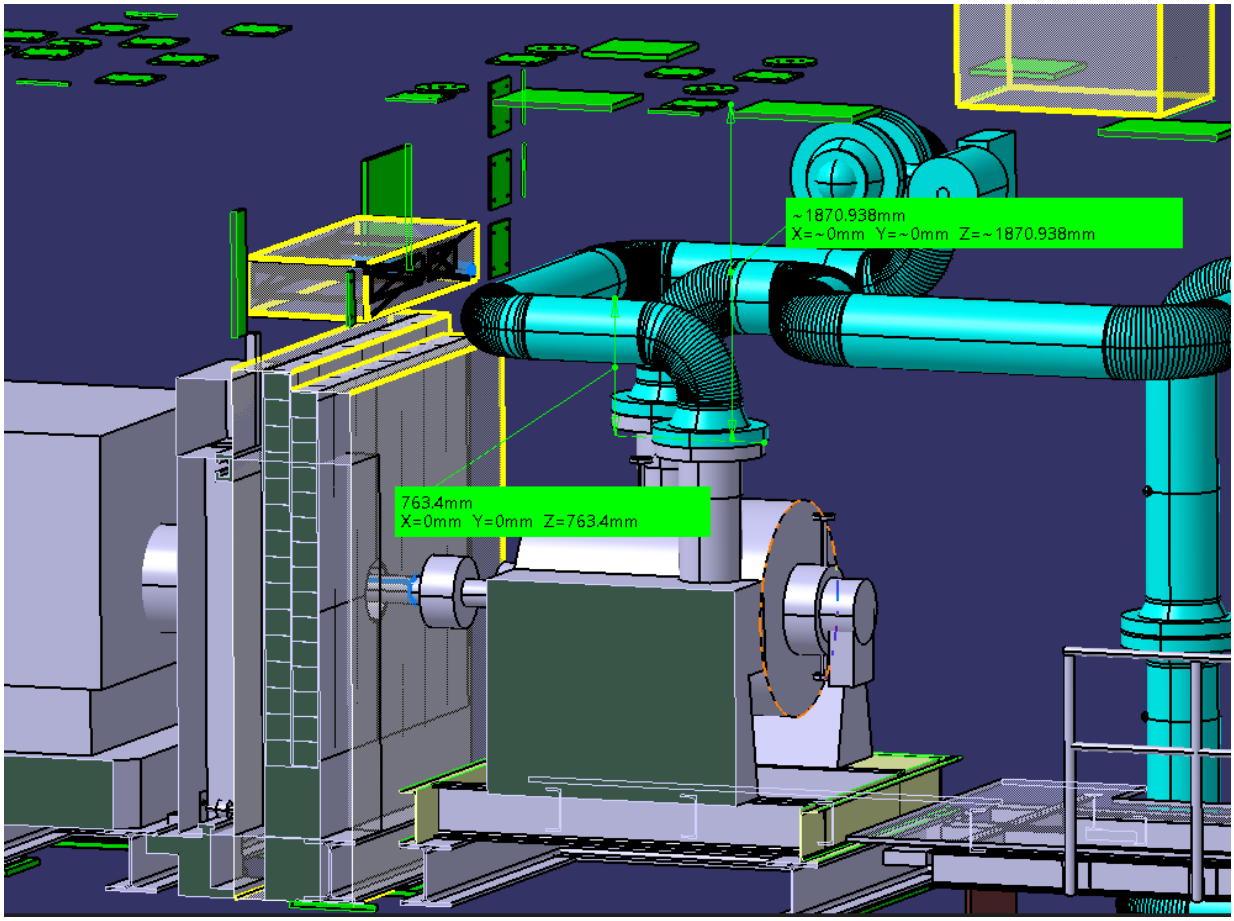


Figure D.5

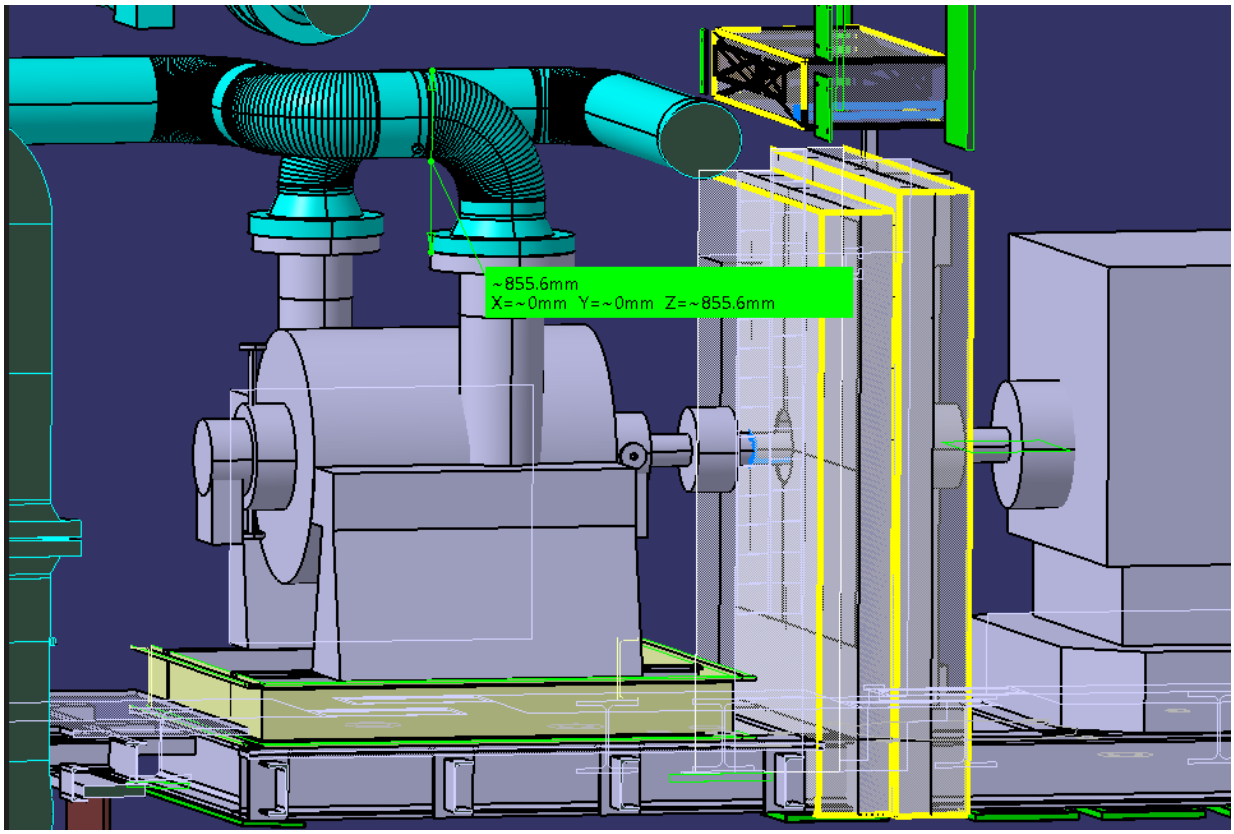


Figure D.6

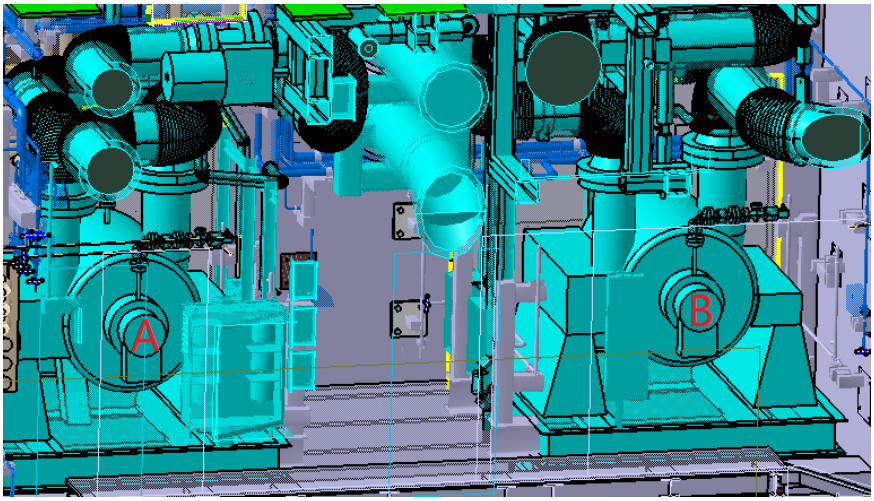


Figure D.7

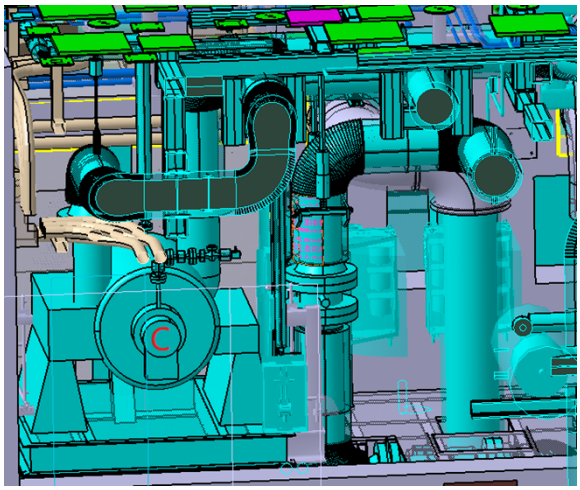


Figure D.8

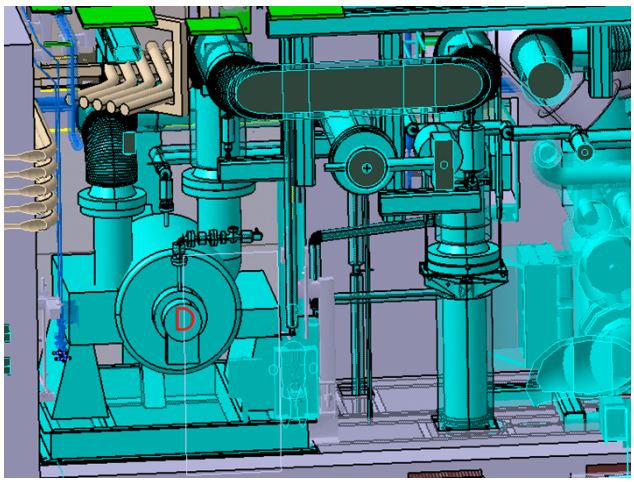


Figure D.9

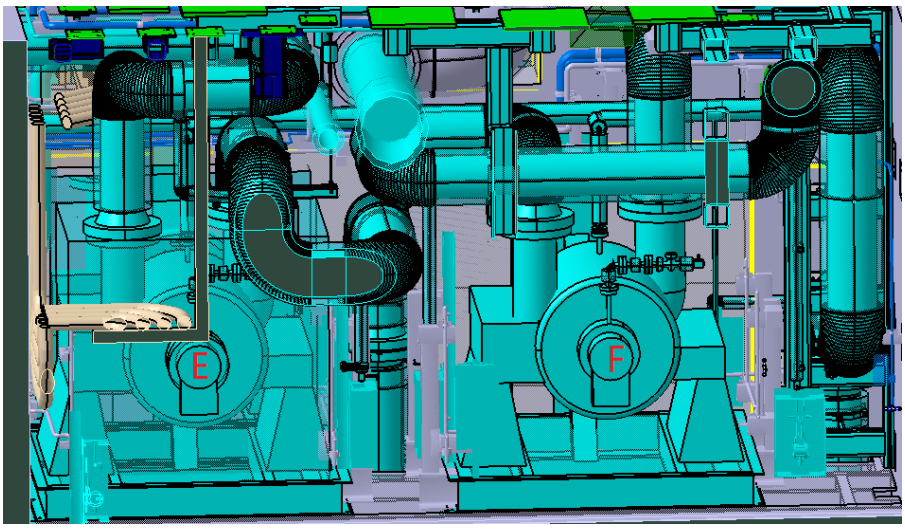


Figure D.10

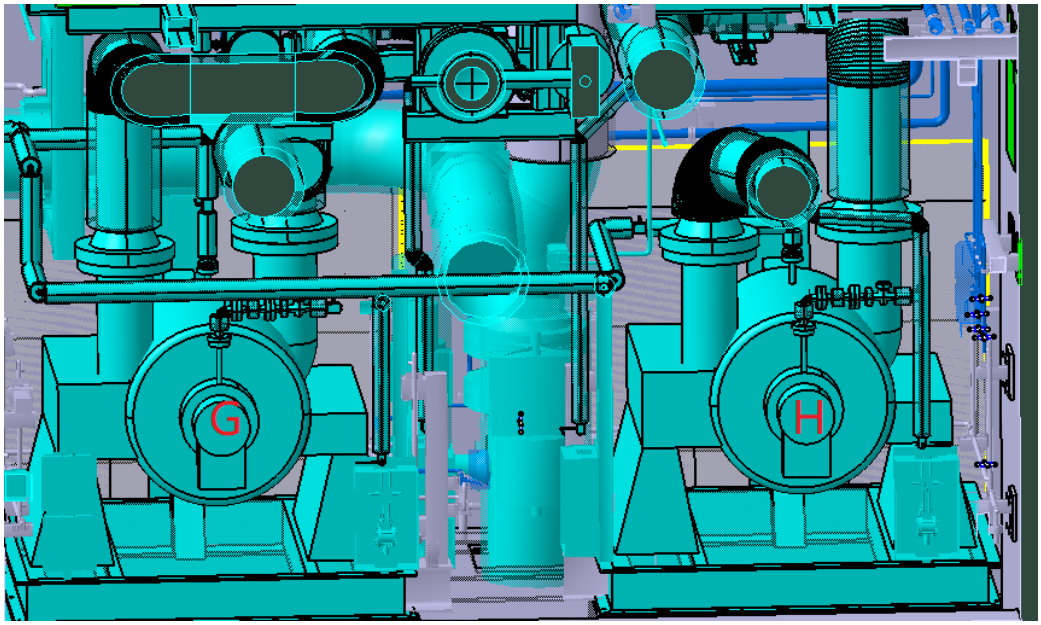


Figure D.11

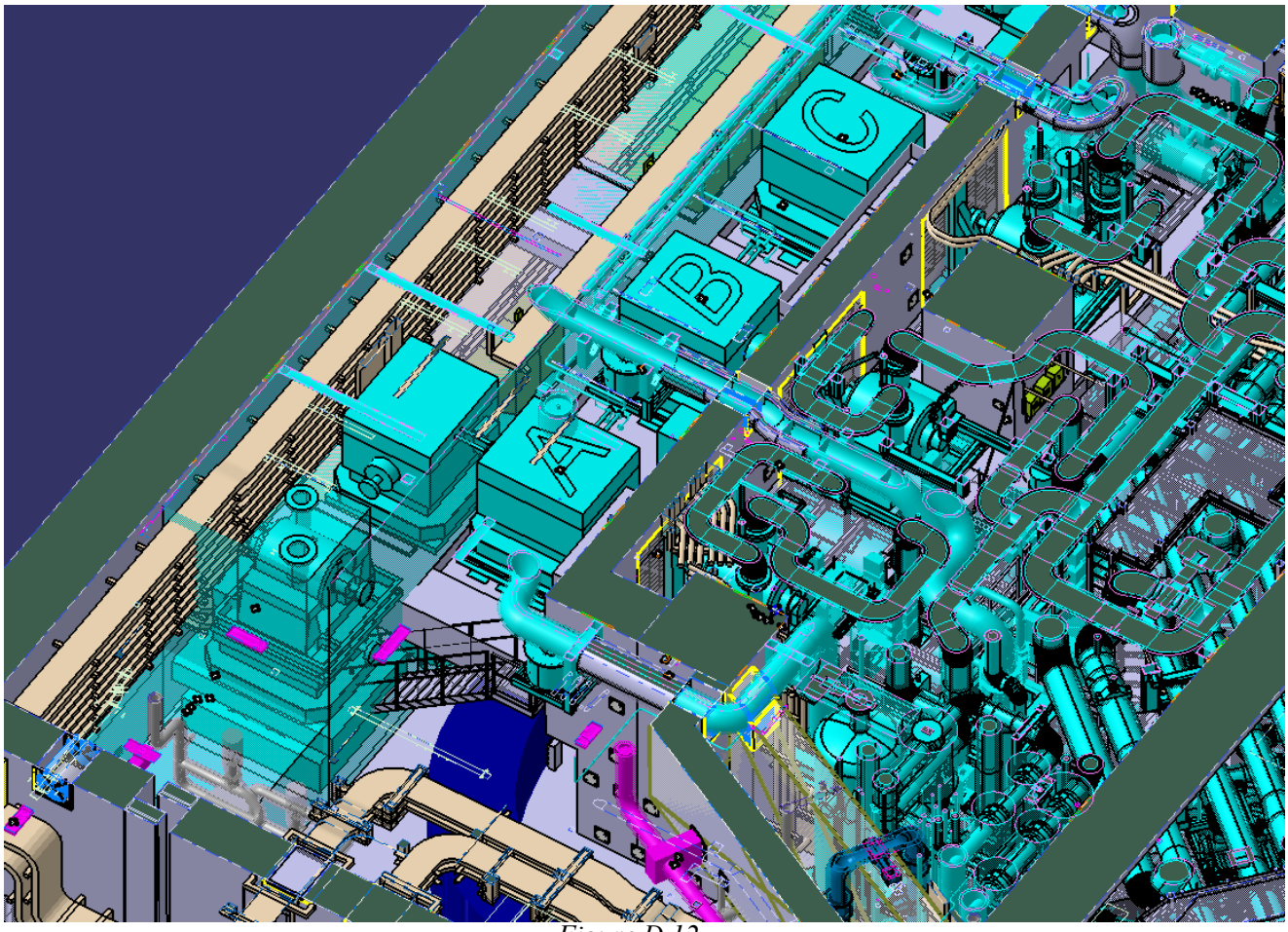


Figure D.12

Appendix E – Seismic Loads

The seismic events applicable to be considered in this scope of supply ITER plant are (see reference [d62]):

a. SL-2 earthquake

Design Response Spectra (DRS) which is defined by two spectra: SMS and PALEO spectra. Earthquake producing maximal vibratory ground movement, during which certain systems, structures and components are designed to remain functional. This is referred to in IEC/IEEE 60980-344 [s46] as Safe Shutdown Earthquake (SSE) or S2 Level.
According to IAEA recommendations, for Safety Importance Class (SIC) components and nuclear buildings (SC-1 or SC-2), the SL-2 seismic load is referred to a return period of about 10000 years (for Paleo earthquake) and the associated earthquake is classified as an "extremely unlikely" event.

b. SMHV earthquake

Séismes Maximaux Historiquement Vraisemblables (Maximum Historically Probable Earthquakes) is the most penalizing earthquakes liable to occur over a period of about 1000 years.
The SMVH earthquake can be considered equal 0.73 of SL-2 (refer to [d7]).

c. SL-1 earthquake

Earthquake which could affect the location during the operating life of the equipment to be qualified. For this type of earthquake, components shall be designed to continue to operate without modification. SL-1 event shall be assumed to occur a maximum number of 5 times. This is referred to in IEC/IEEE 60980-344 as Operating Basis Earthquakes (OBE) or S1 level

SL-1 event corresponds to an event with a probability in the order of 1/100 per year and represents an investment protection earthquake level. The infrastructure/component (nuclear and non-nuclear) must be designed to restart and operate after an SL-1 event without special maintenance or check.

The SL-1 spectrum can be assumed equal to 0.34 of SL-2 spectrum in the structure (refer to [d7]).

d. FRS for IBED PHTS Main Pumps

The Floor Response Spectra here below (IBED Mezzanine FRS) represent the SL-2 FRS in the installation area of Main Skids. Damping value considered for mechanical skids in ITER standards for SL-2 is 3% as per [r4].
Damping to be considered for SL-1 Seismic Event is equal to 2%.
Damping to be considered for SMHV Seismic Event is equal to 3%.

Contractor to check and validate the damping factor to be applied.

Full FRS set of data for main skid installation area at different damping ratios is given in [d61].

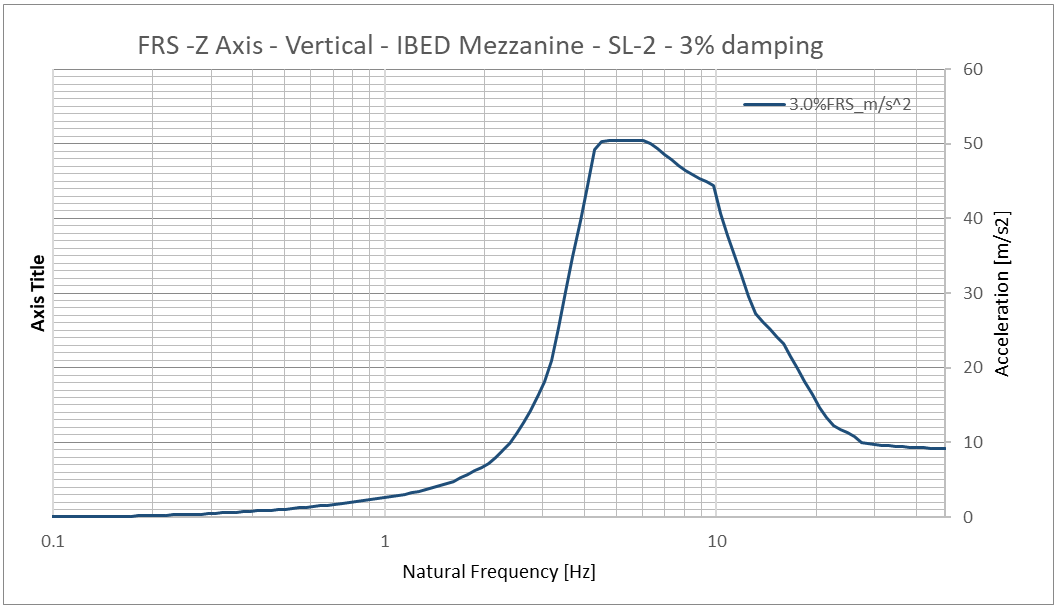
e. FRS for Other Equipment included in the scope

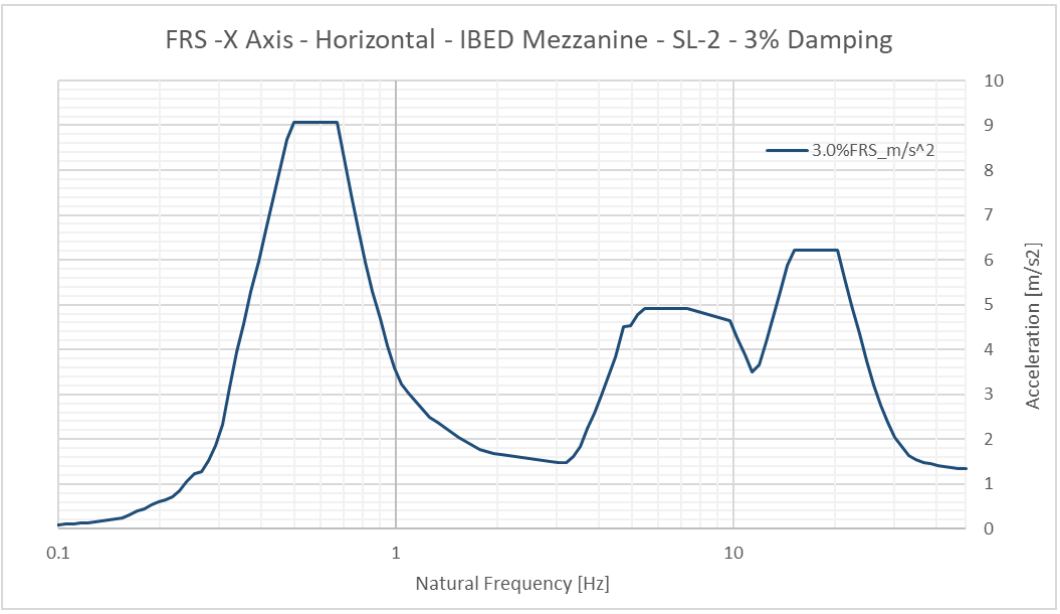
Two possible installations areas have been identified for remotely installed seal support systems (refer to *Appendix D – Installation Data and Drawings*):

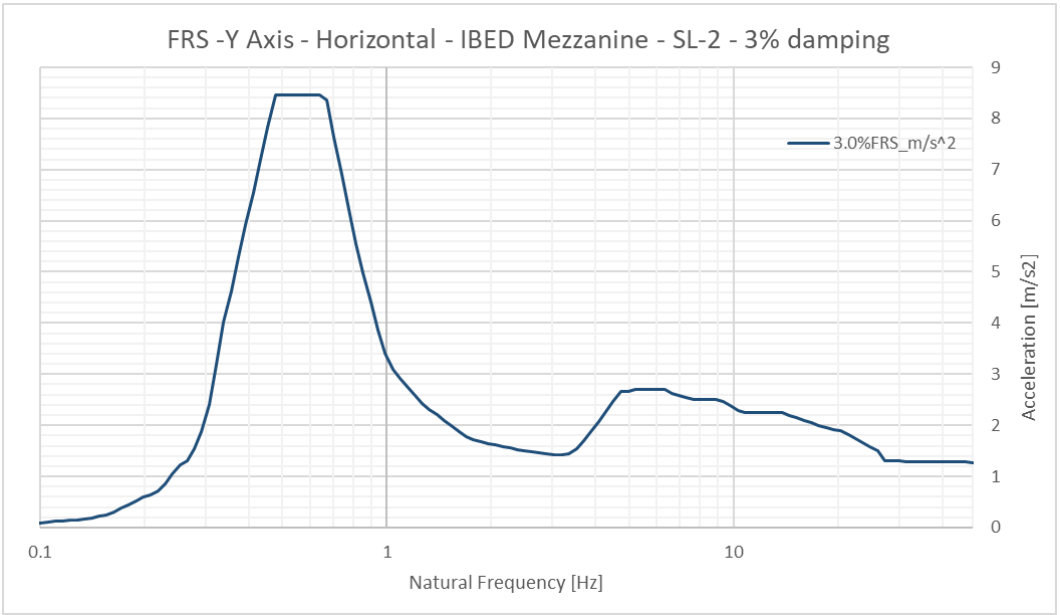
- B11-L4-04 (steel platform): Preliminary SL-2 FRS are given in [d74], final FRS will be shared to Contractor during detailed engineering phase.
- B11-L3-02E: SL-2 FRS are given in [d75].

Same consideration of main pump supply applies for damping factor and SL-1/SMHV earthquake.

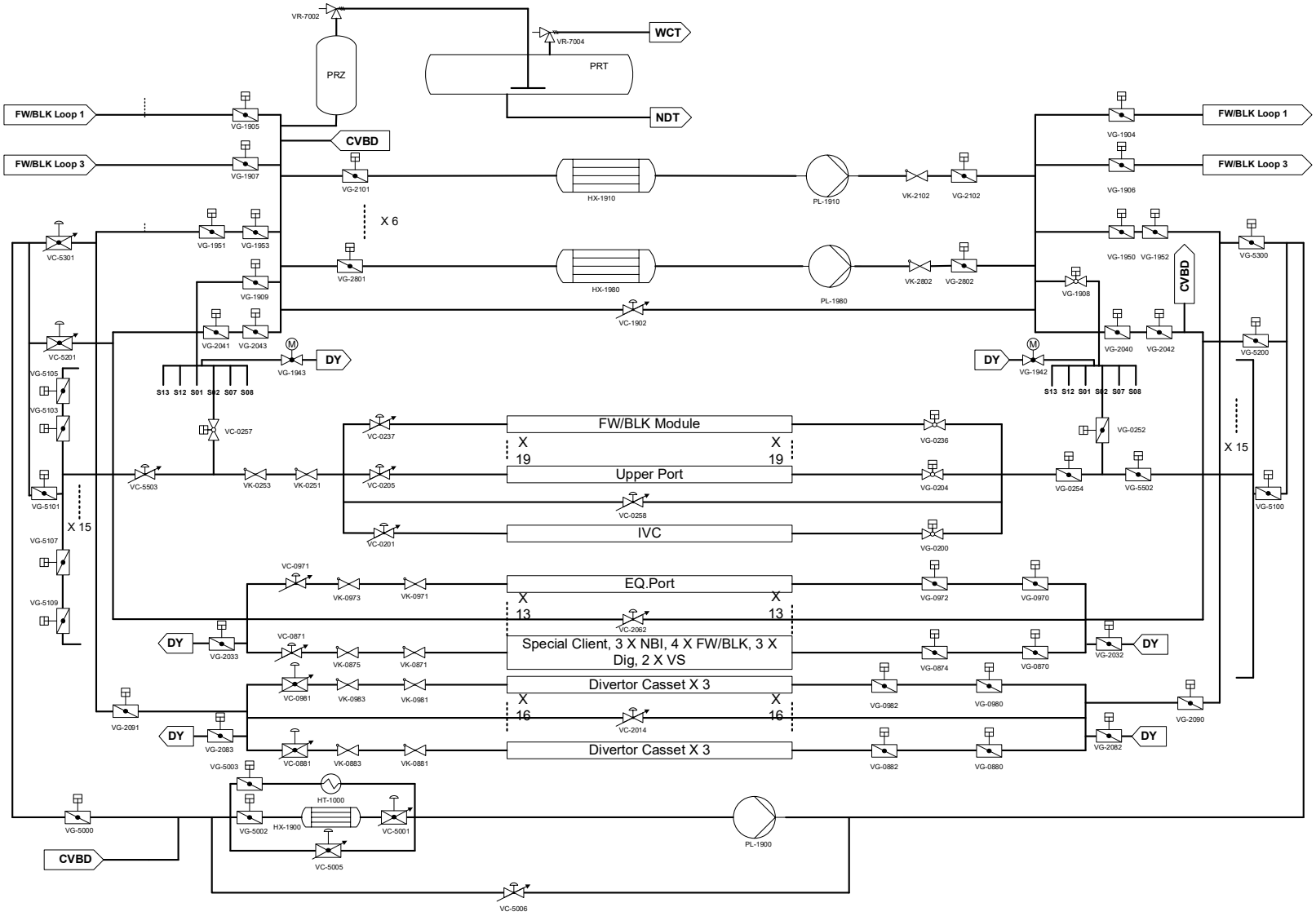
For seismic loads on Electrical and Control Panels, refer to [d2].


FRS -Z Axis - Vertical - IBED Mezzanine - SL-2 - 3% damping
3.0%FRS_m/s^2
Axis Title
Acceleration [m/s2]
Natural Frequency [Hz]
0.1
1
10
0
10
20
30
40
50
60

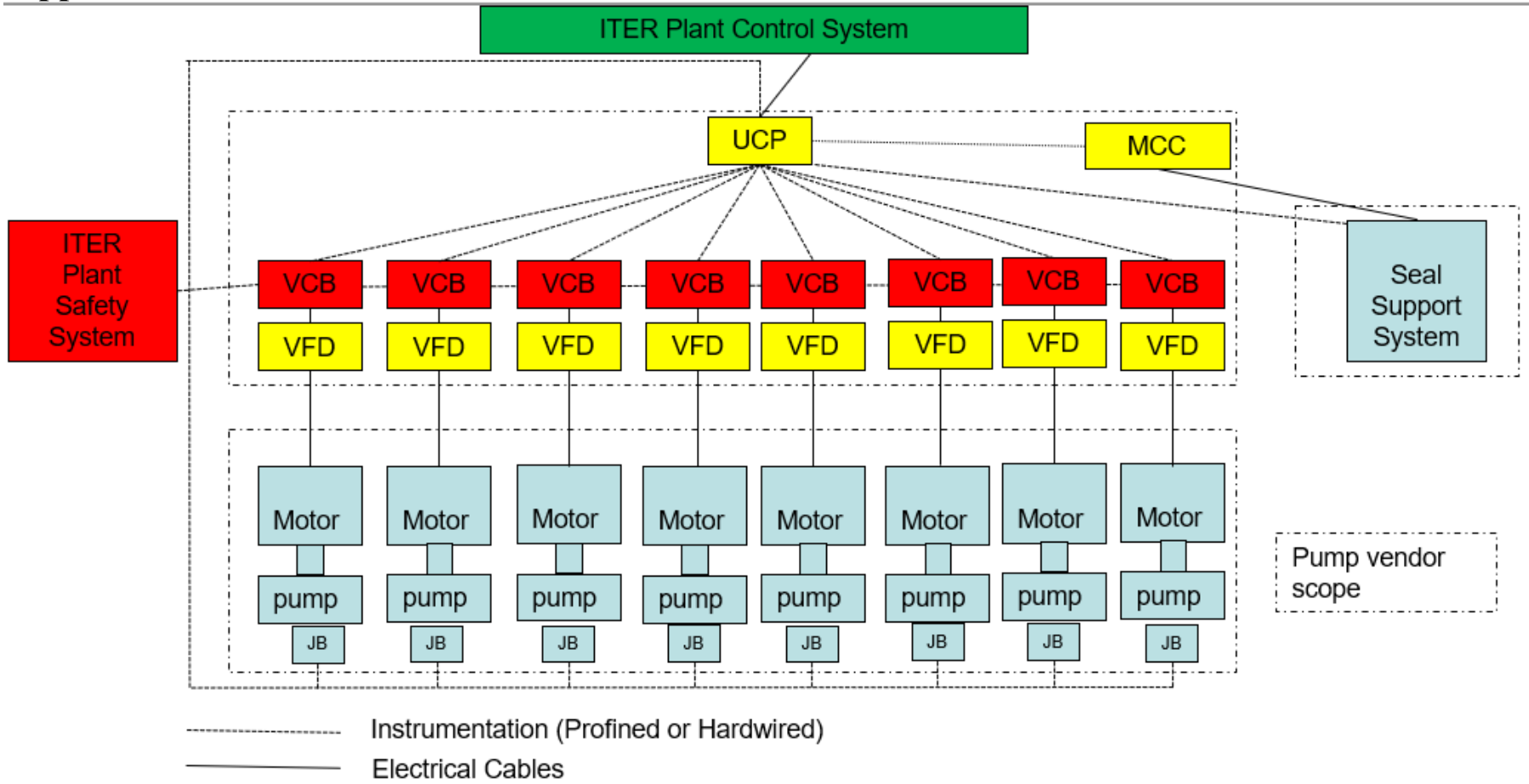

FRS -X Axis - Horizontal - IBED Mezzanine - SL-2 - 3% Damping
3.0%FRS_m/s^2
Acceleration [m/s2]
Natural Frequency [Hz]
0.1
1
10
0
1
2
3
4
5
6
7
8
9
10


FRS -Y Axis - Horizontal - IBED Mezzanine - SL-2 - 3% damping
3.0%FRS_m/s^2
Acceleration [m/s2]
Natural Frequency [Hz]
0.1
1
10
0
1
2
3
4
5
6
7
8
9

Appendix F – Simplified IBED PHTS PFD



Appendix G – Control Architecture



(1) MV Electrical Power Feed to be provided to VCBs
(2) VCBs are SIC classified to allow machine trip with a signal from ITER Safety System
(2) LV electrical line to be provided to MCC. MCC to be istalled in the same area of VFD/VBC/UCP
(3) Each pump and VFD has to be provided with a Local Control Panel
(4) Due to level of radiation on pump area, Electronic shall be remotely installed in VFD/VBC/UCP area
(5) UCP final architecture to be agreed. A common control unit for the 8 pumps is the preferred solution. Common UCP shal have redundant architecture installed in the same cubicle.

Nominating Domestic Agency:

COMPANY NAME	WEB SITE link	POSTAL ADDRESS	POST CODE	CITY	COUNTRY	CONTACT PERSON	PHONE	E-MAIL	ARIBA SUPPLIER ID	COMPANY INFORMATION (if any)