Title	**GeM Bid No. GEM/2026/B/7687092 for Manufacturing, assembly and supply of Temporary First Wall panels for ITER**
Sub Title	**Part-A(II) - Technical Specification** **ITER Document no.: IDM UID EASURR_v2_3**

Additional technical documents i.e Applicable Documents, Engineering drawings, 3D CAD, Reference Documents are to be downloaded from ITER-India Website

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Preamble and General Instruction about the Scope

The present tender is aimed for procurement of Temporary First Wall panels for ITER and the overall scope includes 'Manufacturing, assembly and supply of Temporary First Wall panels for ITER'

The 'Procurement Technical Specification for the Temporary First Wall' (EASURR) (provided in subsequent pages) describes the complete scope and technical details of Temporary First Wall of ITER under this tender.

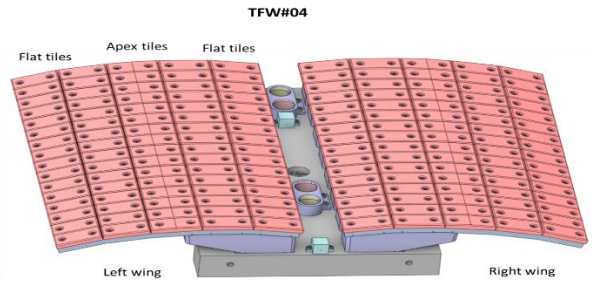
As mentioned in the 'Procurement Technical Specification for the Temporary First Wall' (EASURR), the complete scope is divided into following lots:

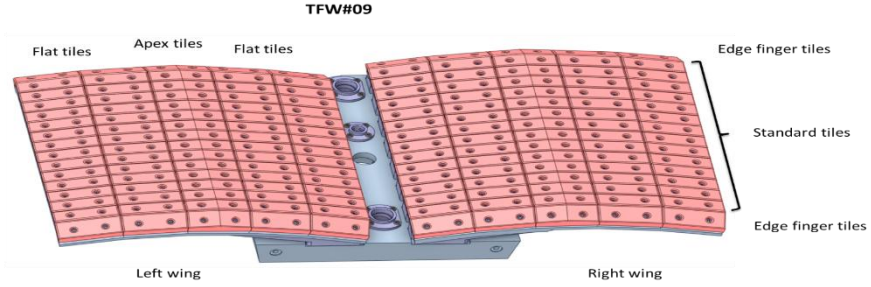
Lot 1 (Firm Scope)	Full scope of manufacturing, assembly and delivery of TFW rows 3, 4, 7 to 9, 18 (126 panels - tungsten) + row 6 (18 panels - tungsten heavy alloy)
Lot 2 (Firm Scope)	Full scope of manufacturing, assembly and delivery of TFW rows 1, 2, 5, 10 to 17 (293 panels - tungsten coating / cladding)
Lot 3 (Optional)	Pad assemblies and Electrical Strap assemblies (Technical Specification section 5.2.2 ; 5.2.3 and Appendix A1)

For the ease of understanding, tables of BOQ (for major components, except fasteners) is prepared (extracted from the EASURR and **[AD2]** *List of variants for the TFW assemblies* ITER_D_CYAHU7 v1.4) as below. The qty for the fasteners are to be taken form respective drawings.

Lot 1 (Firm Scope): Full scope of manufacturing, assembly and delivery of TFW rows 3, 4, 7 to 9, 18 (126 panels - tungsten) + row 6 (18 panels - tungsten heavy alloy)

Examples of Lot-1 Panels:

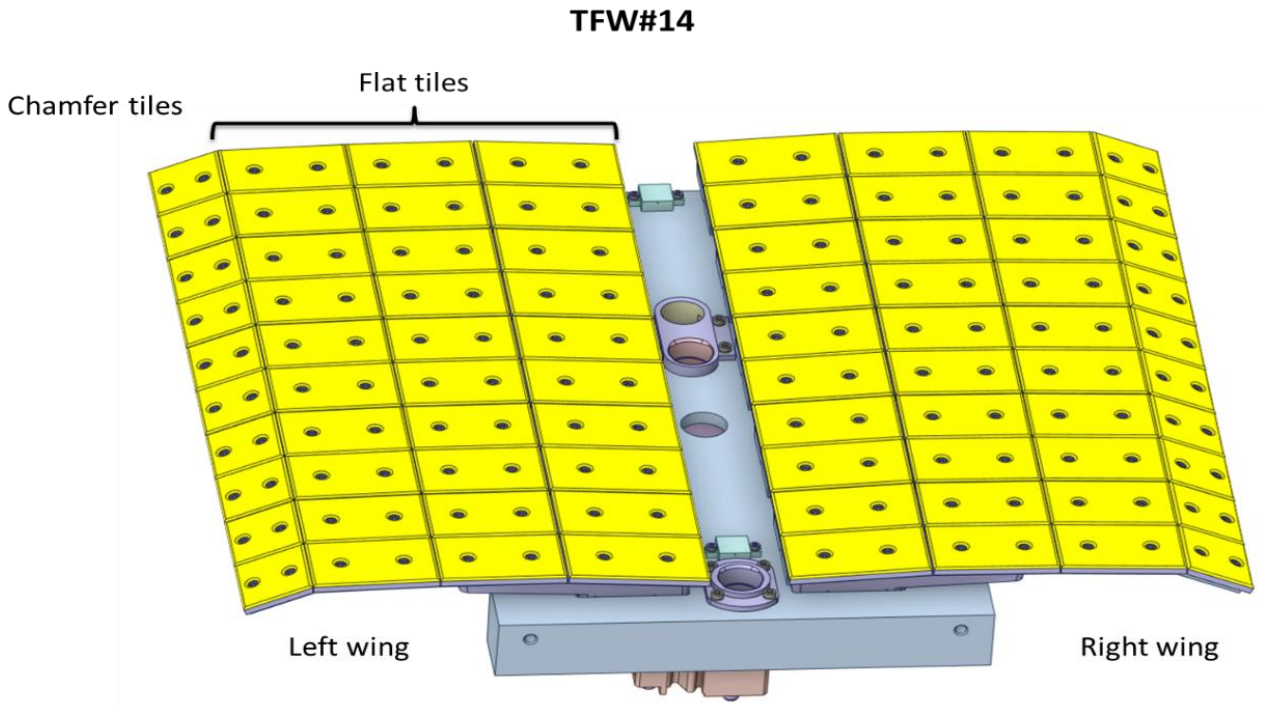




Examples of Lot-2 Panels:

Qty and Size of tiles:
Table 3 shows the quantity of the Tiles to be coated / cladded with Tungsten. It may be noted that quantity and sizes defined are to be re-verified by bidder based on the Procurement Technical specification (EASURR_v2_3) Preliminary_TFW_tile_and_finger_bill_of__EZGQWQ_v1_4 and List of variants for the TFW assemblies (ITER_D_CYAHU7) *of variants for the TFW assemblies.* The same shall be confirmed as a part of technical proposal by the bidder. Should there be any difference in the quantity / size, the same shall be brought to the notice of the purchaser at the time of pre-bid.

Example of a Temporary First Wall Panels with Cladding / coating (Lot 2 Scope)



Clarification about the coating / cladding:
It is the responsibility of the bidder to identify the process of coating / cladding of Tungsten over the SS tiles as required according to the technical specification. Some of the acceptable coating / cladding processes, which may be considered are Plasma Spray, PVD, Cold spray, Diffusion bonding or Hot Isostatic Pressing (HIP). It is bidder's responsibility to explore the suitable processes (considering the functional qualification requirements as per APPENDIX A2 – FUNCTIONAL SPECIFICATION ON TUNGSTEN CLADDING AND HIGH HEAT FLUX TESTING. While bidder is free to choose the High Heat Flux Testing Facility that is available at various locations in the world, ITER India / IPR may also provide the access to their own facility on chargeable basis. The rates for the same may be provided upon request. The final selection of the coating / cladding process shall be after successful qualification of the prototype according to the technical specifications.

Clarification about the scope related to Pad assemblies and Electrical Strap assemblies:
It may be noted that the Pad assemblies and Electrical Strap assemblies are asked as 'optional' scope from IO. This means, bidder shall provide the technical compliance and commercial offer as per price bid format. It will be the prerogative of IO whether or not manufacturing of these components (Pad

assemblies and Electrical Strap assemblies) is to be realised through the selected bidder. In case, IO chooses not to take the supply of these components from the bidder, the same shall be provided to the bidder as 'Free Issue Items' by IO. However, the assembly of these components shall be still remain under the scope of the bidder.

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Total requirement of Coating / cladding of W over SS

		Apex Tiles				Toroidal Chamfer Tiles				Inner Flat Tiles				Outer Flat Tiles			
Row No.	**Material**	**Apex tile length [mm]**	**tile pol height [mm]**	**Tile Thickness [mm]**	**Qty apex tiles**	**chamfer tile length [mm]**	**tile pol height [mm]**	**Tile Thickness [mm]**	**Qty tor chamfer tiles**	**inner tile length [mm]**	**tile pol height [mm]**	**Tile Thickness [mm]**	**Qty inner tiles**	**outer tile length [mm]**	**tile pol height [mm]**	**Tile Thickness [mm]**	**Qty outer tiles**
01-02	W cladding over SS	130	**60**	12	1152					128	60	12	2304	122	60	12	2304
05	W cladding over SS	130	60	12	576					128	60	12	1152	122	60	12	1152
10	W cladding over SS	130	60	12	540					154	60	12	1080	160	60	12	1080
10	W cladding over SS	130	75	12	18					154	75	12	36	160	75	12	36
10	W cladding over SS	130	75	12	18					154	75	12	36	160	75	12	36
11	W cladding over SS	124	60	12	648					142	60	12	648	120	60	12	1296
11	W cladding over SS	124	60	12	448					142	60	12	448	120	60	12	896
11	W cladding over SS	124	78	12	80					142	78	12	80	120	78	12	160
12	W cladding over SS	130	84	12	720					170	84	12	720	138	84	12	1440
13	W cladding over SS	0	82	12	480					125	82	12	960	120	82	12	1440
13	W cladding over SS	0	90	12	240					125	90	12	480	120	90	12	720
15	W cladding over SS	0	100	12	10	80	100	12	10	170	100	12	10	155	100	12	20
15	W cladding over SS	0	100	12	10	80	100	12	10	170	100	12	10	155	100	12	20
15	W cladding over SS	0	100	12	200	80	100	12	200	180	100	12	200	165	100	12	400
15	W cladding over SS	0	100	12	10	80	100	12	10	180	100	12	10	165	100	12	20
15	W cladding over SS	0	100	12	60	80	100	12	60	180	100	12	60	165	100	12	120
14	W cladding over SS	0	100	12	260	80	100	12	260	180	100	12	260	160	100	12	520
14	W cladding over SS	0	100	12	10	80	100	12	10	180	100	12	10	160	100	12	20
14	W cladding over SS	0	100	12	10	80	100	12	10	172	100	12	10	155	100	12	20
14	W cladding over SS	0	100	12	10	80	100	12	10	172	100	12	10	160	100	12	20
14	W cladding over SS	0	100	12	10					185	100	12	10	120	100	12	30
15	W cladding over SS	0	100	12	10					185	100	12	10	120	100	12	30
14	W cladding over SS	0	110	12	8					190	110	12	8	125	110	12	24
14	W cladding over SS	0	110	12	16					190	110	12	16	125	110	12	48
14	W cladding over SS	0	100	12	10					180	100	12	10	128	100	12	30
14	W cladding over SS	130	100	12	20					140	100	12	20	165	100	12	40
14	W cladding over SS	130	110	12	8	80	110	12	8	165	110	12	8	178	110	12	16
14	W cladding over SS	0	100	12	10	80	100	12	10	170	100	12	40	0	100	12	0
14	W cladding over SS	130	110	12	16					172	110	12	16	130	110	12	48
14	W cladding over SS	0	100	12	20					120	100	12	40	155	100	12	60
15	W cladding over SS	120	100	12	10	80	100	12	10	190	100	12	10	125	100	12	40
15	W cladding over SS	160	100	12	10	80	100	12	10	150	100	12	10	150	100	12	30
15	W cladding over SS	120	100	12	10	80	100	12	10	175	100	12	10	155	100	12	30

15	W cladding over SS	0	100	12	10					125	100	12	20	120	100	12	40
15	W cladding over SS	0	100	12	20					150	100	12	100	0	100	12	0
14	W cladding over SS	0	100	12	10					130	100	12	20	162	100	12	30
14	W cladding over SS	0	100	12	10					154	100	12	50	0	100	12	0
15	W cladding over SS	0	100	12	10	80	100	12	10	125	100	12	20	155	100	12	30
15	W cladding over SS	160	100	12	10	80	100	12	10	175	100	12	10	165	100	12	30
16	W cladding over SS	0	95	12	380					125	95	12	760	120	95	12	1140
16	W cladding over SS	0	100	12	40					125	100	12	80	120	100	12	120
16	W cladding over SS	0	100	12	240					125	100	12	480	120	100	12	720
16	W cladding over SS	0	95	12	60					125	95	12	120	120	95	12	180
17	W cladding over SS	0	100	12	720					125	100	12	1440	155	100	12	1440
TOTAL					**7168**				**648**				**11832**				**15876**
Spare	W cladding over SS	0	0	0	0	80	105	12.00	82	180	105	12	432	0	0	0	0
TOTAL spares					0				82				**432**				0

Summary	Qty (Nos.)
W cladding over SS	35524
Spares	514
Grand Total	**36038**

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Table-3: Total Qty (Nos.) requirement of W and WHA Tiles for TFW project

		Apex Tiles				Inner Flat Tiles				Outer Flat Tiles			
Row No.	**Material**	**Apex tile length [mm]**	**tile pol height [mm]**	**Tile Thickness [mm]**	**Qty apex tiles**	**inner tile length [mm]**	**tile pol height [mm]**	**Tile Thickness [mm]**	**Qty inner tiles**	**outer tile length [mm]**	**tile pol height [mm]**	**Tile Thickness [mm]**	**Qty outer tiles**
03-04	Tungsten	130	**60**	15	32	128	60	15	64	122	60	15	64
03-04	Tungsten	**130**	60	15	96	128	60	15	192	122	60	15	192
03-04	Tungsten	130	60	15	896	128	60	15	1792	122	60	15	1792
03-04	Tungsten	130	60	15	32	128	60	15	64	122	60	15	64
03-04	Tungsten	130	60	15	96	128	60	15	192	122	60	15	192
06	**WHA**	135	60	12	504	128	60	12	1008	122	60	12	1008
06	**WHA**	135	64	12	36	128	64	12	72	122	64	12	72
06	**WHA**	135	64	12	36	128	64	12	72	122	64	12	72
07	Tungsten	130	52	20	36	120	52	20	72	135	52	20	72.00
07	Tungsten	130	52	20	36	120	52	20	72	135	52	20	72.00
07	Tungsten	130	55	20	198	120	55	20	396	138	55	20	396
07	Tungsten	130	50	20	234	120	50	20	468	138	50	20	468
07	Tungsten	130	60	20	18	120	60	20	36	135	60	20	36.00
07	Tungsten	130	60	20	18	120	60	20	36	135	60	20	36.00
08	Tungsten	130	60	20	18	130	60	20	36	145	60	20	36.00
08	Tungsten	130	60	20	18	130	60	20	36	145	60	20	36.00
08	Tungsten	130	55	20	18	130	55	20	36	145	55	20	36.00
08	Tungsten	130	55	20	18	130	55	20	36	145	55	20	36.00
08	Tungsten	130	50	20	216	130	50	20	432	145	50	20	432
08	Tungsten	130	50	20	216	130	50	20	432	145	50	20	432
09	Tungsten	**160**	55	20	18	154	55	20	36	165	55	20	36.00
09	Tungsten	160	55	20	18	154	55	20	36	165	55	20	36.00
09	Tungsten	160	50	20	252	154	50	20	504	165	50	20	504
09	Tungsten	160	47	20	252	154	47	20	504	165	47	20	504
09	Tungsten	160	55	20	18	154	55	20	36	165	55	20	36.00
09	Tungsten	160	55	20	18	154	55	20	36	165	55	20	36.00
18	Tungsten	100	60	15	1320	140	60	15	1320	115	60	15	2640
18	Tungsten	100	60	15	228	140	60	15	228	115	60	15	456
18	Tungsten	100	54	15	36	140	54	15	36	130	54	15	**0.00**
TOTAL					**4932**				**8280**				**9792**
Spare	**Tungsten / WHA**	140	60	15	174	129	60	15	690	0	0	0	0
Spare	**Tungsten / WHA**	160	90	20	405	167	89	20	1611	0	0	0	0
TOTAL spares					579				**2301**				0

Summary	Qty (Nos.)

W	20124
WHA	2880
Spares	2880
Grand Total	**25884**

Clarifications on the Technical Specifications:

Sr. No.	Reference	Clarification	Remarks
1	Section 5 of Scope of Procurement Technical specification (EASURR_v2_3): [REQ-5] Design Replication	▪ Design replication shall be TFW assembly, including TFW panels and standard parts. The models are to be registered in ENOVIA Database. Below models are to be used for Design Replication for other rows. ▪ TFW04 will be used as an example for: - Minor variants of Row 03-04 - Row 01-02 with different Plasma Facing Material (PFC, W cladding than Bulk Tungsten), different tile thickness (12mm than 15mm), and different tile connection (Fixed than Flexible) - Row 05 with different PFC (W cladding than Bulk Tungsten) and different tile thickness (12mm than 15mm) - Row 06 with different PFC (Tungsten Heavy alloy than Bulk Tungsten) and different tile thickness (12mm than 15mm) - Row 18 ▪ TFW09 will be used as an example for Row 07-08-09. ▪ TFW14 will be used as an example for Row 10-17, including minor variants of TFW14.	
2	Fig 5-8 of Procurement Technical specification (EASURR_v2_3) : Total Quantity of Tiles	The quantities of tiles and fingers were provided through RD13 as a means to aide the tender in their cost estimations. The BoM should be developed from the Three Models of TFW#04, TFW#09 & TFW#14.	
3	Section 5.2.5 of Procurement Technical specification (EASURR_v2_3): Spare Parts	Tile blanks refer to semi-finished tiles, according to drawings (but with oversized poloidal and toroidal dimensions as per the List of variants for the TFW assemblies ITER_D_CYAHU7 v1.4 [AD2]) with bolt through holes and their chamfering, no chamfering on the tile edges.	
4	Section 5.5 of Procurement Technical specification (EASURR_v2_3): Manufacturing Design Requirements	One full scale finger per Lot per supplier. Lot 1 will be finger prototype with PFM of bulk W, and Lot 2 for finger prototype with W cladded tiles. The full scale finger shall include the finger support.	
5	Section 5.8 & 5.8 of Procurement Technical specification (EASURR_v2_3):Vacuum Requirements & Baking Requirements	▪ Baking requirements on steel components only (removal of hydrogen from SS), which shall be subject to higher temperature/longer duration before assembled to TFW. ▪ Bulk W or WHA Tiles are to baked at 350 C as a part of the TFW assembly according to [REQ-101 of EASURR v2.3] ▪ Baking of W Cladded/coated tiles are performed in two steps: 1. Before cladding baking is to be performed as for steel components. 2. After cladding/coating, Clad steel tiles, being steel, are subject to a high-temperature bake according to [REQ-47 of EASURR v2.3]. This shall be done after coating/cladding. ▪ No baking will be required on spare tiles nor raw material, while baking is required for spare bolt connection (including bolt/screw/washer/spacer...), baking details referring to [REQ-101 of EASURR v2.3]. ▪ Baking requirement for a complete panel assembly is mandatory at 240ºC for 24 hours.	
6	Appendix A2 of Procurement Technical specification (EASURR_v2_3): A2_2 Scope	▪ Cladded tiles must be HHF tested as a part of the cladding qualification, and can be done with the tile only (not needing to be attached to a finger). See [A2_REQ_6]. ▪ Then cladded tiles must be HHF tested during production according to [A2_REQ_5].	

		▪ At least 3 tiles mounted on each finger prototype must be HHF tested as a part of finger qualification to confirm the behaviour of the finger mechanical attachments under thermal loading. See [A2_REQ_7]. For lot 1, the selected tiles for HHFT should be Tungsten.	
7	Appendix A2 of Procurement Technical specification (EASURR_v2_3): Table A2_1 Microscopic Examination	▪ Exanimation of coupon is to check the phase formation and the thickness variation of phase and cladding at the cross-sectional view by SEM (sub-µm) and optical microscope (50 µm). ▪ The examination of coupon at top surface is foreseen by optical microscope. ▪ The examination of tiles at the edges and around bolt holes is foreseen by optical microscope.	
8	Appendix A2 of Procurement Technical specification (EASURR_v2_3): Table A2_1 Dimension Examination	▪ The thickness at coupon surface shall be measured at cross section by microscope. ▪ The thickness at tiles shall be measured after the HHF test at cross section, by microscope. ▪ During qualification, measurements shall capture the distribution within a tile and within a batch.	
9	078194 Assembly Drawing: Typo correction	BoM Lines 27 &28 : Material should be 254 SMO® instead of 304L	
10	Drawings: BKT_TFW_14_G8CP6B_v2 BKT_TFW_09_FRWJD7_v2 BKT_TFW_04_EM3PWK_v3	▪ BoM Table Standard of CYLINDER SCREW in drawings & 3D Model is DIN7991 instead of DIN6912 ▪ Chamfer on W cladded Tiles: A chamfer of min 0.5mm is acceptable instead of requirement of Radius of 3mm on W cladded times.	
11	Table 5.2 of Procurement Technical specification (EASURR_v2_3): Cladded Tiles	WHA can be used instead of W in W cladding tiles.	
12	Buffer Layer for W Cladding/Coating	It's acceptable to add interlayer (such as Ti, Cr, etc) for W cladding (including W coating). Regarding to Ta, the chemical composition shall be within 0.01 wt.% as specified in material sepcification of Tungsten (Bulk tungsten for TFW (DUDN9C v1.0)). Similar like Ta, for the interlayer the requirements for impurity elements, i.e. Co (<0.05wt%), Nb (<0.01wt%) shall be observed.	

IDM UID

EASURR

VERSION CREATED ON / VERSION / STATUS

04 May 2026 / 2.3 / Approved

EXTERNAL REFERENCE / VERSION

Technical Specifications (In-Cash Procurement)

Procurement Technical Specification for the Temporary First Wall

This procurement technical specification is based on the preliminary design of TFW

SUPPLY

SUPPLY

LIST OF FIGURES

SUPPLY

LIST OF TABLES

SUPPLY

1 PREAMBLE

This Technical Specification is to be read in combination with the **[AD1]** *General Management Specification for Service and Supply (GM3S)* that constitutes a full part of the technical requirements.

In case of conflict, the content of this Technical Specification supersedes the content of the *GM3S* **[AD1]**.

2 PURPOSE

This document defines the technical requirements for the procurement of Temporary First Wall (TFW) sub-system. The TFW sub-system is a part of the Blanket System which will be used during the Start of Research Operation (SRO) phase of the ITER machine to protect the Vacuum Vessel (VV) and other already-installed components against possible damage during the SRO phase.

This technical specification provides all technical requirements related to the scope of supply, code and standards, manufacturing requirements, and acceptance requirements.

Each technical requirement in this technical specification is formally identified, using an unambiguous tag. Each requirement paragraph starts with the string [REQ-N], where N is the requirement number. Each requirement related to the Appendix AX starts with a paragraph containing the string [AX_REQ-N]. Each informational paragraph starts with [I].

3 ACRONYMS

The following acronyms are the main ones relevant to this specification, see the complete list in the **[RD1]** *ITER Abbreviations*.

Abbreviation	Description
ASC	Anti-Seizing Coating
ASTM	American Society for Testing and Materials
COTS	Commercial Off-the-Shelf
DA	Domestic Agency
DCP	Dimensional Contral Plan
DIP	Dimensional Inspection Plan
EDM	Electric Discharge Machining
EIC	Electrical Insulation Coating
EN	European Standard
ES	Electrical Strap
FAT	Factory Acceptance Test
FBH	Flat Bottom Hole
FII	Free-Issued Items
GM3S	General Management Specification for Service and Supply
HHFT	High Heat Flux Test
ICRH	Ion Cyclotron Resonance Heating
IO	ITER Organization
ISO	International Standard Organization
MIP	Manufacturing and Inspection Plan
MRR	Manufacturing Readiness Review
PFM	Plasma Facing Materials
Qty	Quantity
SB	Shield Block
SDC-IC	Structural Design Criteria for ITER In-vessel Components
SRO	Start of Research Operation
SS	Stainless Steel
TA	Task Agreement
TFW	Temporary First Wall
UT	Ultrasonic Testing
VT	Visual Testing
VV	Vacuum Vessel
W	Tungsten
W-cladding	W-cladding (including W coating) on SS

4 REFERENCE DOCUMENTATION & CODES AND STANDARDS

The first three sections below include documents to which the procurement must comply, while the last section includes Reference Documents which exist to provide background information.

4.1 Applicable Documents

It is the responsibility of the DA to identify and request any documents that would not have been transmitted by IO, including the below list of Applicable Documents and documents referenced in the Applicable Documents. The Applicable Documents will be made available to the DA as part of the technical specifications.

This Technical Specification takes precedence over the Applicable Documents. In case of conflicting information, this is the responsibility of the DA to seek clarification from IO.

[REQ-1] Upon notification of any revision of the Applicable Documents transmitted officially to the DA, the DA shall advise within four weeks of any impact on the execution of the contract. Without any response after this period, no impact will be considered, and Document is considered as applicable to the DA scope under this TA.

Applicable document	IDM Doc ID	Version
[AD1] *General Management Specification for Service and Supply (GM3S)*	ITER_D_82MXQK	v1.4
[AD2] *List of variants for the TFW assemblies*	ITER_D_CYAHU7	v1.4
[AD3] *ITER Vacuum Handbook*	ITER_D_2EZ9UM	v2.5
[AD4] *ITER Dimensional Metrology Handbook*	ITER_D_46FN9B	v2.1

4.2 Material and Coating Specifications

This is the responsibility of the DA to procure the relevant material and apply the coatings in accordance with specification.

Reference	IDM Doc ID	Version
[AD5] *Bulk tungsten for TFW*	ITER_D_DUDN9C	v1.0
[AD6] *Tungsten heavy alloy WNiFe for TFW*	ITER_D_DUGDDF	v1.2
[AD7] *Steel EN 1.4307 (304L) forgings or forged bars for non-DT in-vessel usage*	ITER_D_DX24Z6	v1.2
[AD8] *Steel EN 1.4404 (316L) forgings or forged bars for non-DT in-vessel usage*	ITER_D_2WRMSW	v1.4
[AD9] *Steel EN 1.4404 (316L) plates for non-DT in-vessel usage*	ITER_D_38GK6Z	v1.6
[AD10] *Steel_14404_grade_316L_Plates_less 5 mm*	ITER_D_U8M5ZZ	v2.0
[AD11] *Steel 316L Grade A4-80 for non-DT in-vessel usage*	ITER_D_3FR65U	v1.6
[AD12] *Steel EN 1.4980 (660) for non-DT in-vessel usage*	ITER_D_38GK5G	v1.6
[AD13] *Alloy 718 for Blanket*	ITER_D_G7N74Y	v1.2

[AD14] *Aluminium bronze rods, bar and shapes Procurement Specification for ITER Blanket System*	ITER_D_PS569U	v1.1
[AD15] *Copper plate for non-DT in-vessel usage*	ITER_D_DUDS8V	v1.2
[AD16] *CuCrZr-IG forgings for Electrical Straps for ITER Blanket Application*	ITER_D_SYL2N7	v1.1
[AD17] *Copper Anti-seize coating specification for In-vessel components*	ITER_D_TLLFHC	v4.0
[AD18] *Insulating coatings for the blanket system components*	ITER_D_D25QF6	v3.1

4.3 Applicable Codes and Standards

In addition to the Table below, several codes and standards are referred in the Applicable Documents in Section 4.1 and 4.2 which the DA shall also apply.

It is the responsibility of the DA to procure the relevant Codes and Standards applicable to that scope of work.

Ref	Title
[CS1]	In-vessel Components, SDC-IC, ITER_D_222RHC v3.0
[CS2]	EN 13445-5:2014 Unfired pressure vessels - Part 5: Inspection and testing.
[CS3]	ISO 2768-1 General tolerances - Part 1: Tolerances for linear and angular dimensions not affected by individual tolerances
[CS4]	ISO 22081:2021 (Replacing ISO 2768-2) Geometric Product Specification (GPS) - Geometric Tolerancing - General Geometric Specifications and General Size Specifications
[CS5]	EN ISO 9712:2012 or 2021 Non-destructive testing – Qualification and certification of NDT personnel – General principles.
[CS6]	DIN 25410:2012 Nuclear facilities - Surface cleanliness of components.
[CS7]	EN ISO 3452-1 Non-destructive testing - Penetrant testing - Part 1: General principles
[CS8]	ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories
[CS9]	EN 583-1: Non-destructive testing – Ultrasonic examination – Part 1: General principles
[CS10]	ASME Section III, Division 1, Subsection NG-254
[CS11]	ASME Section V, Article 9 Visual Examination
[CS12]	ISO 261 - ISO general purpose metric screw threads — General plan
[CS13]	ISO 262 - ISO general purpose metric screw threads ISO general purpose metric screw threads — Selected sizes for bolts, screws, studs and nuts
[CS14]	ISO 965 -1 ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data
[CS15]	ISO 965-2 - ISO general purpose metric screw threads -- Tolerances -- Part 2: Limits of sizes for general purpose external and internal screw threads - Medium quality

4.4 Reference Documents

Reference Documents shall be used as a set of guidelines to assist in executing the contract. The approved current versions are always applicable.

Reference	IDM Doc ID
[RD1] *ITER Abbreviations*	ITER_D_2MU6W5
[RD2] *Quality Requirements for IO Performers*	ITER_D_22MFG4
[RD3] *Blanket numbering system*	ITER_D_UDWNAY
[RD4] *Sub-system Requirements Document (sSRD) for temporary first wall*	ITER_D_C59SXF
[RD5] *Temporary First Wall Design Description Document*	ITER_D_B6HJUU
[RD6] *Temporary First Wall Load Specification*	ITER_D_92NARK
[RD7] *Generic Appendix B1 (welding requirement)*	ITER_D_RV2495
[RD8] *Vacuum Handbook Appendices*	2FHLMC
[RD9] *Material Approval Request Database*	N3SVRJ
[RD10] *Technical specification for outgassing sample*	ITER_D_QUCYDA
[RD11] *List of Deliverables Form*	ITER_D_73MVYS
[RD12] *List of Deliverables Working Instruction*	ITER_D_7AHAL5
[RD13] *Preliminary TFW tile bill of materials*	ITER_D_EZGQWQ
[RD14] *FW, TFW, SB in-vessel map*	ITER_D_YVZ2JY
[RD15] *Presentation: ICP Database for management of Material, Fluid and Processing Material Approval Requests*	ITER_D_WPFGD6
[RD16] *HHFT protocol template*	ITER_D_N4VX53
[RD17] *HHFT Report template*	ITER_D_N6DRRR
[RD18] *MQP L3 Working Instruction for Manufacturing Readiness Review*	ITER_D_44SZYP
[RD19] *Procedure for the management of Deviation Request*	ITER_D_2LZJHB
[RD20] *MQP L2 Procedure for Management of Nonconformities*	ITER_D_22F53X
[RD21] *ITER Numbering System for Components and Parts*	ITER_D_28QDBS

5 SCOPE OF WORK

This section defines the specific scope of work, in addition to the contract execution requirement as defined in the **[AD1]** *GM3S*.

[REQ-2] The TFW items detailed in **[AD2]** *List of variants for the TFW assemblies*, shall be supplied to the IO.

The Contract provisions shall also include the following items:

- **[REQ-3]** Provide CAD resource for design "replication".
- **[REQ-4]** Description of the manufacturing processes and their qualification procedures.
- **[REQ-5]** Design and manufacturing of finger prototype for validation.
- **[REQ-6]** List of the necessary equipment for manufacturing and inspection equipment including calibration dates as agreed with the IO.
- **[REQ-7]** List of Certification of qualified personnel for the manufacturing and examinations.
- **[REQ-8]** Purchase of all required materials according to specified requirements.
- **[REQ-9]** Manufacture of all TFW assemblies to the selected design and per the specified requirements for machining.
- **[REQ-10]** Inspection and reporting of the dimensional accuracy to within specified manufacturing tolerance requirements.
- **[REQ-11]** Cleaning of all assemblies as per the specified procedures.
- **[REQ-12]** Packing of all assemblies to preserve their cleanliness and integrity and ship them to the IO.

[I] The overall quantities within the scope of work, including the Standard Parts, are detailed in the **[AD2]** *List of variants for the TFW assemblies*. All information present on the drawings (e.g., dimensions, tolerances, and coatings) as well as on the 3D CAD Models shall be considered mandatory requirements as part of this technical specification.

[I] The classifications of TFW components are shown in Table 5-1, details referring to **[RD**4**]** *Sub-system Requirements Document (sSRD) for temporary first wall*.

Table 5-1 Classifications of TFW components

Components Description	Quality Class	Vacuum Class	Metrology Class	PIC /PIA	PED /ESPN	Seismic Class	RH Class	Tritium Class
TFW	QC2	VQC-1B	MC-1	Non	No	SC2	Not RH classified	No

[I] The design code for TFW is [CS1] *In-vessel Components, SDC-IC*.

5.1 Configuration Description

[I] The Temporary First Wall is a part of the Blanket System which will be used during the Start of Research Operation phase of the ITER machine to protect the Vacuum Vessel and other already-installed components against possible damage during the SRO phase. The Tungsten (W) TFW provides substantial minimization of the risks associated with physics uncertainties and plasma operational aspects for later operation in the DT-1 phase with deuterium-tritium plasmas.

[I] The Temporary First Wall configuration consists of 437 panels mount onto the Blanket Shield Blocks (SB). Both TFW and SB are inertially cooled.

[I] The Configuration Management Models of all TFW panels are shown in Figure 5-1. The inboard and upper TFW (from TFW 01 to TFW 10) are segmented toroidally into 18 TFW Panels, and the outboard TFW (from TFW 11 to TFW 18, except TFW 14 and 15) are segmented into 36 TFW Panels. In the upper and equatorial port region (TFW 10, 14 and 15), the TFW Panels are located between ports.

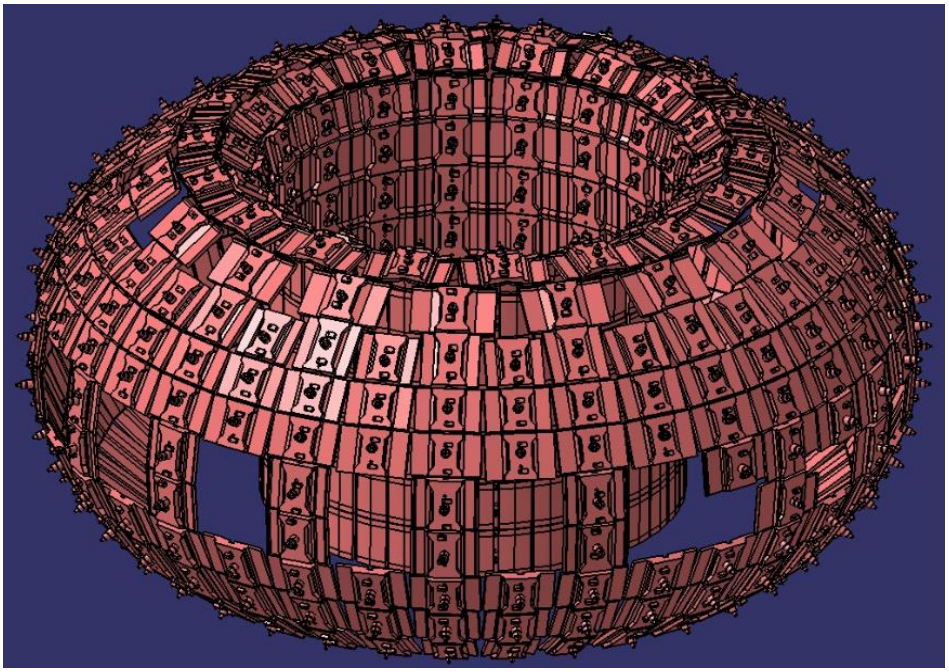


Figure 5-1: Configuration Management Models of all TFW panels.

[I] The Temporary First Wall (16.TW) is a sub-system of the Blanket System (PBS 16), and includes a PBS level 3 item for each of the 18 poloidal rows:

- 16.TW.01 – Temporary First Wall Panels in Poloidal Row 1 (Qty18)
- 16.TW.02 – Temporary First Wall Panels in Poloidal Row 2 (Qty18)
- 16.TW.03 – Temporary First Wall Panels in Poloidal Row 3 (Qty18)
- 16.TW.04 – Temporary First Wall Panels in Poloidal Row 4 (Qty18)
- 16.TW.05 – Temporary First Wall Panels in Poloidal Row 5 (Qty18)
- 16.TW.06 – Temporary First Wall Panels in Poloidal Row 6 (Qty18)
- 16.TW.07 – Temporary First Wall Panels in Poloidal Row 7 (Qty18)
- 16.TW.08 – Temporary First Wall Panels in Poloidal Row 8 (Qty18)
- 16.TW.09 – Temporary First Wall Panels in Poloidal Row 9 (Qty18)

- 16.TW.10 – Temporary First Wall Panels in Poloidal Row 10 (Qty18)
- 16.TW.11 – Temporary First Wall Panels in Poloidal Row 11 (Qty36)
- 16.TW.12 – Temporary First Wall Panels in Poloidal Row 12 (Qty36)
- 16.TW.13 – Temporary First Wall Panels in Poloidal Row 13 (Qty36)
- 16.TW.14 – Temporary First Wall Panels in Poloidal Row 14 (Qty22)
- 16.TW.15 – Temporary First Wall Panels in Poloidal Row 15 (Qty19)
- 16.TW.16 – Temporary First Wall Panels in Poloidal Row 16 (Qty36)
- 16.TW.17 – Temporary First Wall Panels in Poloidal Row 17 (Qty36)
- 16.TW.18 – Temporary First Wall Panels in Poloidal Row 18 (Qty36)

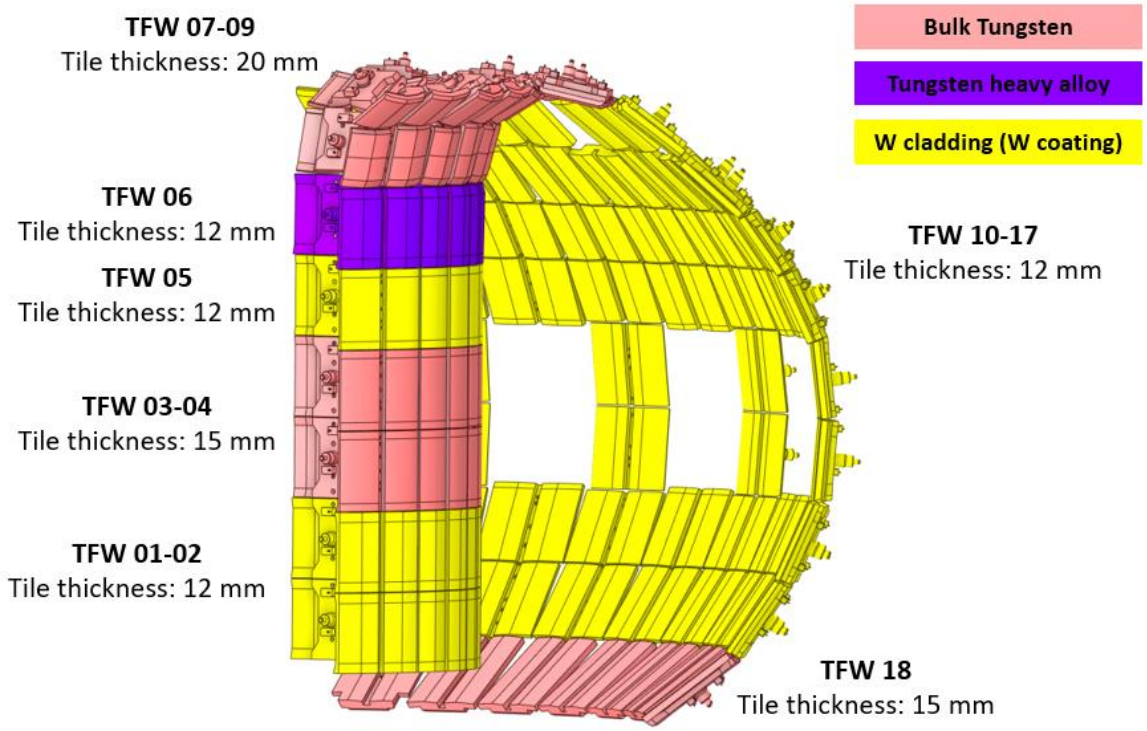


Figure 5-2: Overview of TFW configuration.

Table 5-2: TFW Configuration breakdown.

TFW Row	Armour		Main Design Features	
	Plasma Facing Material	Tile thickness (mm)	Qty of fingers per panel	Type of tile connection
01-02	W Cladding	12	16	Fixed
03-04	Bulk Tungsten	15	16	Flexible
05	W Cladding	12	16	Flexible
06	Tungsten heavy alloy	12	16	Flexible
07-08-09	Bulk Tungsten	20	16	Flexible
10-11	W Cladding	12	16	Flexible
12-17	W Cladding	12*	10	Fixed
18	Tungsten	15	16	Flexible

* Different tile thickness exists for specific panels (see section 5.2.4.2).

SUPPLY

[I] The TFW in-vessel map and variants (post-PDR configuration, for information only) are shown in Figure 5-3 and Figure 5-7, referring to **[AD2]** *List of variants for the TFW assemblies* and **[RD14]** *FW, TFW, SB in-vessel map* for the latest information.

	SECTOR 09		SECTOR 08		SECTOR 07		SECTOR 06		SECTOR 05		SECTOR 04		SECTOR 03		SECTOR 02		SECTOR 01		
	C18	C17	C16	C15	C14	C13	C12	C11	C10	C09	C08	C07	C06	C05	C04	C03	C02	C01	
#01	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	#01
#02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	01-02	#02
#03	04A	03 W	04A	04A	04A	04A	04A	04A	03 TS	03 W	03 W	04A	04A	04A	04A	04A	04A	04A	#03
#04	04A	04 W	04A	04A	04A	04A	04A	04A	04 TS	04 W	04 W	04A	04A	04A	04A	04A	04A	04A	#04
#05	04A	04A	04A	04A	04A	04A	04A	04A	04A	04A	04A	04A	04A	04A	04A	04A	04A	04A	#05
#06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	#06
#07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	#07
#08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	#08
#09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	#09
#10	10 UP18	10 UP17	10 UP16	10 UP15	10 UP14	10 UP13	10 UP12	10 UP11	10 UP10	10 UP09	10 UP08	10 UP07	10 UP06	10 UP05	10 UP04	10 UP03	10 UP02	10 UP01	#10
#11	11A 11B	11A 11B	11A 11C	11A 11C	11A 11B	11A 11C	11A 11C	11A 11B	11A 11B	11A 11B	11A 11B	11A 11B	11A 11B	11A 11B	11A 11B	11A 11B	11A 11B	11A 11B	#11
#12	12 12	12 12	12 12	12 12	12 12	12 12	12 12	12 12	12 12	12 12	12 12	12 12	12 12	12 12	12 12	12 12	12 12	12 12	#12
#13	13A 13B	13A 13B	13A 13B	13A 13A	13A 13B	13A 13A	13A 13B	13A 13B	13A 13B	13A 13B	13A 13B	13A 13A	13A 13A	13A 13A	13A 13A	13A 13B	13A 13B	13A 13B	#13
#14	14A EQ18	14A EQ17	14A EQ16	14A EQ15	14A EQ14	14A EQ13	14A EQ12	14A EQ11	14A EQ10	14A EQ09	14A EQ08	14ADL 14NB	14AND 14NC	14ND 14NC	14ND 14NE	14NDL EQ04	14A EQ03	14A EQ02	14A EQ01	#14
#15	15S 16B	15S 16S	15S 16B	15A 16AICH	15A 16B	15A 16AICH	15A 16B	15A 16B	15A 16B	15A 16B	15A 16B	15ADL 15NB	15AND 15NCA	EQ06 15NC	EQ05 15NE	EQ04 16A	15A 16B	15A 16B	15A 16B	#15
#16	16S 16B	16S 16B	16S 16B	16A 16AICH	16A 16B	16A 16AICH	16A 16B	16A 16B	16A 16B	16A 16B	16A 16B	16A 16A	16A 16A	16A 16A	16A 16A	16A 16B	16A 16B	16A 16B	16A 16B	#16
#17	17 17	17 17	17 17	17 17	17 17	17 17	17 17	17 17	17 17	17 17	17 17	17 17	17 17	17 17	17 17	17 17	17 17	17 17	17 17	#17
#18	18A 18A	18B 18A	18A 18A	18A 18A	18B 18A	18A 18A	18A 18A	18B 18A	18A 18A	18A 18B	18A 18A	18A 18A	18A 18A	18B 18A	18A 18A	18A 18A	18B 18A	18A 18A	18A 18A	#18
	SECTOR 09		SECTOR 08		SECTOR 07		SECTOR 06		SECTOR 05		SECTOR 04		SECTOR 03		SECTOR 02		SECTOR 01		

Figure 5-3 TFW in-vessel map (post-PDR configuration, for information only).

[I] The **[AD2]** *List of variants for the TFW assemblies* includes 40 total TFW design variants, seen visually distributed in Figure 5-3 (for info). To provide an adequate level of detail for specification, this document provides three detailed models that are fully developed with 3D models and 2D drawings. These are TFW04, TFW09, and TFW14 (see below Figure 5-4, Figure 5-5, and Figure 5-6).

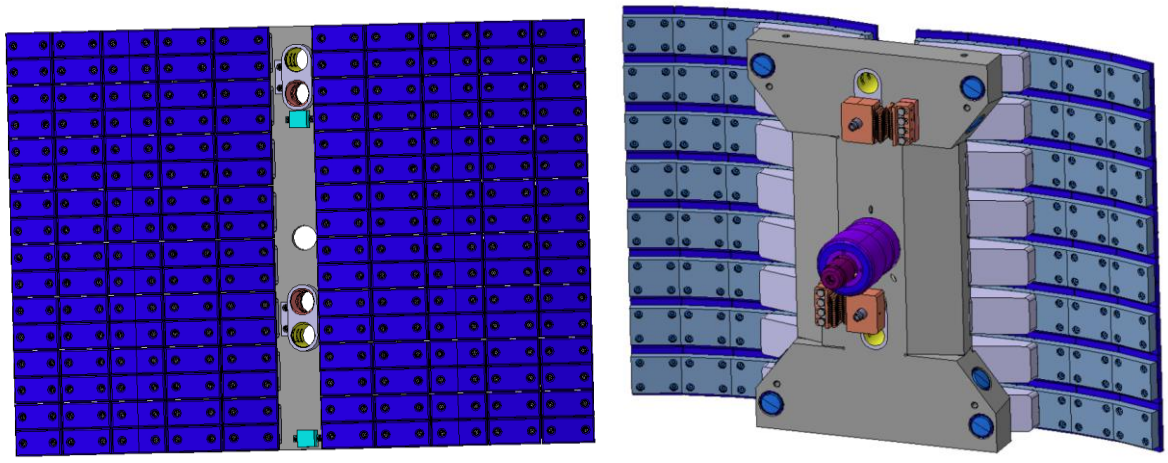


Figure 5-4 Detailed model of Temporary First Wall 04 panel.

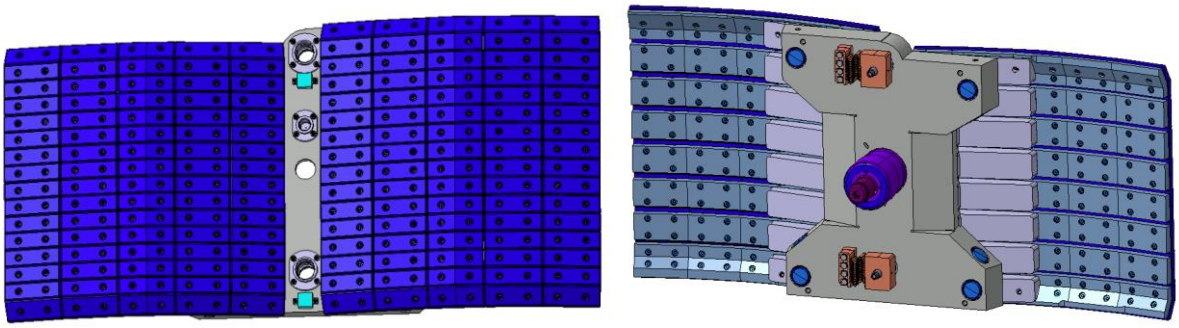


Figure 5-5 Detailed Model of Temporary First Wall 09 panel.

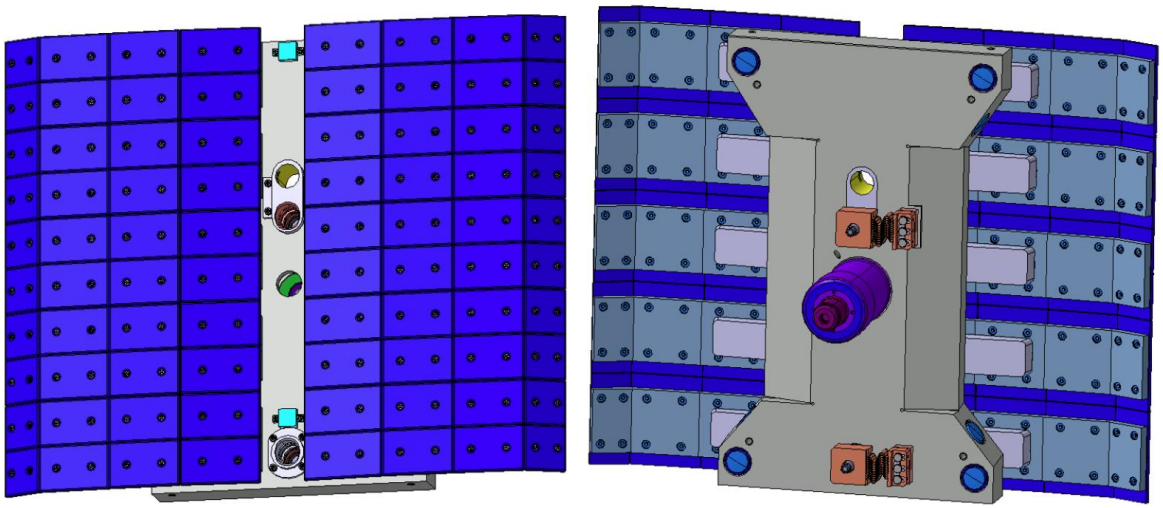


Figure 5-6 Detailed Model of Temporary First Wall 14 assembly.

[I] The above detailed models are to be used for extrapolation of the designs to all other panels, together with provided information in **[RD13]** *Preliminary TFW tile bill of materials* which provides estimates of fingers and tiles based on the configuration model dimensions, noting that the tile and finger estimates of all other panels are subject to minor change during their development with constraints on the plasma interaction and SB coverage. Figure 5-7 gives one such preliminary estimate on the quantities of each finger variant by poloidal row.

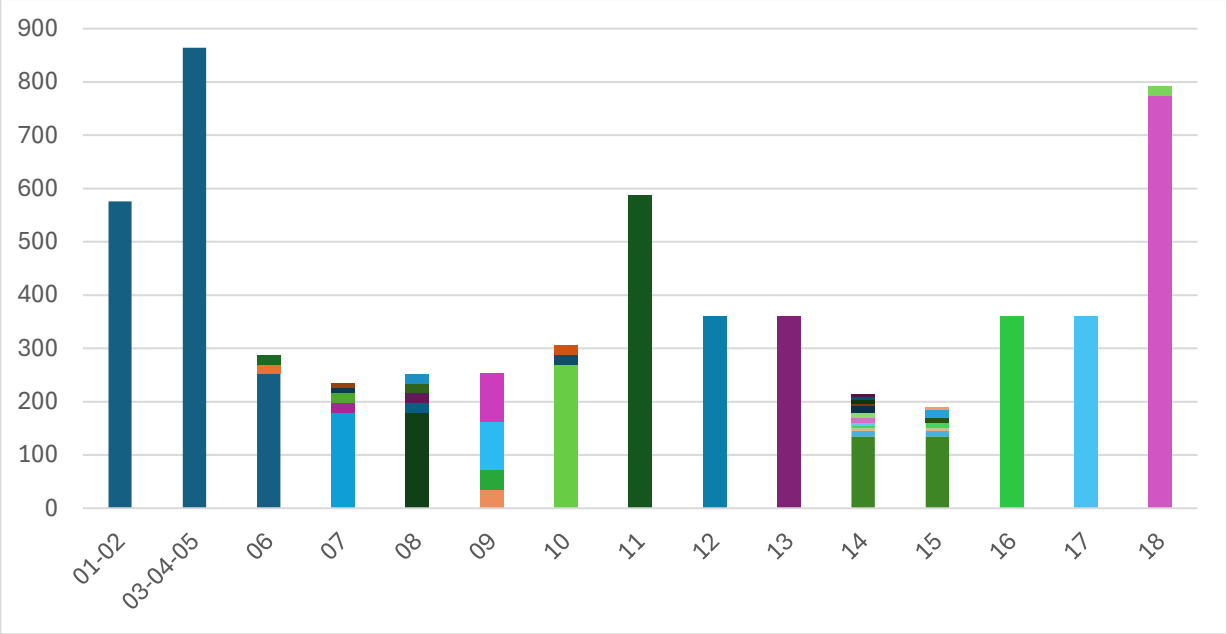


Figure 5-7 TFW Finger Variant distribution and quantities (post PDR configuration, for information only). Colors indicate different finger variants.

[I] As only three model variants are fully specified in this specification, the remaining 37 models are included within the scope of work for design replication (see Figure 5-8). These models are largely identical in design to the three developed models, with differences mainly in poloidal and toroidal span. The designs from TFW04, TFW09, and TFW14 can be replicated using the Configuration models of **[AD2]** *List of variants for the TFW assemblies* together with Table 5-2. See **§5.4 Final Design** requirements for detailed requirements for this model replication.

Row	Variant	Qty							
#01-02	1	36	01-02 36						
#03-04-05	5	54	04A 46	04 TS 1	04 W 3	03 W 3	03 TS 1		
#06	1	18	6 18						
#07	1	18	7 18						
#08	1	18	8 18						
#09	1	18	9 18						
#10	1	18	10 18						
#11	3	36	11A 18	11B 14	11C 4				
#12	1	36	12 36						
#13	2	36	13A 24	13B 12					
#14	8	22	14A 13	14ADL 1	14NB 1	14AND 1	14NC 2	14NE 1	14NDL 1	14ND 2
#15	8	19	15A 10	15S 3	15NE 1	15NC 1	15NCA 1	15AND 1	15NB 1	15ADL 1
#16	4	36	16A 19	16B 12	16S 3	16AICH 2				
#17	1	36	17 36							
#18	2	36	18A 30	18B 6						
	40	437								

Figure 5-8: All TFW panel model variants and the quantity, with fully developed models in green.

5.2 TFW assembly description

[I] This section describes the detailed designs that are present on all TFW panels and important associated requirements for their manufacturing and assembly.

[I] Each Temporary First Wall *assembly* consists of one TFW *panel* plus its "Standard Part" assemblies. The Standard Part assemblies are:

- Central Bolt assembly (Qty 1)
- Electrical Strap assemblies (Qty 2)
- Pad assemblies (Qty 8)

[I] The TFW assembly is attached to the SB by a Central Bolt assembly and two Electrical Strap assemblies. The Central Bolt preload is reacted by four Pad assemblies located in radial position, pressing the TFW onto the SB surface. Four Pad assemblies located at X position are embedded into the sides of the TFW Central Beam for re-acting the radial torque as well as the vertical and lateral forces. The Radial and X-Pad assemblies are identical. The Insulation Coating, LFC/ASC are applied on some components of the Standard Part assembly.

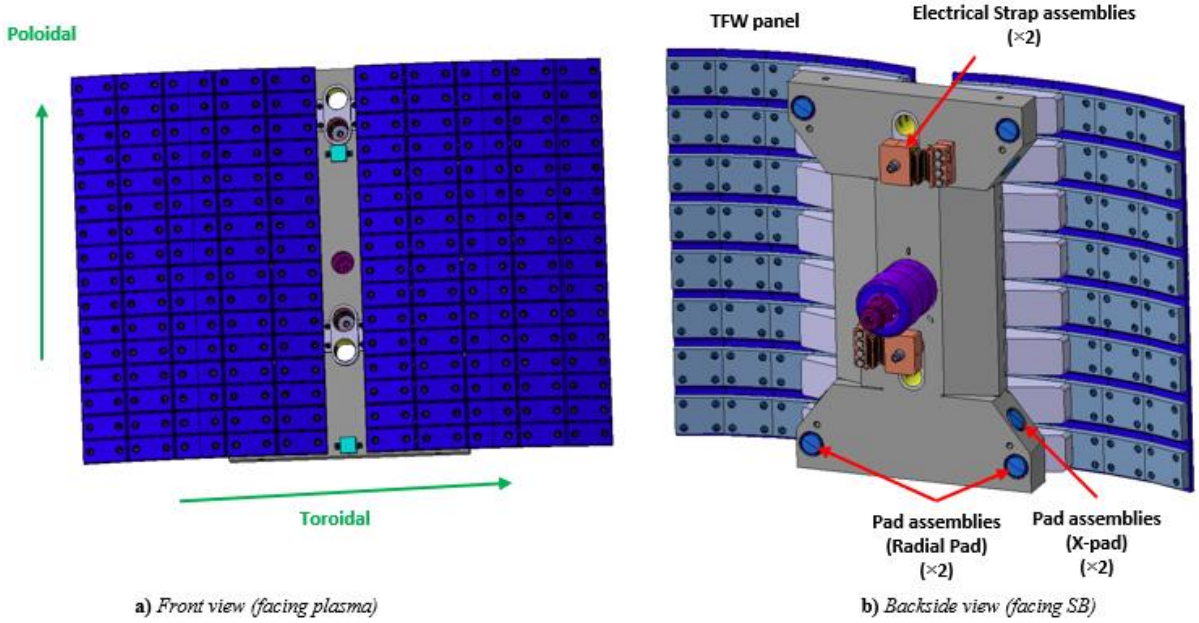


Figure 5-9 Overview of Temporary First Wall 04 assembly, for illustration only.

[REQ-13] All Standard Part assemblies shall be installed into TFW panel, in accordance with the TFW Assembly GAD listed in **[AD2]** *List of variants for the TFW assemblies*.

[I] IO reserves the right to visually inspect the Standard Part assemblies and review their geometrical survey results prior to installation.

[REQ-14] Both TFW Central Bolt and Electrical Strap Bolt shall be in parking position.

[I] The washers for Central Bolt assembly are locked within the Threaded Barrel.

[REQ-15] The DA shall protect coatings during handling, including installation of Standard Part assemblies onto TFW assembly.

5.2.1 Central Bolt assembly

[REQ-16] Two subcomponents of the Central Bolt assembly, specifically the Threaded Barrel and Barrel Shim (red highlighted items in Figure 5-10), shall be supplied by DA. These are detailed through **[AD2]** *List of variants for the TFW assemblies*.

[REQ-17] The Barrel Shim is a customized part, with thickness that shall be machined based on input from the IO (see section 7.1).

[I] The Threaded Barrel will have several types to match the different distances between the TFW and SB for different panels (see Figure 5-13 for illustration).

[I] The rest of Central Bolt assembly will be Free Issued Item from the IO, with below list of distributions:

- Circlips, Set Screw and Shear Key (highlighted by blue in Figure 5-10), to be delivered by CNDA
- Central Bolt Parking Feature, to be delivered by EUDA or the IO
- Central Bolt, Conical Washer, and Spherical Washer, to be delivered by the IO after applying coatings

[REQ-18] Electrical Insulation Coating (EIC) shall be applied on the Threaded Barrel in accordance with **[AD18]** *Insulating coatings for the blanket system components*, and as specified in its drawing indicated in **[AD2]** *List of variants for the TFW assemblies*.

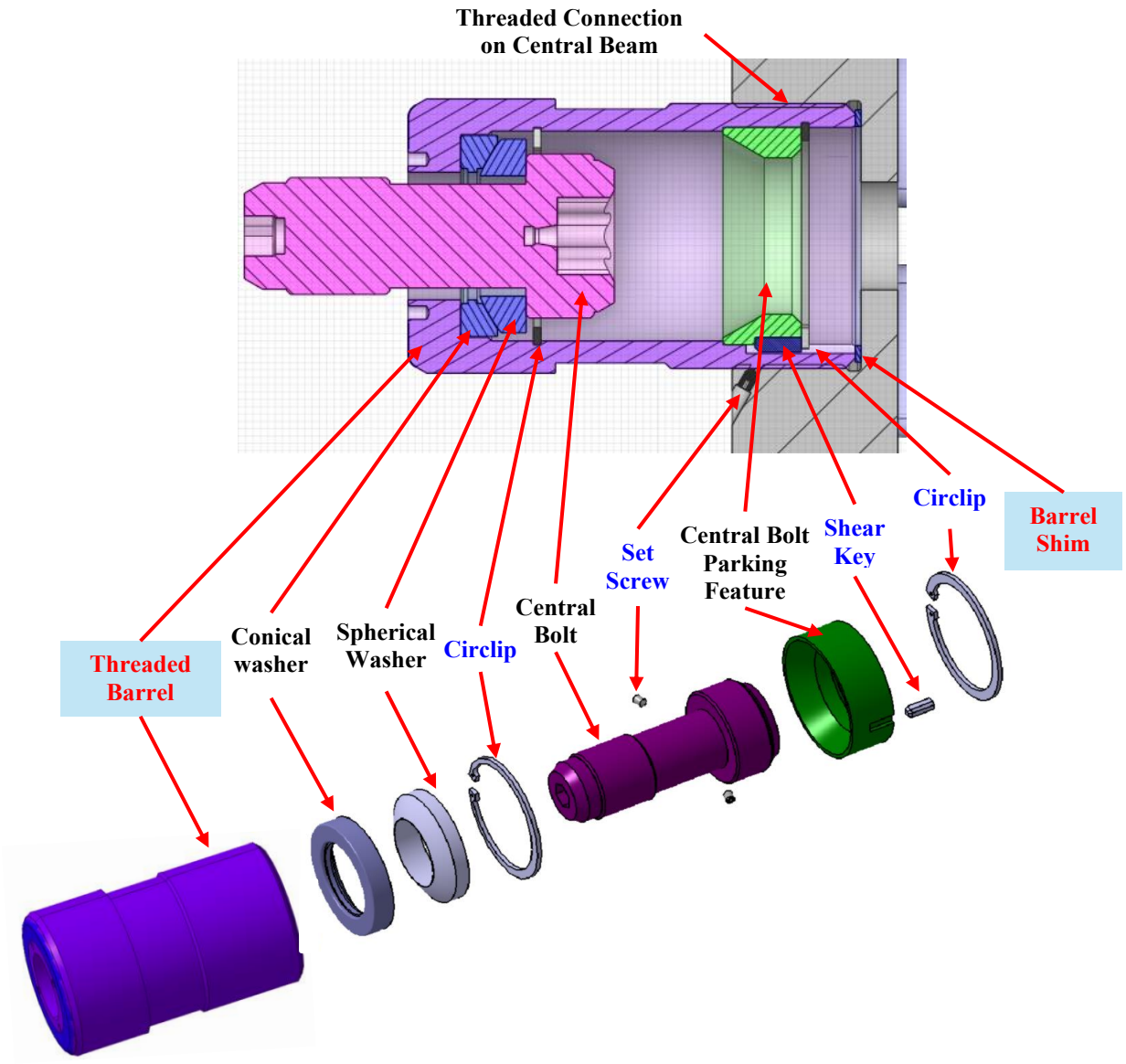
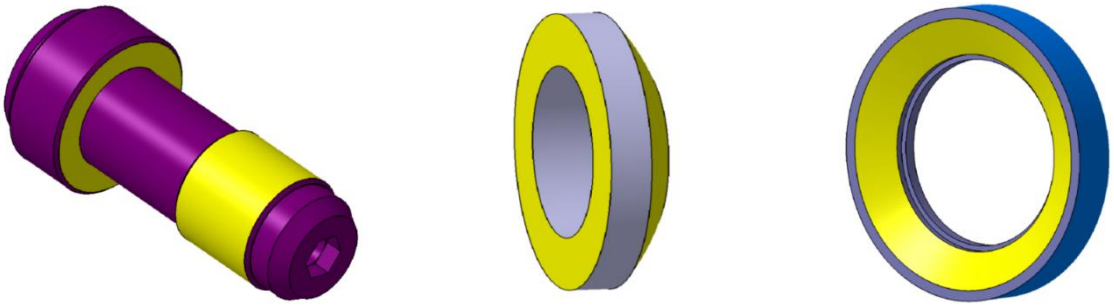


Figure 5-10: Central Bolt assembly and Threaded Barrel assembly



a) Central Bolt b) Spherical Washer c) Conical Washer

Figure 5-11: Coatings on components of FII of Central Bolt assembly (for information only). Insulation coating in blue; LFC/ASC in yellow.

SUPPLY

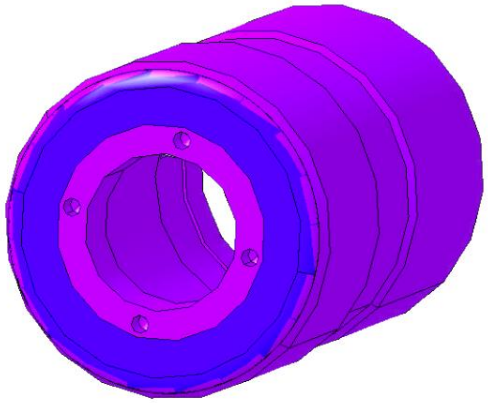


Figure 5-12: Threaded Barrel with an insulation coating (in blue) to be applied by the DA, in accordance with drawings.

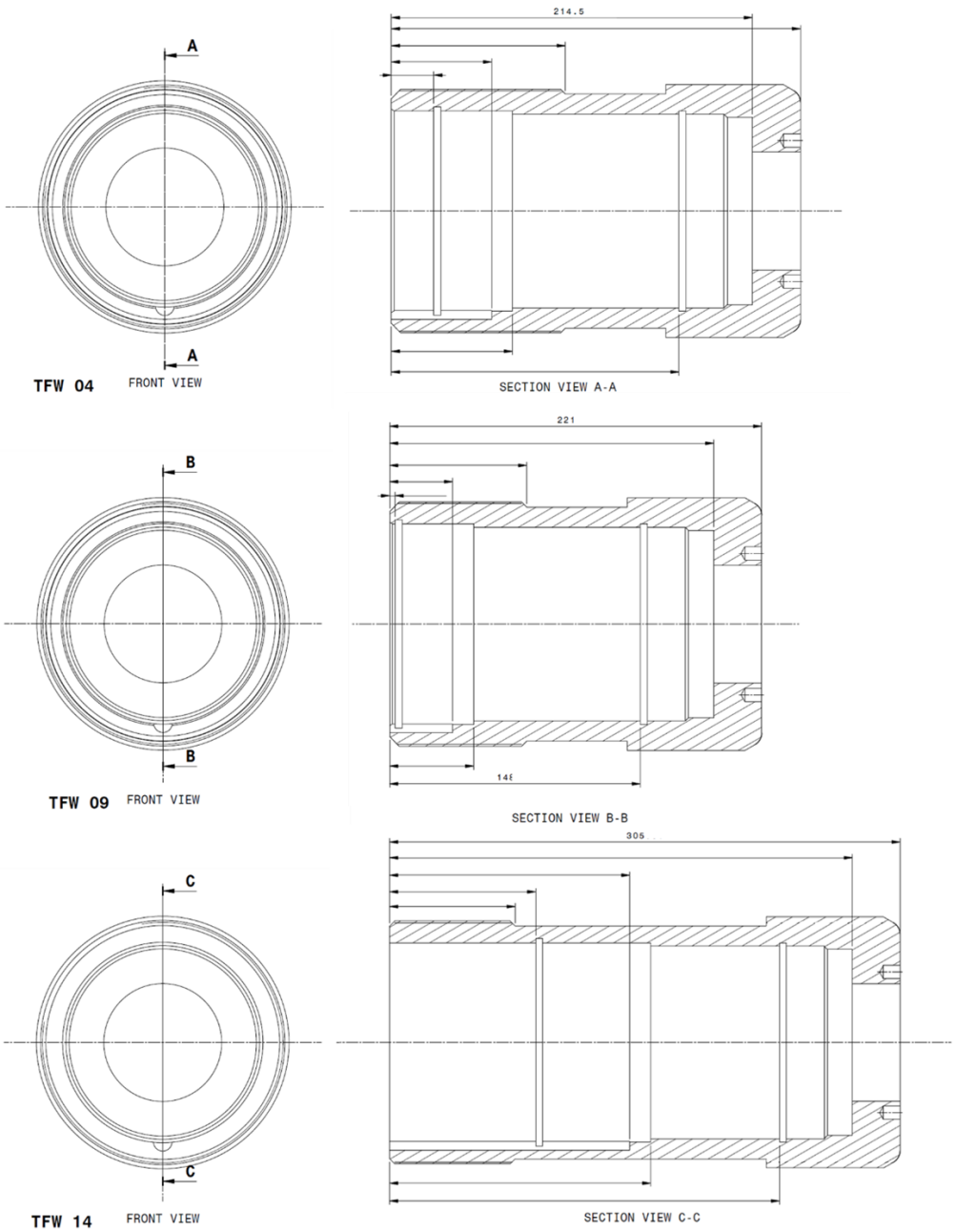


Figure 5-13: Several lengths of threaded barrels are needed to cover all 40 panel variants. These are standardized as much as possible. See GAD for detail.

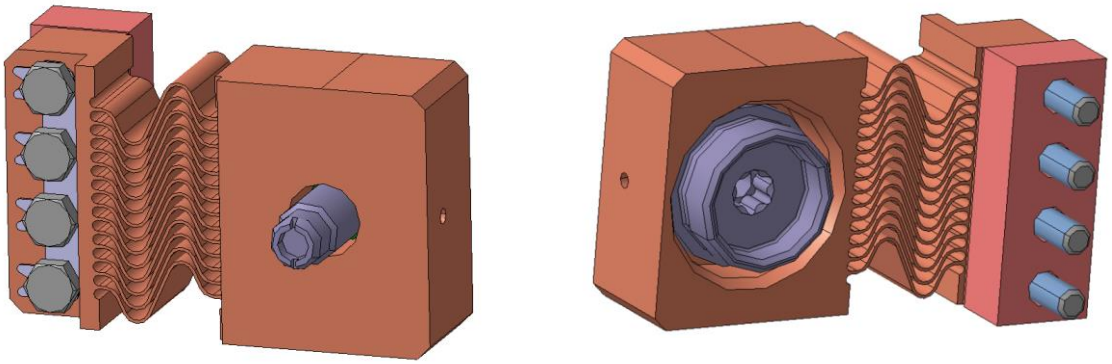
5.2.2 Electrical Strap assembly

[I] The electrical contact between TFW and SB is through two Electrical Strap assemblies (see Figure 5-14).

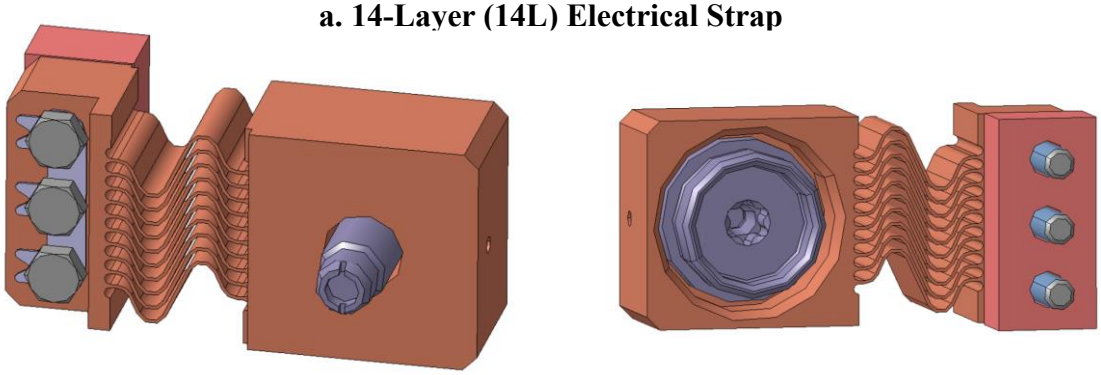
[I] The contacting surface to the Electrical Strap Side Block is TFW Electrical Strap pedestal which made of Copper. Alternative copper alloys may be proposed by the DA.

[I] Both ES Side Block and ES Pedestal are fixed on the Central Beam by a set of Hexagon Head Bolts which are locked in place by Anti-rotation plate.

SUPPLY



a. 14-Layer (14L) Electrical Strap



b. 10-Layer (10L) Electrical Strap

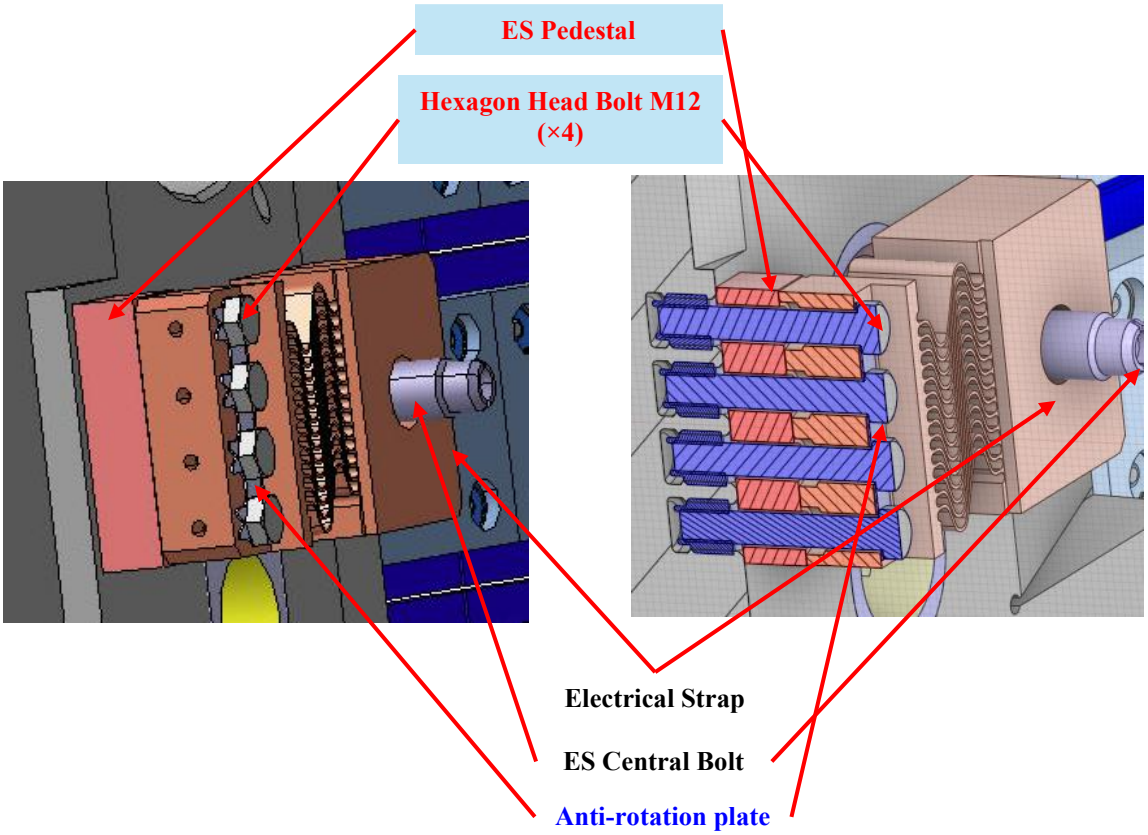
Figure 5-14 TFW Electrical Strap assembly

[REQ-19] The quantities of 10-Layer and 14-Layer ES assemblies, and their associated parts to be procured, shall be determined from the quantities listed in the "Std Parts (for info)" tab in **[AD2]** *List of variants for the TFW assemblies*.

[REQ-20] Two subcomponents of Electrical Strap assembly, specifically the Hexagon Head Bolts and ES Pedestal (red highlighted items in Figure 5-15), shall be supplied by DA. These in accordance with **[AD2]** *List of variants for the TFW assemblies*.

[I] The rest of Electrical Strap assembly will be Free Issued Item from the IO, with below list of distributions:

- Anti-rotation plate (highlighted by blue in Figure 5-15), to be delivered by CNDA
- ES Central Bolt and Spring Washer, to be delivered by the IO after applying coatings
- Electrical Strap, to be delivered by RFDA



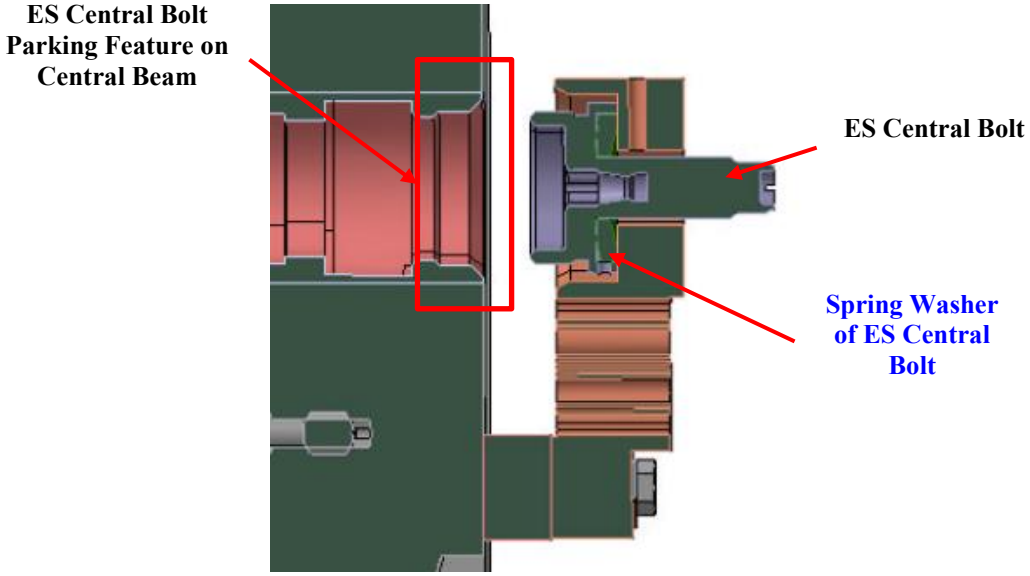
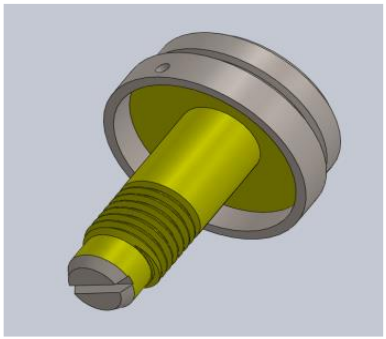
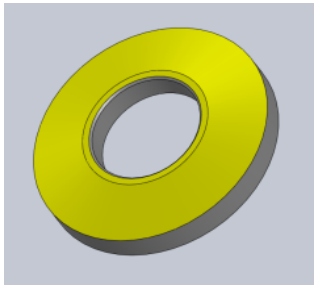


Figure 5-15 Electrical Strap (14L) assembly installed onto TFW Central Beam

SUPPLY



ES Central Bolt



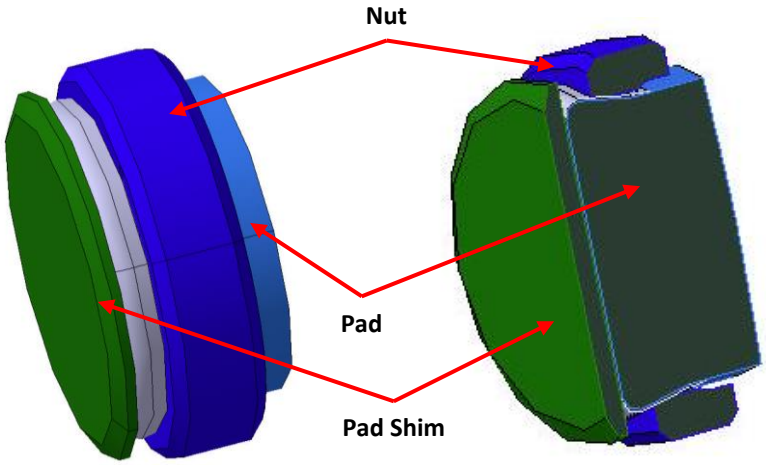
Spring Washers of ES Central Bolt

Figure 5-16. Coatings applied by IO on Electrical Strap assembly (for information only). LFC/ASC shown in yellow.

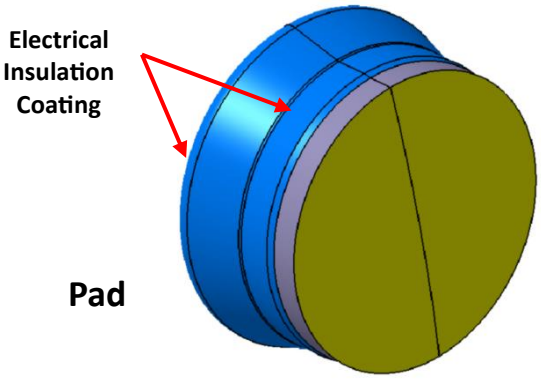
5.2.3 Pad assembly

[I] There are eight sets of identical Pad assemblies on TFW assembly, which are located on Radial and X position of Central Beam. Each Pad assembly includes Pad, Nut and Pad shim (see Figure 5-17). These react to the EM forces of the TFW against the SB.

[I] The Pad assemblies will be Free Issued Item from the IO (to be delivered by RFDA).



a) Components for each Pad assembly



b) Coating on Pad, blue is Insulation Coating

Figure 5-17 Pad assembly for TFW (for information only).

5.2.4 TFW panel

[I] Each Temporary First Wall panel consists of one Central Beam assembly together with its Finger assemblies. These assemblies are bolted together as described in the following sections.

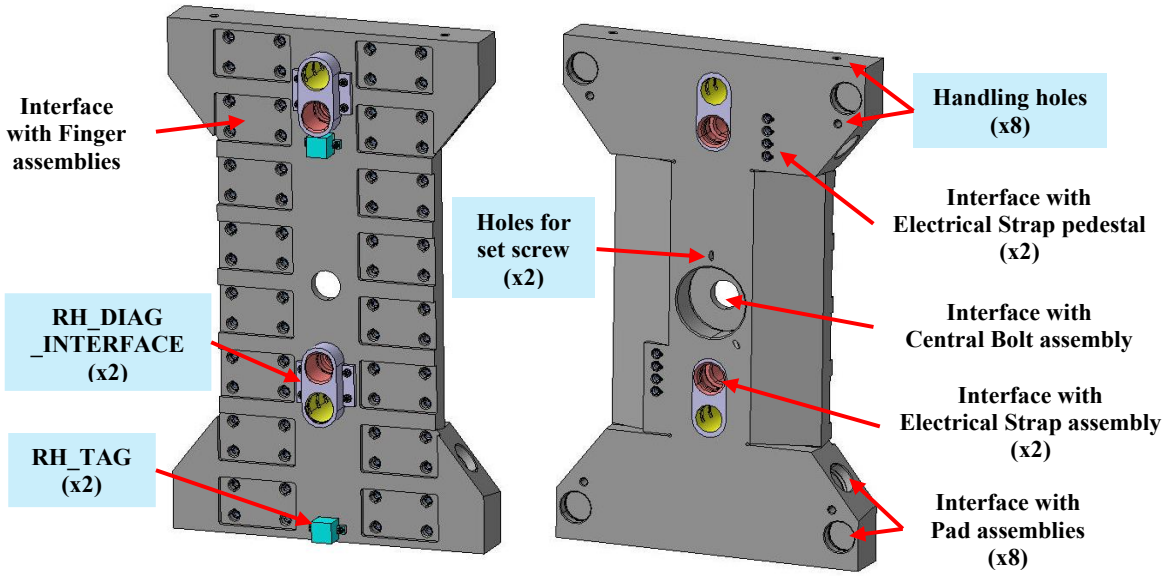
[REQ-21] The TFW panels shall be manufactured in accordance with the panel GADs as specified in **[AD2]** *List of variants for the TFW assemblies*.

5.2.4.1 TFW Central Beam assembly

[I] The TFW Central Beam is the support structure for all other parts, designed to be sufficiently thick to resist the expected EM loads.

[I] Included in this assembly are bolted interface parts for the Remote Handling and Diagnostics as well as bolted tags for robot vision for assembly (see Figure 5-19). These are locked with locking washers (see Section 5.10). Minor modifications to this bolted interface may be considered to facilitate manufacturing tolerances.

[I] Also included in the Central Beam Assembly are several thread inserts, each fit with self-locking threads (see Section 5.10) for finger Figure 5-20 and Figure 5-21, respectively).



a) Front view (facing PFM) b) Backside view (facing SB)

Figure 5-18: Overview of Temporary First Wall 04 Central Beam assembly

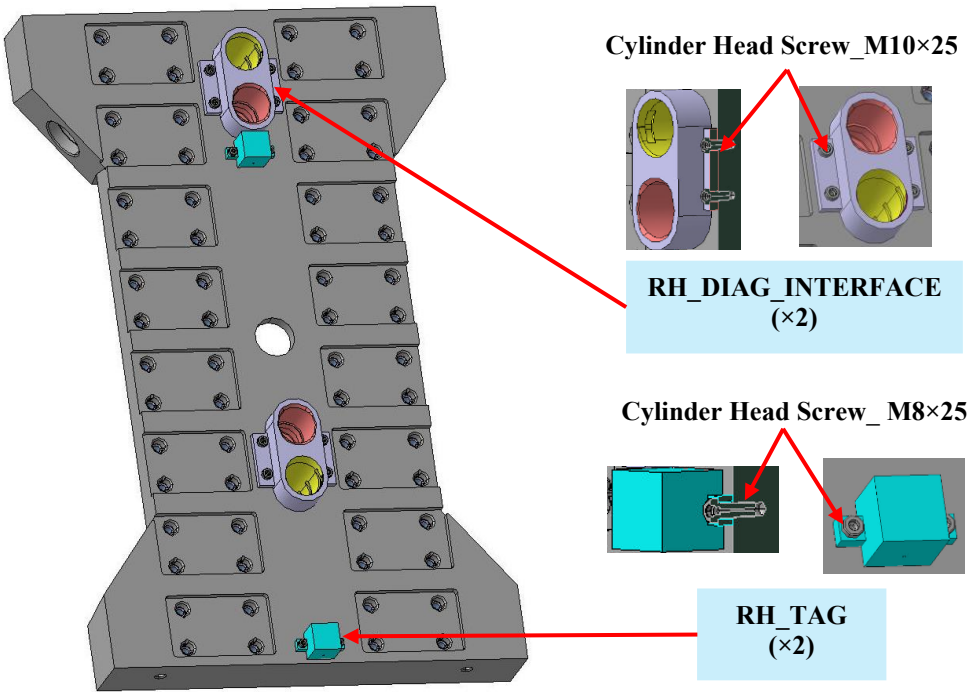


Figure 5-19: Bolted interfaces for handling, targeting, and diagnostics (Locking washers are not shown, see 2D drawing for detail).

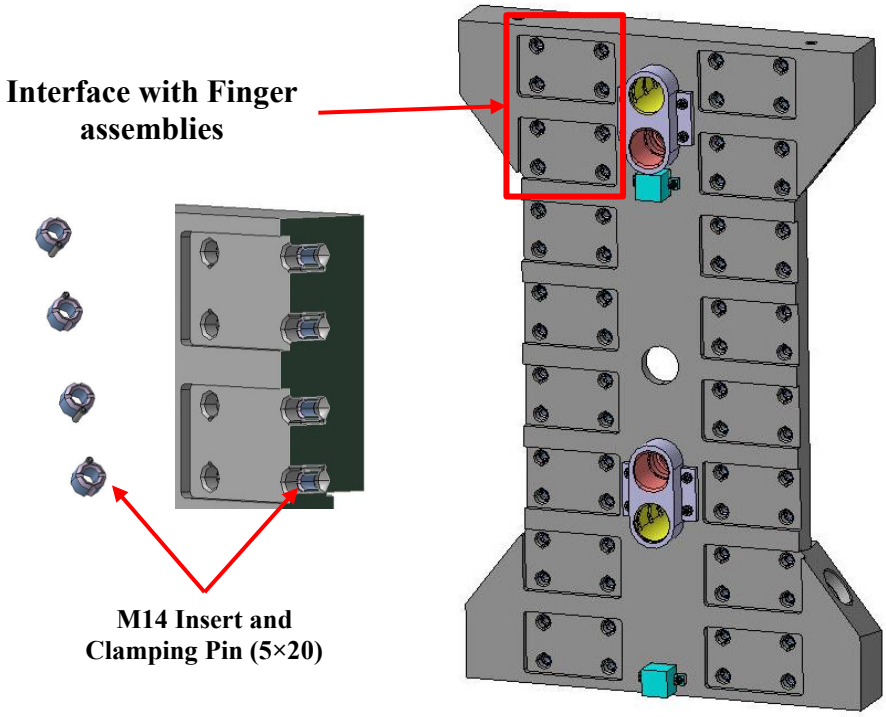


Figure 5-20. Inserts for finger interface (see 2D drawing for detail).

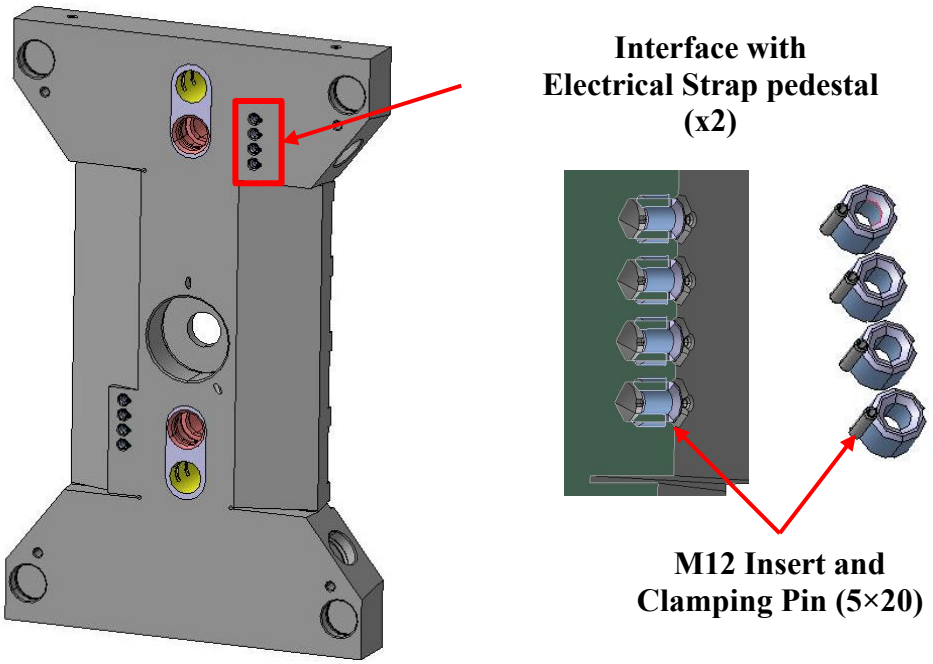


Figure 5-21. Inserts for Electrical Strap interface (see 2D drawing for detail).

5.2.4.2 TFW Finger assembly

The TFW Finger assembly includes a finger support, finger plate, several tiles, and all bolting elements to join these items together (see Figure 5-22). The number of tiles may vary depending on the toroidal span of the panel (see **[RD13]** *Preliminary TFW tile bill of materials*). As specified in Table 5-2, two finger widths are included in the design for standard fingers: wide (rows 12-17) and narrow (rows 1-11 and 18).

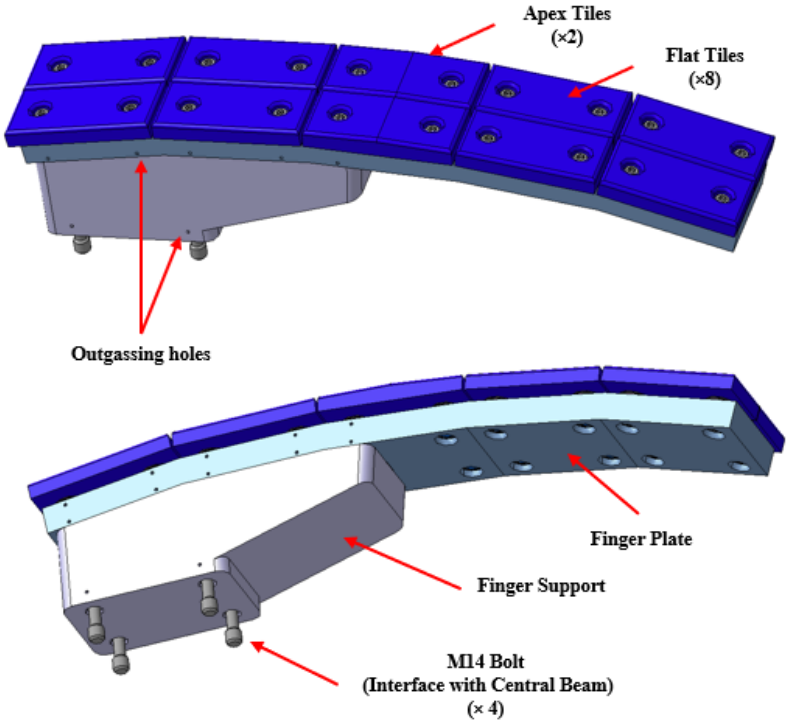


Figure 5-22: TFW04 Finger assembly

[I] Note that the finger plate is assumed to be uniform thickness. The DA may alternatively propose a non-uniform thickness to create a flat interface between the finger plate and finger support.

[I] Specific rows also include “edge” fingers on the poloidal extremity of the panels (see Figure 5-23). These exist on variants 06, 07, 08, 09, and 10 and require specific tile shapes.

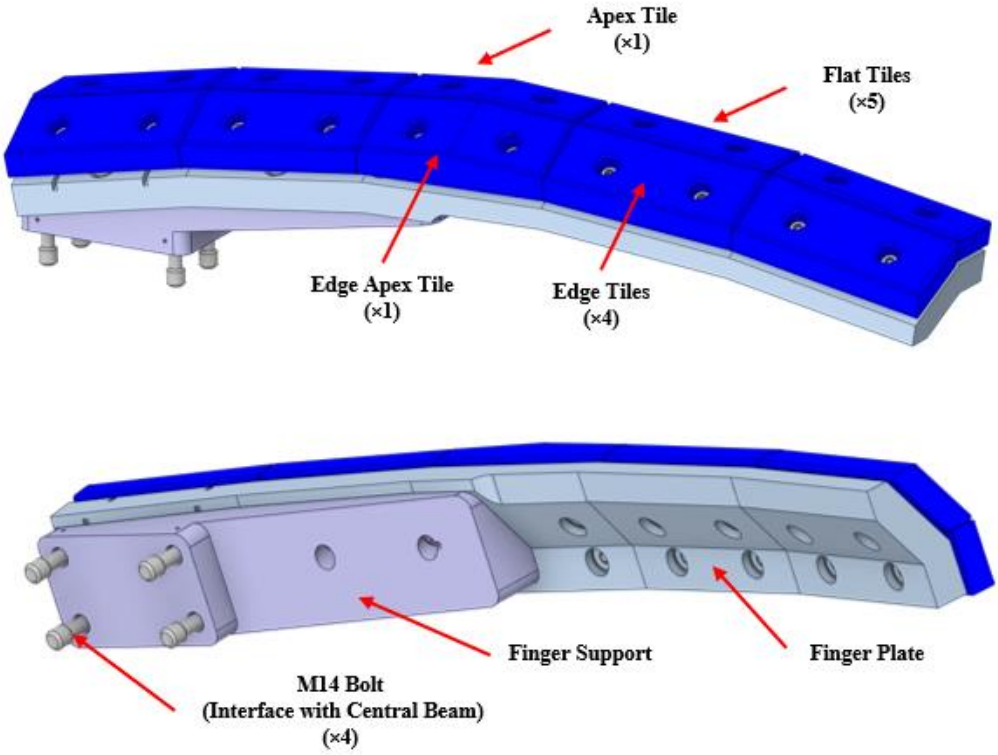


Figure 5-23: TFW09 Edge Finger assembly

[I] Outboard panels near the equatorial ports (i.e. rows 14 and 15) include toroidal chamfers at the ends of the fingers to intercept plasma that traverses the large opening of the ports. These require a special “chamfer tile” at the end (see Figure 5-24).

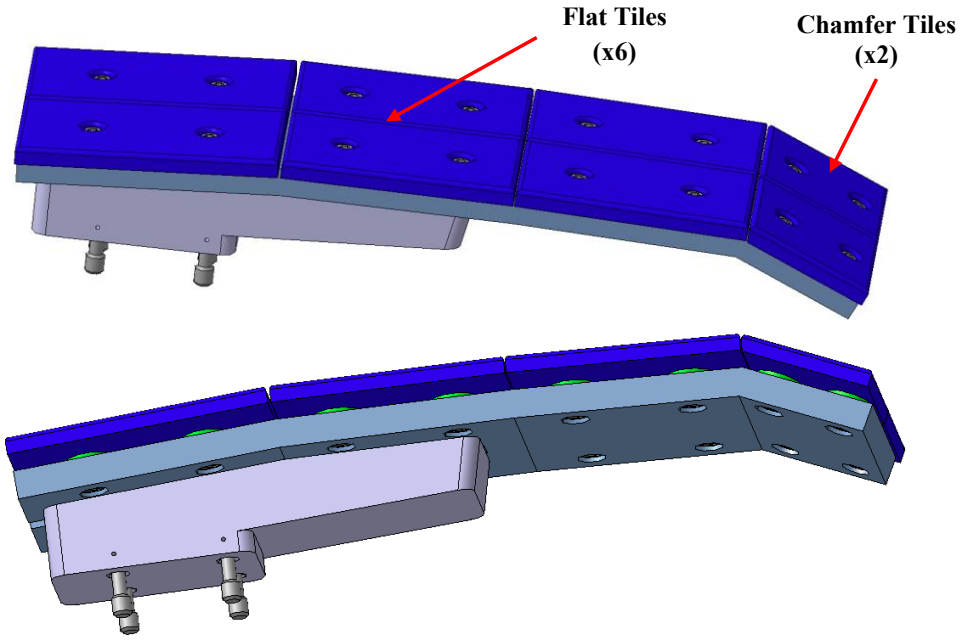


Figure 5-24: TFW14 Finger assembly

[REQ-22] Panels in row 14 and 15 around Equatorial Port 15 shall have Tungsten Heavy Alloy tiles of **20 mm** thickness on the chamfer that faces that port to accommodate the parasitic heating loads from the ICRH antennae (see Figure 5-25).

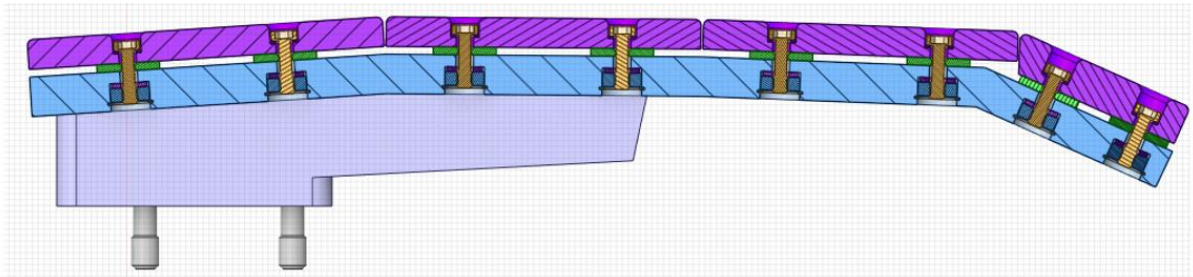
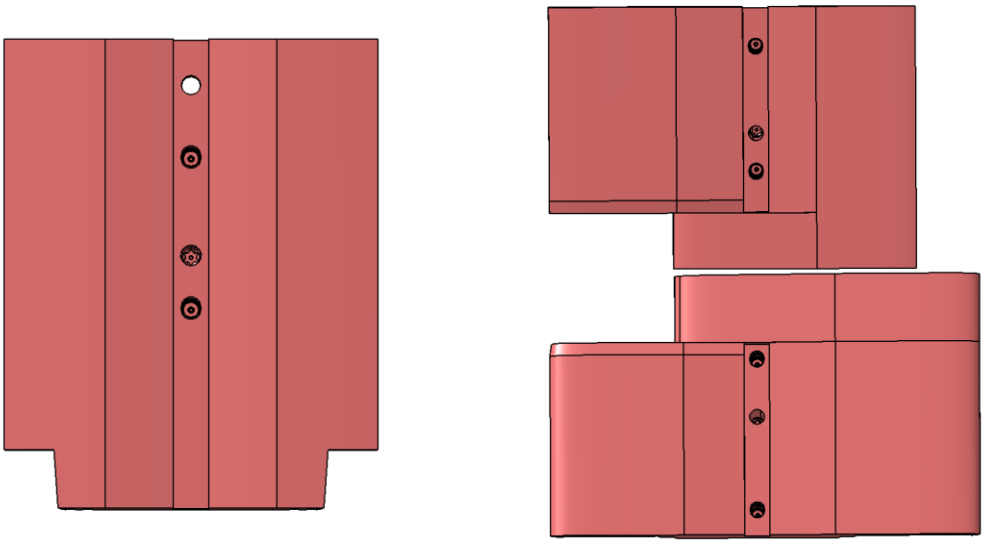


Figure 5-25: A thick chamfer tile is expected on row 14/15 panels around the ICRH port.

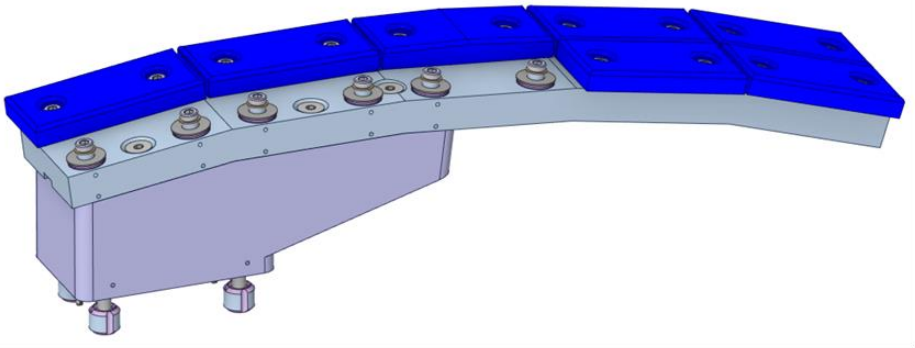
[I] A few panels include other specific geometries which are worth noting. The first is variant 18B, with short fingers (at left in Figure 5-26) to allow access by the In-Vessel Viewing System. This variant will require modified tile lengths and widths to accommodate the configuration model.

[I] The other irregularities are variants 14NE and 15NE (at right in Figure 5-26). These may be dramatically simplified from what is shown in the image below thanks to the fact that the Diagnostic Neutral Beam will not be operational during SRO. Because of this, the large cut-out can be neglected and replaced with standard fingers on both panels.

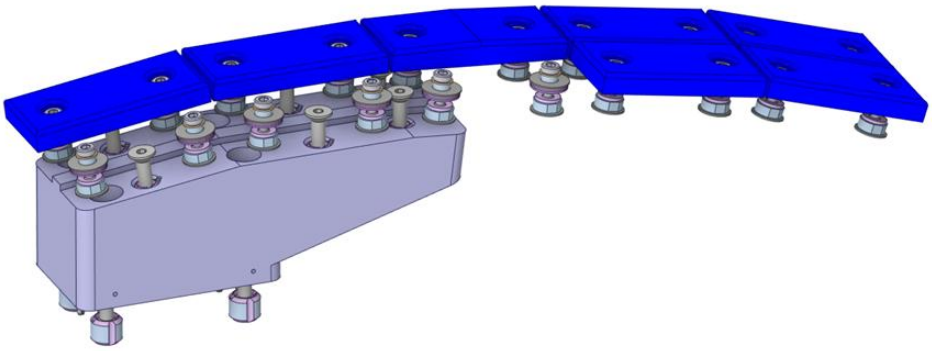


(a) TFW18B (b) TFW14NE and TFW15NE

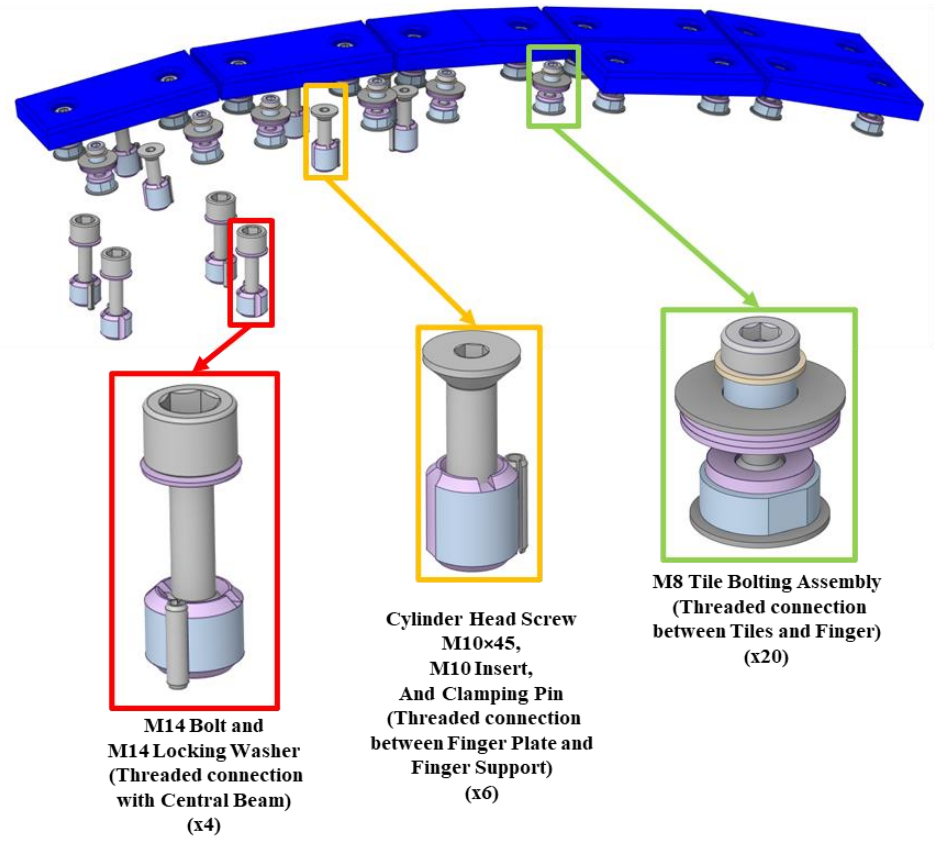
Figure 5-26: Special variants 18B and 14/15NE.



a) Three tiles hidden to show access to plate-to-support bolts.



b) Plate hidden to show access to support-to-beam bolts.



c) Support hidden to show all finger bolt integration.

Figure 5-27 Threaded Connections of TFW04 Finger assembly

Two types of tile attachments are included in the design, as specified in Table 5-2: a “flexible” attachment (see Figure 5-28), and a “fixed” attachment (see Figure 5-29).

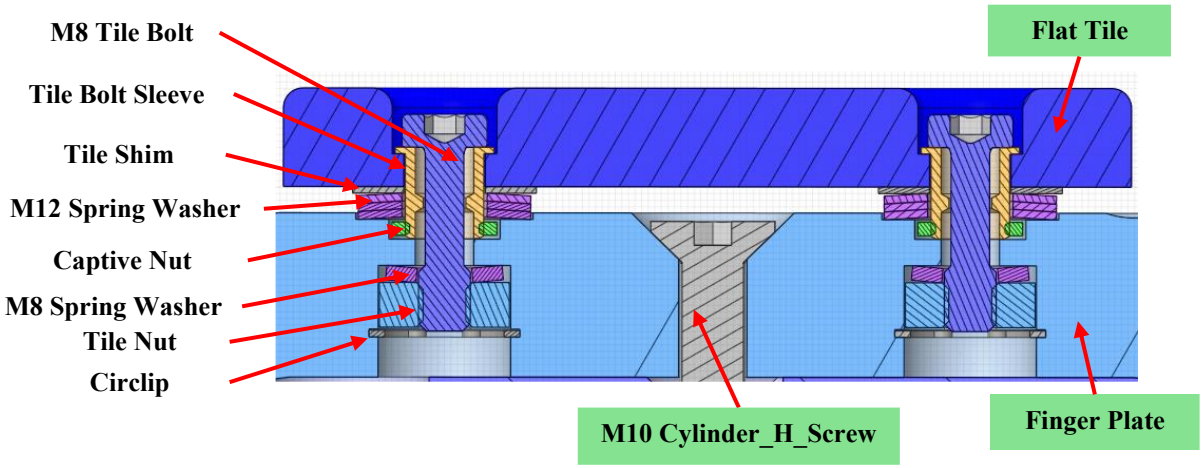


Figure 5-28: “Flexible” tile connection. See Table 5-2 for usage.

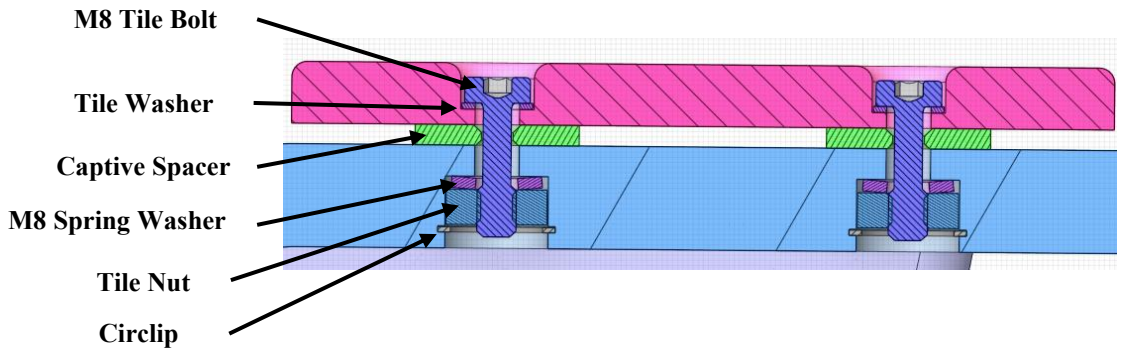


Figure 5-29: “Fixed” tile connection. See Table 5-2 for usage.

5.2.5 Spare parts

[REQ-23] To account for potential damage to the Temporary First Wall during both assembly and during operation, a provision of spare parts shall be provided. The specific parts and their quantities are listed in the “Spare Parts” tab in **[AD2]** *List of variants for the TFW assemblies*. No complete spare TFW assemblies are requested.

[I] The spare tiles that are to be provided are considered as “blanks” with standardized dimensions such that they can be located in one of several positions in the machine.

[I] In addition to the spare tile blanks, the spare list contains sufficient quantities to fabricate several new fingers and a few complete panels if necessary.

[I] *Uncoated* Off the shelf spare parts are out of scope (and are not listed in the table).

5.3 Contract Execution

[I] The contract gates as defined in the **[AD1]** Section 6.1.5 applies, including:

- Manufacture Readiness review
- Factory Acceptance Test Readiness review
- Delivery Readiness review

[REQ-24] For each item, a MRR shall be held upon the completion of manufacture design, engineering documentation (as indicated MRR in Section 5.7) and the readiness of materials (parts). The DA and IO will mutually agree with the content for MRR.

[REQ-25] The DA shall manufacture, test, and resolve any issues for a first-of-a-kind for parts that have many instances or variants prior to manufacturing the rest of the variants.

[REQ-26] The DA shall carry out the production of the TFW according to the technical specification and Reference Documentations.

[REQ-27] The DA shall carry out the Factory Acceptance Tests (FAT) of the TFW as detailed in Section 5.13.

[I] After components are delivered to ITER site, IO will carry out the Site Acceptance Tests (SAT) of TFW as detailed in Section 5.13.

5.4 Final Design requirements

[I] The IO is responsible for carrying out design development to final detailed design for Temporary First Wall. The IO is responsible for providing all necessary Technical Specifications, 3D models, 2D Drawings and baseline documents.

[I] The 2D Drawings of the TFW components cover at least the following information:

a. Nominal dimensions and geometrical references
b. Resulting overall tolerances on the finished surfaces and identified interfaces of the procured assembly
c. Surface roughness on locations and areas with specific requirements
d. Locations and definitions of the fixing and connecting features of the procured assemblies with other ITER components

[REQ-28] The DA shall replicate the three TFW panel designs provided in **[AD2]** *List of variants for the TFW assemblies* the complete set of variants.

[**I**] The IO remains responsible for design approval, justification, and design review.

[REQ-29] The tolerances and requirements provided in the assembly drawings of **[AD2]** *List of variants for the TFW assemblies* shall be the basis for replication to other variants.

5.5 Manufacturing Design Requirements

[I] After the replication of IO models, the DA takes over responsibility for the Manufacturing Design.

[REQ-30] Wherever a deviation from the IO-supplied models and drawings is foreseen prior to implementation, the DA shall issue a Deviation Request (DR) in accordance with **[RD19]** for IO acceptance. The DR shall include a presentation of all detailed changes and a corresponding 3D model file (preferably in CATIA format, although STEP is acceptable).

[REQ-31] After manufacturing design completion and before the manufacturing starts, the DA shall provide "manufacturing" model (in CATIA format and uploaded in Enovia database) and drawings (as revision of IO drawing and uploaded in Enovia database and SMDD) to IO with either of the following:

- stamp as "No Change" during the manufacturing design preparation; or
- highlight the changes in updated drawings.

[REQ-32] Wherever the manufactured parts deviate from IO requirements, the DA shall issue a NCR in accordance with **[RD20**], together with a presentation of all detailed changes and a corresponding 3D model file (preferably in CATIA format, although STEP is acceptable) and drawing revision (uploaded in SMDD) with identification of the non-conform dimensions and list of applicable NCRs.

[REQ-33] A prototype of one full-scale finger, representative of the most complex finger to be manufactured, shall be produced prior to MRR and subjected to dimensional inspection and high heat flux testing, according to requirements in Section 5.12 and Appendix A2.

5.6 Interface requirements

[I] See **[RD**4**]** *Sub-system Requirements Document (sSRD) for temporary first wall* for all technical interfaces, for information.

[REQ-34] The DA shall comply with 3D models and 2D drawings, referring to **[AD2]** *List of variants for the TFW assemblies*, for design requirements of the interfaces.

5.7 Manufacturing requirements

[REQ-35] Manufacturing shall start only after the successful Manufacturing Readiness Review (MRR) according to**[RD18].**

[REQ-36] A descriptive document of the manufacturing processes and their qualification procedures shall be provided for IO acceptance.

[REQ-37] The Manufacturing Drawings (revised according to Manufacturing Design), Manufacturing and Inspection Plan (MIP) and procedures which need qualification or IO acceptance shall be provided for IO acceptance.

[I] IO's acceptance of the manufacturing process is only aimed at checking whether the DA's proposal is ITER relevant and whether it is consistent with the requirements of the TFW. IO's acceptance does not relieve the DA from any of their responsibility. The DA has the sole responsibility in the success or failure of the proposed manufacturing process.

[I] Other equivalent national or international standards than those mentioned in this specification may be acceptable with prior written IO's approval. This approval is subject to the submission of evidence that the alternative standard is equivalent to the proposed one.

[REQ-38] The DA shall ensure no contact between stainless steel with carbon steel during fabrication and storage.

[REQ-39] The assembly of TFW at the factory shall be performed in a suitably clean area which is compatible for handling VQC-1B components.

[REQ-40] After the final cleaning procedure, all components shall be handled with care, using appropriate gloves and procedures.

[I] It's recommended to use Manufacturing Database for manufacturing record,

[REQ-41] Vacuum brazing for W cladding onto SS is not allowed.

[REQ-42] In case of using Electric Discharge Machining (EDM), in particular Wire Electric Discharge Machining that uses Brass wire as the electrode, the surface of the component shall be cleaned, in order to comply with the requirement specified in the **[AD3]** *ITER Vacuum Handbook*. The process shall be qualified to demonstrate that an acceptably contamination free surface has been produced.

[REQ-43] Unless otherwise specified in the 2D drawings, the finishing of all the external metallic surfaces shall be Ra = 6.3 µm or finer except when non-destructive examinations require better values.

[REQ-44] Unless otherwise specified in the 2D drawings, all the dimensions shall satisfy the tolerance Class "m" of [CS3] *ISO 2768-1* and tolerance Class "K" of [CS4] *ISO 22081* (Replacing ISO 2768-2).

[REQ-45] Access to the DA suppliers' premises shall be ensured for IO representatives and regulatory bodies, when required to oversee or support the work being executed.

5.8 Vacuum requirements

[I] The TFW does not form part of the primary vacuum boundary but is inside the primary vacuum. The TFW has a Vacuum Classification VQC-1B.

[REQ-46] Manufacturing of TFW components shall comply with the requirements stated in the **[AD3]** *ITER Vacuum Handbook*. Any conflict with the requirements of this specification shall be brought to the attention of IO for resolution.

[I] Section 5.4 of the **[AD3]** *ITER Vacuum Handbook* includes the requirements for outgassing rates of materials with details and guideline given in Appendix 17 of the **[AD3]** *ITER Vacuum Handbook*.

[REQ-47] In addition to the baking requirements specified in **[AD3]** *ITER Vacuum Handbook*, the TFW steel components shall be subject to high-temperature baking (up to 550 C) for long duration (up to 48 hrs) to reduce outgassing during operation. This may be performed by parts before the assembly of the TFW panels.

[REQ-48] Provision of a clean work plan in accordance with Section 24.1 of the **[AD3]** *ITER Vacuum Handbook* shall apply.

5.9 Coatings

[**I**] The "Tile support to Finger support bolt" and "Tile fixation bolt" are coated with Anti-Seize Coating (ASC) to prevent seizing during assembly.

[REQ-49] The ASC coatings shall follow the requirements defined in **[AD17]** *Copper Anti-seize coating specification for In-vessel components*.

[I] The Threaded Barrel is coated with Electrical Insulation Coating (EIC) to control the flow of eddy currents and halo current instead through the Electrical Straps.

[REQ-50] The EIC shall follow the requirements defined in **[AD18]** *Insulating coatings for the blanket system components*.

5.10 Requirements for Threaded Components

[REQ-51] Thread dimensions and tolerances shall be in accordance with relevant ISO standards [CS12] *ISO 261*, [CS13] *ISO 262*, [CS14] *ISO 965 -1* and [CS15] *ISO 965 - 2*, unless specified differently in the drawings.

[REQ-52] The TFW threaded components shall be 100% visually examined in accordance with [CS11] *ASME Section V, Article 9* or EN corresponding standard. The acceptance criteria shall be in accordance with [CS10] *ASME Section III, NG-2582* or EN corresponding standards.

[I] Three main bolt locking systems are used for TFW: self-locking thread, locking washer, and for the ES side bolts, physical plates. The type of locking system to be used for a specific bolt system is presented in the corresponding assembly drawing.

[I] The DA is free to choose between Spiralok® or Selflock® in case of self-locking thread and between NordLock® and Schnorr® safety washer type "VS" in case of locking washer.

[REQ-53] The TFW bolted system shall be tightened with nominal torque in accordance with Table 5-3.

[REQ-54] The bolt torquing shall be performed with a calibrated tool to achieve accuracy of ±10%.

[I] The TFW central bolt and the ES bolt for interface between TFW and SB are to be torqued during In-vessel Assembly at ITER site; bolt torquing of these bolts are out of scope of this contract.

Table 5-3. Bolt Torquing Specification

Bolted Connection	Material	Nominal Applied Torque [Nm]
Finger support to central beam	**SS660**	**125**
Finger plate to Finger support	**718**	**100**
Tile bolts	**718**	**70**
Electrical Strap side flange	**SS660**	**100**
TFW central bolt	**SS660**	**6000**
RH Tag bolt	**316L**	**10**
RH_Diag_interface bolt	**316L**	**20**
Pad nut	**AlBr**	**80**
Central bolt set screw	**A4-80**	**5**
Central Barrel	**AlBr**	**100**

5.11 Materials

5.11.1 General Requirements

[REQ-55] All materials shall conform to the requirements of this specification (see Table 5-4) and Section 5 of the **[AD3]** *ITER Vacuum Handbook.*

[REQ-56] In case Liquid Penetrant Testing is required, it shall comply with the **[AD3]** *ITER Vacuum Handbook.*

[REQ-57] All materials shall be new and of specified quality, where “New” means materials to be manufactured according to material specification, or procurement of Commercial Off-the-Shelf (COTS) material, but can’t be “used” or “recycled”.

[REQ-58] All materials shall be properly identified; each block of material being assigned a unique traceable number.
[REQ-59] Traceability of each material shall be maintained throughout all manufacturing processes. Traceability documentation which cross-references component parts to material certificates shall be included in the given documentation.
[REQ-60] All the materials required to manufacture the components shall meet the requirements in material specifications.

5.11.2 Material Specifications

[I] The detailed material assignments for all items are specified in the 2D drawings.

[REQ-61] Each TFW material shall be in accordance with the specified applicable document in Table 5-4.

Table 5-4: TFW Material Specifications

Material/Grade (as spec'd in 2D)	**Material Specification**
Tungsten	**[AD5]** *Bulk tungsten for TFW*
Tungsten Heavy Alloy	**[AD6]** *Tungsten heavy alloy WNiFe for TFW*
Steel 304L	**[AD7]** *Steel EN 1.4307 (304L) forgings or forged bars for non-DT in-vessel usage*
Steel 316L (EN 1.4404)	**[AD8]** *Steel EN 1.4404 (316L) forgings or forged bars for non-DT in-vessel usage* **[AD9]** *Steel EN 1.4404 (316L) plates for non-DT in-vessel usage* **[AD10]** *Steel_14404_grade_316L_Plates_less 5 mm*
Steel A4-80 fasteners	**[AD11]** *Steel 316L Grade A4-80 for non-DT in-vessel usage*
Steel 660	**[AD12]** *Steel EN 1.4980 (660) for non-DT in-vessel usage*
Alloy 718	**[AD13]** *Alloy 718 for Blanket*
Al-Bronze (C63200)	**[AD14]** *Aluminium bronze rods, bar and shapes Procurement Specification for ITER Blanket System*
Bulk Copper	**[AD15]** *Copper plate for non-DT in-vessel usage*

[REQ-62] When procuring COTS materials, all missing test results compared to the material specification shall be reported.

[REQ-63] When procurement off the shelf materials, below test results shall be provided for information:

- Chemical analysis results of Co, Ta, Nb (radiation protection requirements);
- Magnetic permeability.

5.11.3 Processing Materials

[REQ-64] Other materials, if exposed to the vacuum environment, shall comply with the requirements of the **[AD3]** *ITER Vacuum Handbook* and as such shall be on the IO approved materials list **[RD9]** *Material Approval Request Database*. Specifications for these materials are managed by the DA and hence specifications shall be developed and supplied to IO for vacuum compatibility approval and IO acceptance, referring to **[RD15]** *Presentation: ICP Database for management of Material, Fluid and Processing Material Approval Requests*.

5.12 Examinations and Acceptance Criteria

5.12.1 General Requirements

[REQ-65] All surfaces to be visually examined shall be clean and free from all foreign matters, which may adversely affect evaluation of the test results.

[REQ-66] Following any non-destructive examination in which materials are applied to the piece, the piece shall be thoroughly cleaned in accordance with suitable procedures which do not degrade or introduce impurities in the examined surface. The applicable standards are those specified for each examination.

[I] The minimum required examinations and the acceptance criteria are given hereinafter.

[REQ-67] The examinations shall be carried out by qualified personnel.

[I] The DA is recommended to envisage all the additional examinations that it deems to be necessary to detect possible non-conformities at an early stage of the manufacturing process and thus to be able to perform suitable and timely corrective actions.

[REQ-68] The non-destructive examinations to be applied shall be performed in accordance with a written procedure (non-destructive testing protocol) that shall include, as a minimum, the following information in addition to the requirements of the applicable standards:

- Scope of examination and stage of manufacture at which it is conducted,
- Surfaces on which examination will be performed: drawings may be used to indicate areas of examination for each procedure and any limitations due to size, shape or other physical characteristics,
- Data to be recorded.
- Applicable standards for the examination

[REQ-69] The DA shall prepare a report for each non-destructive examination carried out to be included in the given documentation. All reports shall, as a minimum, contain the following information in addition to the requirements of the applicable standards:

- All procedural, equipment, and calibration parameters of sufficient detail to provide a basis for comparison with later examinations.
- A marked-up drawing or sketch indicating the weld or part examined, the item or piece number, the datum points and co-ordinate conventions used for location, and other identification information necessary.
- An acceptance or rejection statement on the detected defect indications.

5.12.2 Calibration of measuring equipment

[REQ-70] Measures shall ensure that tools, gauges, instruments, and other inspection, measuring, and testing equipment and devices used to determine the acceptance criterion's conformance are acceptable range, type, accuracy, and precision.

[REQ-71] Testing and measuring devices used in activities affecting quality shall be controlled, calibrated, and adjusted at specified intervals (at least once a year) or before use to maintain accuracy within limits.

[REQ-72] The DA shall perform the above activities in a calibration laboratory accredited to [CS8] *ISO 17025*, which may be the DA's own or external.

[REQ-73] Proposal of other international standards for accreditation shall be demonstrated the equivalence in deviation request and be subject to IO approval.

5.12.3 Qualification of personnel

[REQ-74] NDT personnel shall be qualified and certified in accordance with the standard [CS5] *EN ISO 9712* except for direct visual examination (if the inspector has a qualification in another NDT method, IO accept it as qualification for visual testing).

[REQ-75] The inspection shall be performed by the NDT Inspector of level 1 at minimum.

[REQ-76] The interpretation shall be performed by the NDT Inspector of level 2 at minimum.

[REQ-77] The procedure shall be approved by the NDT Inspector of level 3.

[REQ-78] The DA shall ensure that the personnel who perform and evaluate the non-destructive examinations are qualified and certified in accordance with the standard [CS5] *EN ISO 9712*.

[REQ-79] The DA shall ensure that personnel performing tests other than NDT have experience performing similar tests/inspections.

5.12.4 Visual Examination

[REQ-80] The DA shall visually examine all TFW sub-components and assemblies at the appropriate manufacturing stage.

[REQ-81] The finishing of the surface shall be as required in the manufacturing drawings.

[REQ-82] The cleanliness of the surface shall be as defined in Appendix_13 of **[AD3]** *ITER Vacuum Handbook*. The TFW is VQC-1B component.

[REQ-83] All surfaces, including cladding if applicable, shall be free from wrinkles, ripples, buckles, blowholes, tears, cracks, moisture, oil, rust and inclusions or foreign bodies.

5.12.5 Geometrical Shape and Tolerances

5.12.5.1 Introduction

[REQ-84] The geometrical shape and tolerances shall be measured on each final component, after the completion of the manufacturing process, in accordance with 2D drawing requirements.

[REQ-85] The geometrical shape and tolerances shall be measured according to a testing protocol and Dimensional Inspection Plan (DIP) agreed with IO and compliant with the **[AD4]** *ITER Dimensional Metrology Handbook*. The TFW is Metrology Class 1 component.

[REQ-86] The dimensional metrology shall be carried out at room temperature.

[I] The **[AD4]** *ITER Dimensional Metrology Handbook* outlines the mandatory requirements for dimensional control of the components, assemblies and systems for the ITER machine. In addition, the handbook provides significant guidance and helpful information on best practice for metrology applications.

[REQ-87] The DA shall prepare a dimension report, as a minimum, containing the following information:

- The implemented Dimensional Inspection Plan with all data sheet tables.
- All Meta data files, electronic measurement files e.g. Spatial Analyzer, Polyworks, PCDMS etc. An acceptance or rejection statement on the detected defects.

- Record or Log for Instrument, Personnel and Temperature.
- Drift & Artifact Record for use with Laser Tracker.
- Calibration certificates SHALL BE provided upon request.
- Photograph(s) of each instrument(s) and part in use to provide record of part set up and instrument operations.

5.12.5.2 General Tolerances

[REQ-88] Unless otherwise specified, the dimensions shall satisfy the tolerance Class "m" of [CS3] *ISO 2768-1* and tolerance Class "K" of [CS4] *ISO 22081* (Replacing ISO 2768-2). General tolerances do not require a specific check unless there are doubts that they have been met.

[REQ-89] The above tolerances also apply to the maximum deviation from the straightness and flatness of straight lines and flat surface, respectively.

5.12.5.3 Specific Tolerances

[REQ-90] The conformity with the required specific tolerances shall be demonstrated and reported in an appropriate table (DIP). The format of DIP must contain all the necessary information in order that the correct controls can be exercised.

[I] Specific tolerances are shown in the IO 2D General Assembly Drawings, as detailed in the **[AD2]** *List of variants for the TFW assemblies*.

5.13 Acceptance Tests

[REQ-91] A Free Issue Items Acceptance Test shall be conducted for the Free Issued Items from the IO (specifically the components from the Pad, Electrical Strap, and Central Bolt assemblies), including:

- 100% Visual examination of the components.

[REQ-92] Factory Acceptance Tests (FAT) shall be conducted for the Temporary First Wall *assemblies* and Spare components, including:

- Visual examination
- **[REQ-93]** Dimensional examination shall be conducted for the Temporary First Wall *panels* and Spare components in accordance with the Dimensional Inspection Plan. A dimensional check of the Temporary First Wall *assemblies* shall also confirm that the added parts like barrel, straps and pads are properly installed.
- A record of the as-built position of the tags for robot vision.

[I] The Final Acceptance will be carried out by the IO at ITER site, after agreement with IO on the delivery date. This will include:

- Receiving Inspection at ITER site, which is to inspect the records of status of the packages during the delivery; If the accelerometers record shocks above 5g, a visual examination of the TFW for signs of damage will be performed. A decision on acceptance will be made by mutual agreement between IO and the DA.

- ITER Site Acceptance Tests (carried out outside the scope of this Contract), including:
  - 100% Visual examination of the TFW assemblies and spares.

5.14 Component Labelling and Traceability

[REQ-94] The IO and DA shall agree to a permanent identification and numbering system, which comply with the IO official numbering system, according to the document **[RD21]** *ITER Numbering System for Components and Parts*. All TFW assembly and the main subcomponents shall be clearly marked in a permanent way with the IO official numbering system. All fabrication records shall be electronically archived following the IO requirements and templates.

[I] In addition to the coding and marking as defined in Section 9 of the **[AD1]**, before the start of manufacturing activities, the IO and DA will agree on a component and sub-component numbering system in line with **[RD3]** *Blanket numbering system*.

[REQ-95] All parts of the TFW components shall be marked in accordance with marking procedures agreed with IO.

[REQ-96] Wherever possible marking shall be done on each part. It is allowed to provide marking on the bag comprised few small parts from the same batch, like nuts, pins, bolts, set-screws, etc.

5.15 Cleaning

[REQ-97] The DA shall submit cleanliness control plan including validation of the cleaning procedures for components during assembly and final delivery for the IO acceptance in accordance with Section 24 of the **[AD3]** *ITER Vacuum Handbook*.

[REQ-98] The cleaning fluids shall be compliant with the Appendix 4 of the**[AD3]** *ITER Vacuum Handbook* and as such shall be on the IO approved materials list **[RD9]** *Material Approval Request Database*

[I] The use of incompatible cleaning materials with vacuum conditions is not permitted.

[REQ-99] The TFW shall be properly cleaned and dried before packaging.

[REQ-100] Final cleaning shall not damage the surface finish, coating performance, material properties or metallurgical structure of the materials.

5.16 Baking

[REQ-101] Before final packaging, all TFW components and subcomponents shall be baked in accordance with approved procedures base on Section 26.2 of the **[AD3]** *ITER Vacuum Handbook*. A report of the baking shall be provided including time, temperature and vacuum level in plots.

[REQ-102] Vacuum ovens containing heating filaments within the vacuum shall not be permitted for the TFW components baking operation unless a complete qualification is performed.

[I] The baking cycle may be performed as part of the cleaning process.

5.17 Handling, packing, preservation & shipping

[REQ-103] In order to handle, support and protect the TFW assembly during transportation and storage, a support frame shall be manufactured. The frame shall also ensure suitable Tungsten protection and storage conditions, ease of removal and replacement of the TFW assembly into the crate (or container) and shall be based on a modular approach to enable stacking and minimize necessary storage volume. The support frame and the crate (or container) shall be able to accommodate a fully assembled TFW with its full complement of Standard Parts, including jig to support/protect TFW Central Bolt assembly and Electrical Strap assembly.

[I] For best practice the metallic design structure is requested to follow EN 1993 Eurocode 3.

[REQ-104] The detailed design of support frame and support jig shall be agreed between the DA and IO.

[REQ-105] The handling of the components shall be minimized and strictly controlled to preserve cleanliness.

[REQ-106] The DA shall design and supply appropriate packaging, adequate to prevent damage during shipping and handling operations.

[REQ-107] Provision of transportation box handling features (for forklift and slinging) shall be implemented as agreed with IO.

[REQ-108] Components shall be packed with adequate protection from thermal or mechanical stresses which may adversely affect the operation of the component.

[REQ-109] All packing shall be sealed and marked externally stating ITER Vacuum Category of the components inside.

[REQ-110] Handling instructions shall also be clearly marked on the outside of the packaging.

[REQ-111] All parts shall be shipped dry, irrespective of final acceptance testing at the DA's site.

[REQ-112] The use of adhesive tape for the protection and packaging of parts shall be restricted to prevent the risk of contamination from the tape.

[REQ-113] If adhesive tape is used on austenitic stainless steel, the tape shall meet leachable chloride and fluoride limits of 15 ppm and 10 ppm, respectively.

[REQ-114] If it is used, adhesive tape shall be fully removable leaving no residue, using isopropyl alcohol or acetone as solvent to remove all traces of the adhesive.

[REQ-115] To prevent damage and contamination during transit, the packaging of parts shall be done as soon as possible after acceptance testing and final cleaning at the DA's premises. Cleaning and packaging operations may be witnessed by ITER.

[REQ-116] The components shall be entirely enclosed in heat-sealed polyethylene which has been purged and backfilled with dry air (<4000 ppm H_2O).

[REQ-117] Where the purging and backfilling of the polyethylene enclosures is not practical, alternative conditions shall be submitted for IO approval.

[REQ-118] Packaging shall be non-returnable and of a robust nature, suitable for the foreseeable transportation method (for air transport this should include an un-pressurized cargo hold) without damage to the parts.

[REQ-119] One tri-axial accelerometer per each batch of products shipped shall be used.

[I] A 3 -directional ShockLog 298 accelerometer, is preferred.

6 LOCATION FOR SCOPE OF WORK EXECUTION

[I] The DA can perform the work at their own location.

7 IO DOCUMENTS & IO FREE ISSUE ITEMS

7.1 IO Documents

[I] Under this scope of work, IO will deliver the following documents by the stated date:

Table 7-1: IO documents to be delivered to permit continuation of the procurement.

Ref	Title	Doc ID	Expected date
1	Model and drawing of TFW panel assembly (Input for fabrication)	ITER_D_CYAHU7 (Revision of [AD2])	Jun-2027 (After TFW FDR closure)
2	Input for Barrel Shim manufacturing	To be created	Apr-2030

7.2 Free issue items

[I] Under this scope of work, IO will deliver the following equipment/parts by the stated date:

Table 7-2: Free issue items to the procurement.

Standard part ENOVIA description	Qty	Assembly	From	ENOVIA ID	Expected date
DIN 472-1 Retaining ring 115x4	459	Central Bolt	CNDA	4JYN9M	Apr-2030
DIN 472-1 Retaining ring 120x4	459	Central Bolt	CNDA	4JYK3B	Apr-2030
ISO 4027 set screw M8x12	918	Central Bolt	CNDA	SJCLMX	Apr-2030
FW Barrell Shear Key	459	Central Bolt	CNDA	SJ522P	Apr-2030
BKT_FW_CENTRAL_BOLT	459	Central Bolt	EUDA	T4FZH2	Apr-2030
BKT_PARKING_FEATURE	459	Central Bolt	EUDA	T4G9P9	Apr-2030
BKT_FW_SPHERICAL_WASHER	459	Central Bolt	EUDA	T4G4RH	Apr-2030
BKT_CONICAL_WASHER_CENTRAL_BOLT	459	Central Bolt	EUDA	T4G53E	Apr-2030
BKT_FW_PAD	3671	Pads	RFDA	DN2PBV	Apr-2030
BKT_FW_NUT	3671	Pads	RFDA	LXU9UQ	Apr-2030
BKT_FW_STD_PAD-SHIM	3671	Pads	RFDA	3DKU2E	Apr-2030
BKT_ES_10L_FW	389	10L ES assy	RFDA	RNJB59	Apr-2030
BLKT_ES_PLATE_10L	389	10L ES assy	CNDA	4AZXQG	Apr-2030
BKT_ES_14L_FW	529	14L ES assy	RFDA	RNJ89Y	Apr-2030
BLKT_ES_PLATE_14L	529	14L ES assy	CNDA	4AZXSM	Apr-2030
BLKT_ES_BOLT_M24_65_SPEC_HEAD	918	Common ES	EUDA	FDNS3Z	Apr-2030
SPRING_WASHER_22_53_4	918	Common ES	CNDA	4AZXNF	Apr-2030

[REQ-120] The DA shall quote as option the supply of Pad Assemblies and Electrical Strap in accordance with the requirements in Appendix A1 – Electrical Strap and Pad Requirements.

8 DELIVERABLES AND SCHEDULE MILESTONES

8.1 Schedule for delivery Hardware

[REQ-121] The DA shall deliver 437 TFW assemblies as well as several TFW spare components, as detailed in the **[AD2]** *List of variants for the TFW assemblies*.

[REQ-122] All hardware shall be supplied to the ITER site no later than 4.5 years (54 months) after TA signature.

8.2 List of deliverable documentation

[REQ-123] The DA shall provide IO with the documents and data required in the application of this technical specification, the **[AD1]** *GM3S* and any other requirement derived from the application of the contract.

[I] Table 8-1 below provides a minimum (i.e. non-exclusive) list of documents that are required along with their expected timing.

Table 8-1: List of deliverable documentation.

Doc Category	Document tile	Further Description	Expected Timing (T0 + X month)[2]
KOM	Contract Management Plan (or Quality Plan)	*GM3S* [AD1] Section 8.2 and [RD2]	T0 + 1
KOM	List of Deliverables	Living document [RD11] *GM3S* [AD1]	T0 + 1
KOM	Contract Implementation Schedule	Living document *GM3S* [AD1] Section 6.1.4.1	T0 + 1
KOM	Progress Report	*GM3S* [AD1] Section 6.1.4.2 and Appendix IV/ Appendix II	T0 + 1
KOM	Contract Risk and Opportunities	*GM3S* [AD1] Section 6.1.4.3	T0 + 1
KOM	KOM Minutes	*GM3S* [AD1] Section 6.1.5.1 and Appendix III	T0 + 2
Model and drawings	Replication of model and drawings to be released in batches		T0 + 9
Prototype	Report on prototype qualification		T0 + 11
MIP	Manufacturing and Inspection Plan to be released in batches	*GM3S* [AD1] Section 8.4.2 and Appendix VIII	T0 + 12

[2] T0= Contract signature date; X in months.

SUPPLY

MRR	Manufacturing Readiness Review	*GM3S* [AD1] Section 6.1.5.2.3 and [RD18]	T0 + 12
MRR	Material Report (Conformity of Material), by batch		T0 + 12
Production	Manufacturing and Test Report of TFW tiles, by batch		T0 + 16 (first batch)
Production	Manufacturing and Test Report for TFW threaded components, by batch		T0 + 16 (first batch)
Production	Manufacturing and Test Report of TFW beams, by batch		T0 + 18 (first batch)
Production	Manufacturing and Test Report of TFW panels, by batch		T0 + 20 (first batch)
Production	Manufacturing and Test Report of TFW panel assembly, by batch		T0 + 22 (first batch)
FAT	FAT readiness review	*GM3S* [AD1] Section 6.1.5.2.4	T0 + 24
DRR	Release Note	*GM3S* [AD1] Appendix VII	T0 + 42
DRR	Package and Packing List	*GM3S* [AD1] Appendix XII	T0 + 42
DRR	Delivery Report of TFW panel assembly to be released in batches	*GM3S* [AD1] Appendix XIII	T0 + 42
DRR	Storage & Preservation requirement	*GM3S* [AD1] Appendix XIV	T0 + 42
DRR	Delivery Readiness Review of TFW panel assembly to be released in batches	*GM3S* [AD1] Section 6.1.5.2.5 and Ref [5]	T0 + 42 (first batch)
Close-out			T0 + 54 (4.5 years)

[REQ-124] DA shall prepare their document schedule based on the above and using the template available in the *GM3S* **[AD1]** appendix II (click here to download).

9 QUALITY ASSURANCE REQUIREMENTS

[I] The Quality class under this contract is Quality Class 2, the *GM3S* **[AD1]** Section 8 applies in line with the defined Quality Class.

[REQ-125] Prior to commencement of the task, a Quality Plan shall be submitted for the IO acceptance giving evidence of the above and describing the organization for this TA. Manufacturing activities shall not start prior to acceptance of the MIP by the IO in accordance with **[RD2**].

[REQ-126] Deviation and Nonconformity management shall follow the procedures detailed in **[RD19]** and **[RD20]**.

[I] The DA shall ensure that the quality of services meet the requirements. In case of any questions, the DA shall ask IO for clarification prior to proceeding with the work.

[REQ-127] The documentation submitted to IO shall be available in English.

10 SAFETY REQUIREMENTS

[I] No specific safety requirement related to Protection Important Components and Protection Important Activities apply.

10.1 Nuclear class Safety

[I] No specific safety requirement related to Pressure Equipment and Nuclear Pressure Equipment apply.

10.2 Seismic class

[I] The Seismic class under this contract is Seismic Class 2.

11 SPECIAL MANAGEMENT REQUIREMENTS

[I] Requirement for the *GM3S* **[AD1]** Section 6 applies in full.

11.1 CAD design requirements

[I] This contract requires for CAD activities, the *GM3S* **[AD1]** Section 6.2.2.2 applies.

APPENDIX A1 – ELECTRICAL STRAP AND PAD REQUIREMENTS

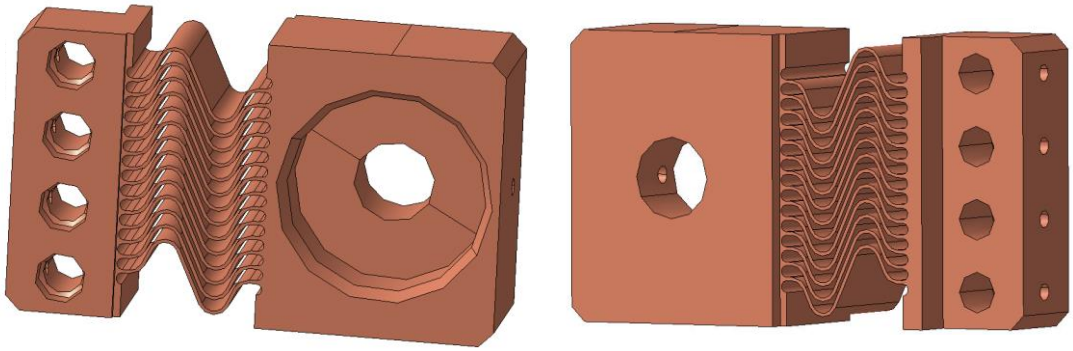
A1_1 SCOPE

[I] This section defines specific manufacturing and testing requirements for both Electrical Strap and Pad Assembly. It will be alternative strategy to the IO Free Issued Item as shown in Section 5.2.2 and 5.2.3.

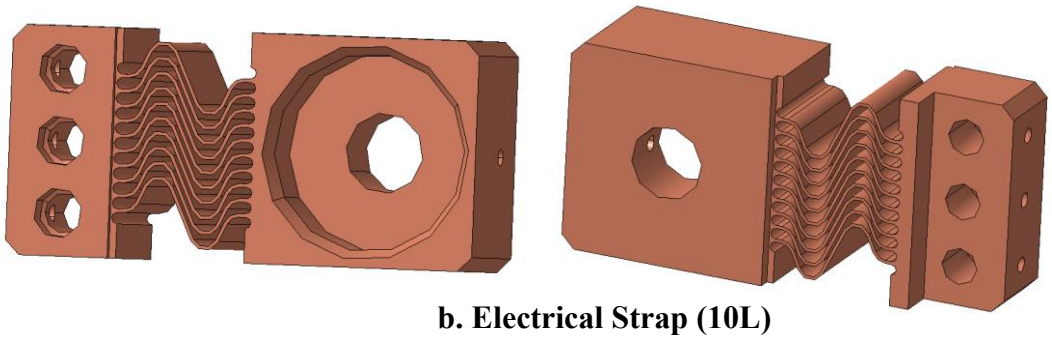
[I] Referring to Section 5.7 and 5.12 for standard manufacturing and testing requirements.

A1_2 Specific Requirements for Electrical Strap

[**A1_REQ-1**] The Electrical Strap (see Figure A1_1) shall be manufactured from CuCrZr in the solution annealed and aged condition as per **[AD16]** *CuCrZr-IG forgings for Electrical Straps for ITER Blanket Application*.



a. Electrical Strap (14L)



b. Electrical Strap (10L)

Figure A1_1 TFW Electrical Strap

A1_2.1 Ultrasonic Testing

[**A1_REQ-2**] The Ultrasonic Testing shall be performed on the ES blank for acceptance prior to manufacturing of the ES.

[**A1_REQ-3**] The UT procedure for the ES blank shall be prepared for the IO acceptance in accordance with [CS9] *EN 583-1: Non-destructive testing – Ultrasonic examination – Part 1: General principles*.

[**A1_REQ-4**] The middle zone of the ES blank shall be subjected to the UT control at 30 mm from the ends. The scanning is carried out over the entire volume of the middle zone of the blank in three mutually

perpendicular directions. At the same time, the scanning along the face of the blank 185 mm long is carried out in two directions, from opposite surfaces.

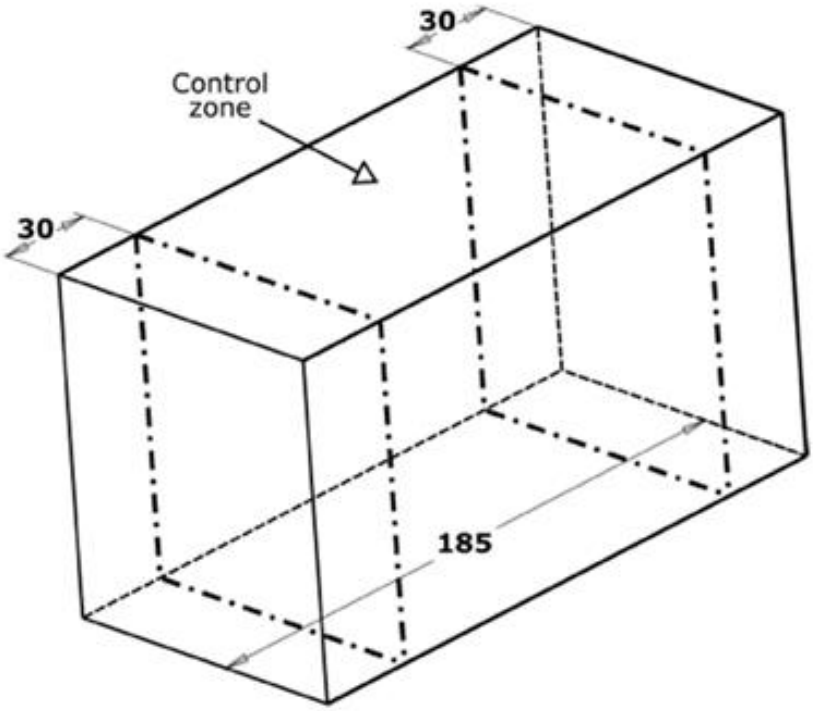


Figure A1_2 UT Control Zone of the ES blank

[**A1_REQ-5**] A reference block with Flat Bottom Hole (FBH) with diameter of 1.5 mm shall be used for setting up the UT inspection.

[**A1_REQ-6**] Acceptance Criteria: The quality of the blanks is determined in accordance with [CS10] *ASME Section III, Division 1, Subsection NG-2542* and considered unsatisfactory if:

1. One or more reflections greater than-equal reference FBH
2. One or more reflections which produce indications less than reference FBH reflector when the back reflection falls below 5% of full calibration screen height

[**A1_REQ-7**] 100% of the ES blanks shall be subjected to UT.

A1_2.2 Visual Testing

[**A1_REQ-8**] The Visual Testing procedure for the ES shall be prepared for the IO acceptance in accordance with [CS11] *ASME V*.

[**A1_REQ-9**] 100% of ES shall be subjected to VT in accordance with the following acceptance criteria:

- Any defects located on the lamella edges that reduce the distance between lamellas are not permitted.
- The surfaces of the ES shall have a homogeneous appearance. Heat scale or presence of temper colours are prohibited.
- It is allowed to have the presence of groove of EDM wires in zone of the ES lamella roots with width no more than 0.1 mm as shown in Figure A1_3.

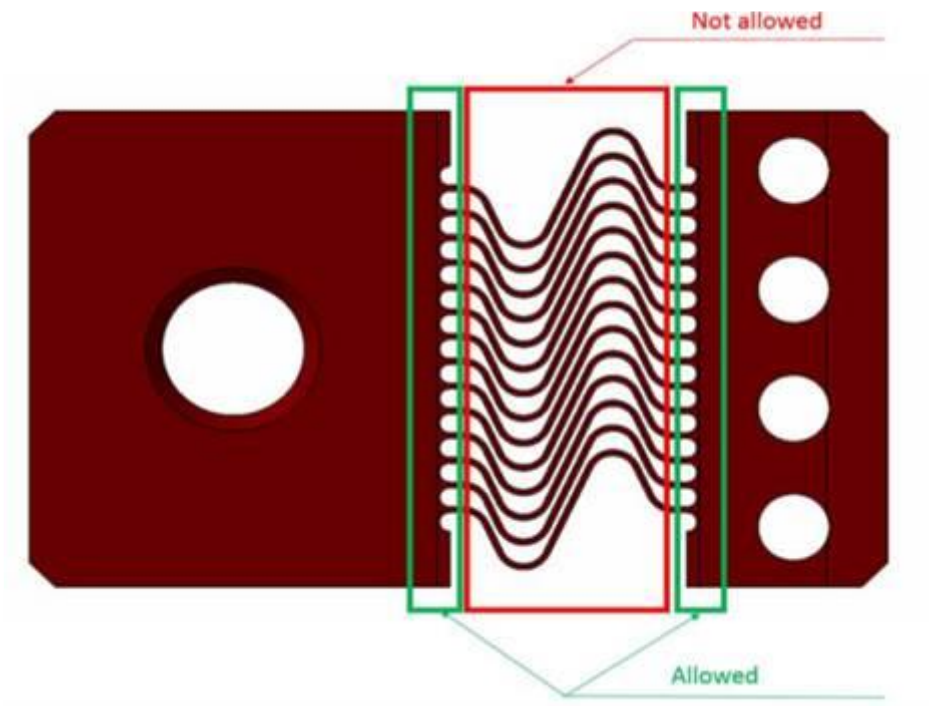


Figure A1_3 Location of allowed and not allowed EDM grooves on the ES.

A1_3 Specific Requirements for Pad Assembly

[**A1_REQ-10**] The TFW Pad shall be manufactured from Aluminium Bronze as per **[AD14]** *Aluminium bronze rods, bar and shapes Procurement Specification for ITER Blanket System*.

[**A1_REQ-11**] The TFW Pad Nut shall be manufactured from Aluminium Bronze as per **[AD14]** *Aluminium bronze rods, bar and shapes Procurement Specification for ITER Blanket System*.

[**A1_REQ-12**] The TFW Pad Shim shall be manufactured from SS316L **[AD10]** *Steel_14404_grade_316L_Plates_less 5 mm*.

[**A1_REQ-13**] The TFW Pad shall be coated by the DA with qualified EIC as per **[AD18]** *Insulating coatings for the blanket system components* on it bottom and side surfaces to be electrically insulated from the TFW central beam. See Figure 5-17 for illustration and 2D drawing through **[AD2]** *List of variants for the TFW assemblies*.

SUPPLY

APPENDIX A2 – FUNCTIONAL SPECIFICATION ON TUNGSTEN CLADDING AND HIGH HEAT FLUX TESTING

A2_1 Purpose

[I] This Appendix is the functional specification of Tungsten (W) cladding to define requirements for qualification and production of Tungsten cladding on 316L Stainless Steel plates for tiles used in ITER Temporary First Wall panel, including High Heat Flux (HHF) testing. W cladding includes W coating.

[I] This Appendix also describes the requirements for HHF testing of TFW finger prototype.

A2_2 Scope

[I] This section provides the requirements applicable for:

1. High Heat Flux Test (HHFT) of W cladding tiles.
2. HHFT of TFW finger prototype.

A2_3 Requirements for cladding sample manufacturing and examination

[I] The following examination and high heat flux test shall be performed as the qualification.

[A2_REQ_1] Two W cladded steel plates /technology /DA shall be manufactured from **[AD9]** *Steel EN 1.4404 (316L) plates for non-DT in-vessel usage* and from the relevant requirements within **[AD5]** *Bulk tungsten for TFW* in accordance with the requirements herein. For coating, chemical compositions of tungsten source plates or powder shall meet the requirements of **[AD5]** *Bulk tungsten for TFW*.

[A2_REQ_2] W cladding thickness shall be 0.01 - 1 mm and the W thickness variation shall be ±10% of nominal thickness.

[A2_REQ_3] Applicable non-destructive test and detection limit shall be proposed for cladding.

[A2_REQ_4] The following examination shall be performed for the W cladding steel plates according to Table A2_1.

Table A2_1: Examination of W cladding coupons and tiles

Examination	Instructions
On W cladded coupons	
Visual examination	Imperfection (>0.5 mm) shall be reported.
Microscopic examination	Performed at the cladded surface and cross section including interfaces
Surface roughness.	Ra ≤ 1.6 micro m at W surface and Ra ≤ 6.3 micro m at steel surfaces.
On Final W cladded tiles	
Visual examination at W surfaces	Imperfection (>0.5 mm) shall be reported.
Non-destructive tests	Applied inspection, the detection limit and detected imperfection (if any) shall be reported.
Dimension Inspection	The W cladding samples shall meet dimensional and geometrical requirements in the drawings.
Surface roughness examination	Ra ≤ 1.6 micro m at W surface and Ra ≤ 6.3 micro m at steel surfaces.

[A2_REQ_5] The W cladding coupons shall be manufactured during production phase. Both coupon production rate and testing rate shall be agreed with the IO.

A2_4 Requirements for High Heat Flux Testing

[I] The objective of HHF testing in an e-beam facility is to apply controlled heat loads in the ranges expected at the envisaged locations of the W cladded tiles in ITER to test the resistance and thermal fatigue performance of W-coated samples.

[I] This section outlines the requirements for high heat flux tests to qualify the performance of tungsten (W) cladded steel samples under high heat flux loading.

[A2_REQ_6] The following two types of HHF tests shall be performed for W cladding tiles:

(1) HHF test of W cladding under cyclic longer pulse loading (> 1 s) to simulate the steady-state thermal loads.

(2) HHF test of W coatings and bulk sample under cyclic short pulse loading (~ 1 ms) to test the performance under radiation flash load.

[A2_REQ_7] The following HHF test shall be performed for TFW finger assembly prototypes.

(1) HHF test of W cladding under cyclic longer pulse loading (> 1 s) to simulate the steady-state thermal loads on TFW finger assembly by its prototypes.

A2_4.1 Planning of HHF test

[A2_REQ_8] The HHF test facility, data acquisition, and data post-process shall meet the IO requirements for the test as listed in section A2_5 Requirements for the HHF tests.

[A2_REQ_9] A report demonstrating IO requirement compliance for the HHF test facility, data acquisition, and data post-process shall be submitted as a part of HHF test protocol for IO approval.

[A2_REQ_10] The HHF test protocol for the tests shall be submitted for IO approval, describing at minimum test preparation, test execution, monitoring, data acquisition and characterization. Refer to template **[RD16]** *HHFT protocol template*.

[A2_REQ_11] Plan of Data analysis which includes performance evaluation and failure modes shall be submitted as a part of HHF test protocol for IO approval.

A2_4.2 HHF test of W cladded plates under long pulse duration (> 1 s)

[A2_REQ_12] The cladding plates shall be loaded under cyclic heat flux at the power density P_L for N_L number of cycles, at loading area A_{L_cyclic}. Two cyclic loading shall be performed at the different areas. The loading area shall include the tile edges or bolt hole edges. The cladding shall not show indication of delamination. See Figure A2_1 for schematic illustration and Table A2_2 for requirements of detailed test parameters.

[A2_REQ_13] The duration of heat loads is t_L (t-time, L-long pulse) on at the P_L shall be limited to the maximum allowable temperature at T_{L_max2}.

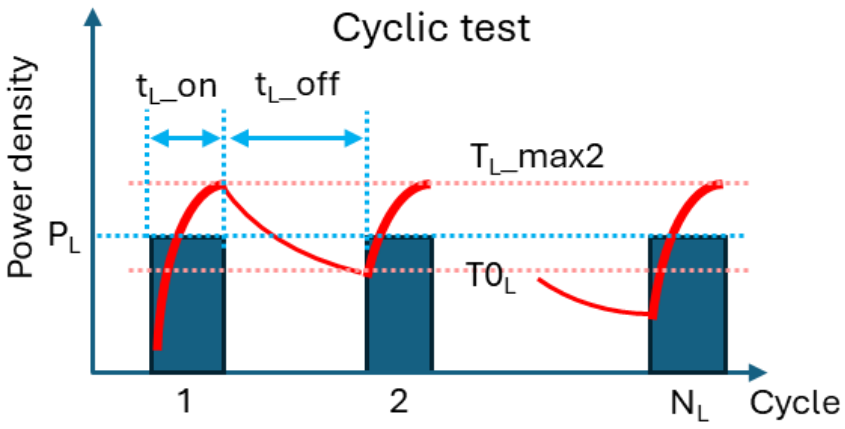
[A2_REQ_14] The initial temperature shall be less than $T0_L$ prior to each cyclic load.

[A2_REQ_15] The surface temperatures (start and end of the load) at every 50th cycle shall be reported.

[A2_REQ_16] The test report-1 for the longer pulse cyclic loading shall be submitted for the IO approval.

SUPPLY

[I] A general template of the HHF testing report, outlining the main chapters to be reflected in the report, is given in **[RD17]** *HHFT Report template*.



T_L_max2, $T0_L$, P_L, t_L_on and t_L_off, N_L stand for upper limit of surface temperature [°C] during cyclic test, upper limit of starting temperature [°C], power density [W/m2], loading time [s], dwel time [s], and cycle number, respectively.

Figure A2_1 Schematic illustration of the cyclic test of longer pulse loading.

Table A2_2 HHF test parameters for cyclic test of longer pulse loading.

Parameters		Required Values
Power density for screening tests and cyclic load tests	P_L [MW/m^2]	≤ 2 MW/m^2
Duration for cyclic load	t_L_on [s]	Duration shall be limited by defined T_L_max2
Dwell time for cyclic load	t_L_off [s]	Dwell time shall be determined by the time to reach at $T0_L$
Maximum surface temperature before loading; Maximum surface temperature during cyclic test	$T0_L$; T_L_max2 [°C]	$T0_L$ = 300 °C T_L_max2 = 1000 °C
Cycle number/ sample	N_L	500
Cyclic test areas/ sample		2 areas
Loading area for cyclic load [mm x mm]	A_{L_cyclic} [mm^2]	~80 × ~20 mm^2 (different area can be acceptable after agreement with the IO)

A2_4.3 HHF test of W cladded plates under short pulse duration (~1 ms)

[A2_REQ_17] The W cladding samples shall be loaded under cyclic heat flux at the power density, P_S for N_S number of cycles, at loading area A_s. The different cyclic loading shall be applied at different areas. The W cladding shall not show indication of delamination. See Figure A2_2 for schematic illustration and Table A2_3 for requirements of detailed test parameters.

SUPPLY

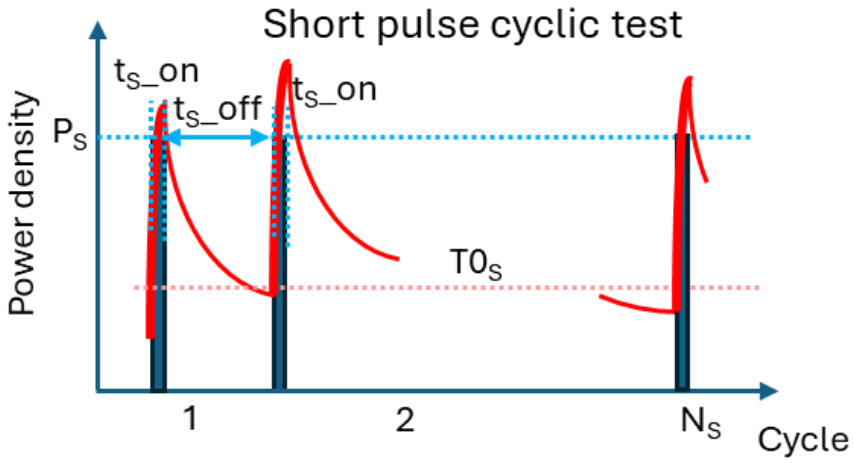
[A2_REQ_18] The duration of heat loads at the P_S shall be t_S_on in the defined waveform.

[A2_REQ_19] The initial temperature shall be less than $T0_S$ at each cyclic load.

[A2_REQ_20] The surface temperatures (start and end of the load) at every 10th cycle shall be reported.

[A2_REQ_21] The test report-2 for the short pulse cyclic loading shall be submitted for the IO approval.

[I] A general template of the HHF testing report, outlining the main chapters to be reflected in the report, is given in **[RD17]** *HHFT Report template*.



T_{0S}, P_S, t_S_on, t_S_off, N_S stand for upper limit of starting temperature [°C], power density [W/m2], pulse duration [s], dwel time [s], and cycle number, respectively.

Figure A2_2 Schematic illustration of the cyclic test of short pulse loading.

Table A2_3 HHF test parameters for cyclic test of short pulse loading.

Parameters		Required Values
Power density for cyclic load	P_S [MW/m^2]	≤ 0.20 GW/m^2 (four power density/W sample, to be selected for cyclic loading)
Duration	t_S_on [s]	2.4 ms (triangular waveform) ~ 1.2 ms (rectangular)
Dwell time	t_S_off [s]	Dwell time shall be determined by the time to reach at $T0_S$
Maximum surface temperature before loading	$T0_S$ [°C]	$T0_S$ = 300 °C
Cycle number/ sample	N_S	100
Cyclic test area/ sample		Minimum four areas at different power density
Loading area [mm x mm]	A_S [mm^2]	30 x 30 mm^2 (different area can be acceptable after agreement with the IO)

SUPPLY

A2_4.4 Characterization of samples before and after heat loading

[A2_REQ_22] W sample surfaces and cross sections shall be observed by microscopes including scanning electron microscopy, e.g. secondary electron images; back scattered electron (BSE) images Electron Back Scattered Diffraction (EBSD), and element analysis, e.g., Energy Dispersion Spectroscopy (EDS). These characterizations shall be performed at the thermally loaded and non-loaded (as-received) areas.

[A2_REQ_23] The characterizations report shall be submitted for the IO approval.

A2_4.5 HHF test of TFW finger prototype under long pulse duration (> 1 s)

[A2_REQ_24] The tiles of TFW finger prototype shall be loaded under cyclic heat flux at the power density P_L for N_L number of cycles, at loading area $A_{L\_ptototype}$. The loading area shall be around the fixation bolt (s). The fixation bolt shall not be directly thermal-loaded. The tile fixture shall remain unchanged in terms of preloads, after the cyclic loading. See Figure A2_1 for schematic illustration and Table A2_2 for requirements of detailed test parameters.

[A2_REQ_25] The duration of heat loads is t_L (t-time, L-long pulse) on at the P_L shall be limited to the maximum allowable temperature at T_L_max_prototype.

[A2_REQ_26] The initial temperature shall be less than $T0_L$ prior to each cyclic load.

[A2_REQ_27] The surface temperatures (start and end of the load) at every 50th cycle shall be reported.

[A2_REQ_28] The test report for prototype for the TFW finger assembly prototype loading shall be submitted for the IO approval.

[I] A general template of the HHF testing report, outlining the main chapters to be reflected in the report, is given in **[RD17]** *HHFT Report template*.

Table A2_4 HHF test parameters for TFW finger prototype.

Parameters		Required Values
Power density for screening tests and cyclic load tests	P_L [MW/m^2]	≤ 2 MW/m^2
Duration for cyclic load	t_L_on [s]	Duration shall be limited by defined T_L_max_prototype
Dwell time for cyclic load	t_L_off [s]	Dwell time shall be determined by the time to reach at $T0_L$
Maximum surface temperature before loading; Maximum surface temperature during cyclic test	$T0_L$; T_L_max_prototype [°C]	$T0_L$ = 300 °C T_L__T_max_prototype= °C
Cycle number/ sample	N_L	500
Cyclic test areas/ sample		2 areas
Loading area for cyclic load [mm x mm]	$A_{L\_Prototype}$ [mm^2]	~80 × ~20 mm^2 (different area can be acceptable after agreement with the IO)

SUPPLY

A2_5 Requirements for the HHF tests and reporting

A2_5.1 Requirements for HHF Test Facility and HHF Testing (mandatory)

- Power density at 5 and 100 MW/m^2 shall be ± 5%.
- Homogeneous heat flux profile (2D power density profile) at 5 MW/m^2 over area to be used for test shall be ± 10% and at 100 MW/m^2 over 30 x 30 mm^2, ± 10%.
- Interlock protection system shall be demonstrated.
- Dimension tolerances of the loaded area shall be ±1 mm. The method to limit the loading footprint over the power density range shall be proposed.
- Reproducible defined waveform of beam power at longer pulse (>1 s) and short pulse (2 ms) within the HHF test power density range shall be demonstrated.
- Temperature measurement by infrared camera in the range of 200 -1500 C, accuracy ± 5% at 1200 ^{o}C
- Maximum pixel size of surface temperature measurement by Infrared camera shall be ≤2 mm
- Temperature measurement by fast pyrometer shall be capable up to 2000 C and higher, accuracy ± 5% at 1500 ^{o}C
- Maximum spot size of pyrometer shall be ≤15 mm diameter at the measurement position

A2_5.2 Mandatory data acquisition and recommended data acquisition rate

- Record of heat loads (data acquisition rate >10 Hz for the longer pulse, >10k Hz for the short pulse)
- Record of distribution of surface temperature by means of an infrared camera (data acquisition rate: ≥ 10 Hz)
- Record of surface's temperature, measured by pyrometers (data acquisition rate: ≥10k Hz).
- Record of heat source power (data acquisition rate: ≥1k Hz)
- Record of vacuum level in the working chamber (data acquisition rate: ≥1 Hz)

A2_5.3 Mandatory data post-processing

- Surface temperature and their evolution over the power density steps
- Surface temperature and their evolution over the cycles
- Images of all the tested surface and microstructure at surfaces and cross sections

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