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Technical Specification

Manufacturing Technical Specification for the ITER NEUTRAL BEAM SEALING BOLTS (NBSB)

This document is the Manufacturing Technical Specification for the ITER NEUTRAL BEAM
SEALING BOLTS (NBSB) to be used on NB Flange Sealing System:NBV Sealing Bolts NB FEC Sealing Bolts

Approval Process			
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1 Purpose

This document is the Manufacturing Technical Specification for the ITER NEUTRAL BEAM SEALING BOLTS (NBSB) to be used on NB Flange Sealing System:

- NBV Sealing Bolts
- NB FEC Sealing Bolts

The ITER Organization (hereinafter called "IO") requires the manufacture of bolts to be incorporated into NB Flange Systems on the ITER Machine.
These bolts ensure the compression of double Metallic seals (HELICOFLEX ®) and shall meet all the RCCM-MR criteria defined in RB 3282 as Preloaded bolted assemblies maintaining leak tightness.
The material of the bolts shall be in accordance with standard EN 10269:2013 plus requirements of product procurement specification RM 3300 of RCC-MR 2007.

The ITER NEUTRAL BEAM SEALING BOLTS are currently foreseen to be manufactured in INCONEL 718 (NiCr19Fe19Nb5Mo3 [No. 2.4668]). They have been analysed according to RCC-MR §RB 3282 and document [30] which specify that Inconel 718 shall be procured through a specification based on the standard EN 10269:2013 plus requirements of product procurement specification RM 4123 of RCC-MR 2007 for hot rolled or forged bars for mechanical application of alloy No. 2.4668.

This Technical Specifications shall define the technical requirements for the Supplier:

- **to manufacture, supply and deliver the required bolts according to current materials requirements defined in this document**

or/and

- **To propose an alternative solution that fulfil the material, design and analysis requirements (**) defined in this document, to be delivered on IO site**

(**) Analysis reports:

- NB Vessels ITER_D_YRHXVY - Analysis Report Final Design HNB Vessels + Annex A of this document
- Drift Duct ITER_D_3B6JBS - Analysis Report HNB Drift Duct

2 Definitions

This section is mandatory.
For a complete list of ITER abbreviations see: ITER_D_2MU6W5 - ITER Abbreviations
Include here all those relevant to this document.

AAR	Accident Analysis Report
ACCC	Active Compensation Cooled Correction Coils
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
BLC	Beam Line Components
BS	Beam Source
BLV	Beam Line Vessel

BSV	Beam Source Vessel
CDR	Conceptual Design Review
DA	Domestic Agency
DD	Drift Duct
DDD	Design Description Document
DOF	Degree Of Freedom
DRS	Design Response Spectra
EM	Electro Magnetic
ESP	French decree dated December 13, 1999 related to the manufacture of pressure equipment (Implementation of the European Pressure Equipment Directive 97/23/EC PED in French law).
ESPN	French order dated December 12, 2005 related to the manufacture of Nuclear Pressure Equipment (NPE)
FEC	Front End Component
FRS	Floor Response Spectra
HNB	Heating Neutral Beam
ICE	Ingress of Coolant Event
kN	Kilo Newton
LOCA	Loss of Coolant Accident
LOFA	Loss of (forced) Flow Accident
LOOP	Loss Of Off-site Power
LOVA	Loss of Vacuum Accident
MD	Major Disruption
MFD	Magnet Fast (current) Discharge
MN	Mega Newton
MPa	Mega Pascal
MQP	Management Quality Program
NBI	Neutral Beam Injector
NRC	Nuclear Regulatory Commission
NSC	Non-Seismic Class
PA	Procurement Arrangement
PR	Project Requirement (Document)
PHTS	Primary Heat Transfer Systems
PRS	Point Response Spectra - Spectra calculated at specific points of a structure (also called "In-Structure Spectra" and "Secondary Spectra
RD	Rupture Disk
RPrS	Preliminary Safety Report (Rapport Préliminaire de Sûreté)
SC	Seismic Class
SIC	Safety Importance Class (-1 or -2)
SL	Seismic Level
SL-1	Seismic Level 1 – Defined by ITER for investment protection
SL-2	Seismic Level 2 – equivalent to Safe Shutdown Earthquake
SMHV	Séismes Maximaux Historiquement Vraisemblables = Maximum Historically Probable Earthquakes

SRD	System Requirement Document
SRSS	Square Root of Sum of Square
SSE	Safe Shutdown Earthquake
ST	Suppression Tank
ST-VS	Suppression Tank Venting System
TGCS	Tokamak Global Coordinate System
VDE	Vertical Displacement Event
VST	Venting System Tank
VV	Vacuum Vessel
VVPSS	Vacuum Vessel Pressure Suppression System
ZPA	Zero Period Acceleration

3 Regulatory Requirements

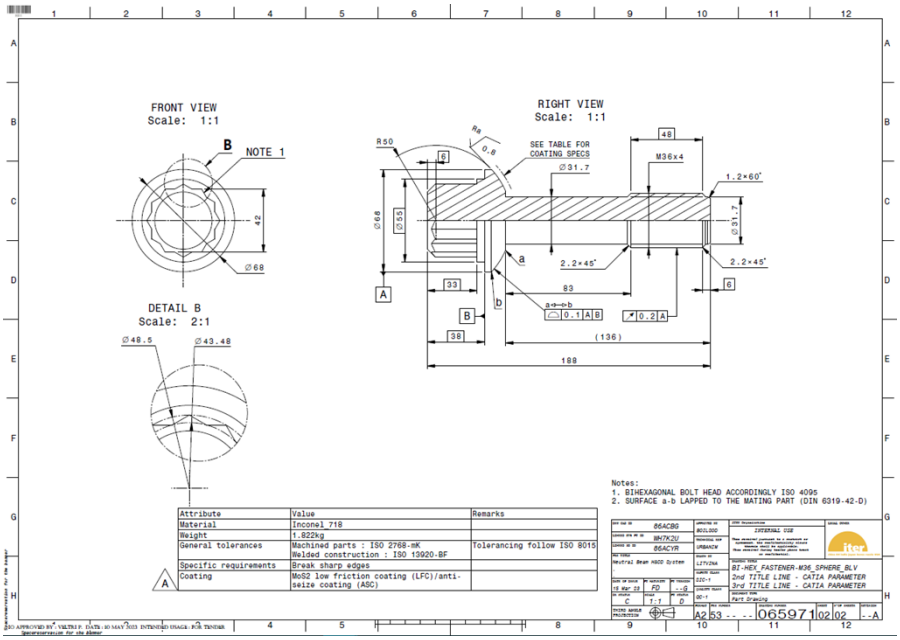
ITER is a licensed nuclear facility as defined in the Decree of Authorisation of Creation of ITER-INB-174 [7] and consequently IO, the Nuclear Operator, shall comply with the French Order of 7th February 2012 [5] establishing the general rules for licensed nuclear installations (INB-Order).
Certain components, structures and systems of ITER are classified as important for the interests of public safety as defined under Article L 593-1 of the French Environmental Code and are further classified according to the area or service (i.e. their function).

The bolts defined in this document will be used for the NB Flange Sealing System which provides primary confinement from inventory to atmosphere. Under the scope of the INB-Order [5], these flanges are classified as Safety Important Class 1 (SIC 1) and, consequently, as the Bolts' Safety Function is to provide the closing force to seal the flange. The Bolts are classified as Protection Important Components (PIC). Therefore the quality assurance requirements of Section 12 shall be applied.

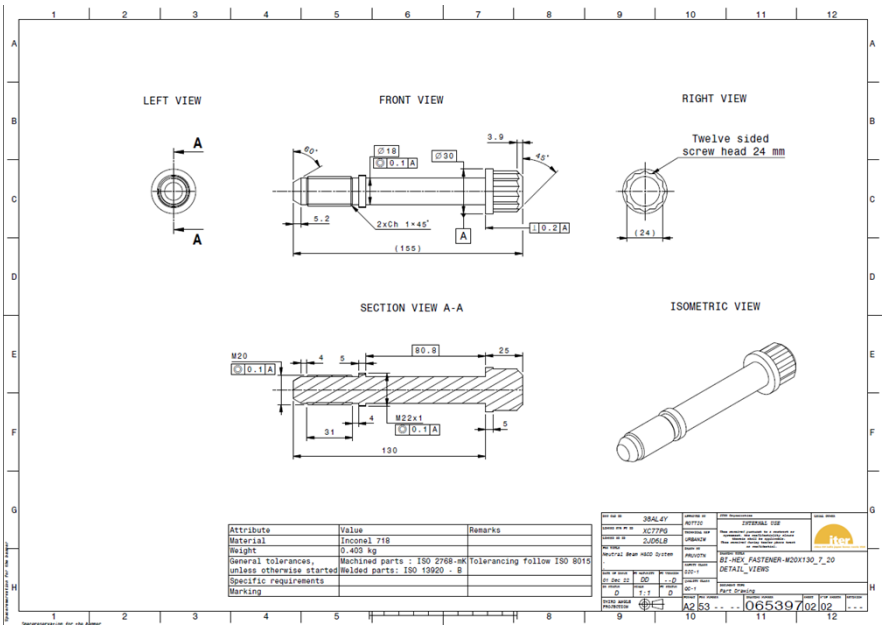
4 Scope

ITER NB flange bolts in the sizes according to the drawing references:

1. NBV Bolts are defined by the drawing 065971 revision A [8]



2. NB FEC Bolts are defined in the drawing 065397 revision A [31]



5 System Classification

The Safety Classification (for confinement function)of the ITER NEUTRAL BEAM SEALING BOLTS (NBSB) is SIC-1 and the Quality Classification is QC- 1

6 Technical Requirements

The supplier shall manufacture in the exact quantities specified in the Request for Offer. The Request for Offer shall define the standard, material, socket head type, sizes, quantities and delivery dates required for the bolts.

The batches, if required will be defined in the Request for Offer. The Supplier shall manufacture, test, and ship the Lots in accordance with the following specific requirements. Where a standard is specified on the Request for Offer then the Supplier shall follow the requirements for that standard.

The drawings form the basis of this specification and in conjunction with this Technical Specification contains all the information required to manufacture these fasteners. In each case these drawings detail dimensions and features that are important to function.
The manufacturer can propose improvements of the design for manufacturability purposes; this proposal shall be approved by IO.

The dimensions shall be inspected and reported in the component inspection report. Statistical Process Control (SPC) may be used to control these dimensions if the batch size justifies this and it is supported by a suitable Quality Plan.

All drawings referenced and CAD models of the bolts can be found in ENOVIA data base and are available on request from IO as a STEP files [9] using a Data Exchange Request .
The Bolts shall comply to these part drawings found in the SMDD folder [8].

6.1 Head and Socket Dimensions

For what concern the NBV Bolts, Head and Socket Dimensions shall be to ISO 4095 and shall be specified on the request for offer.

For what concern the NB FEC Bolts (pop up bolt design being specified in the drawing for Remote Handling compatibility), the head shall comply with drawing provided (065397 – revision A)

6.2 Bolts Material

As mentioned in the purpose of the document (section1), thee ITER NEUTRAL BEAM SEALING BOLTS are currently foreseen to be manufactured in INCONEL 718 (NiCr19Fe19Nb5Mo3 [No. 2.4668]). They have been analysed according to RCC-MR §RB 3282.

This specification covers NiCr19Fe19Nb5Mo3 (No. 2.4668) structural hardening nickel-chromium-iron alloy (known as Alloy 718) hot rolled or forged bars with a diameter less than or equal to 160 mm for the NB Components . The bars are considered for mechanical parts which are not intended to be pressure resistant (not bearing pressure). They shall be used for the manufacturing of bolting components.

This specification is based on the standard EN 10269:2013 plus requirements of product procurement specification RM 4123 of RCC-MR 2007 for hot rolled or forged bars for mechanical application of alloy No. 2.4668 and additional requirements arising from the features of the NB Components.

The Safety parts (SIC-1) of the NB Components are classified as RCC-MR Class 2 or RCC-MR Support Class S1 (RH 1300) for the PMS Accordingly, the materials of the Safety parts (SIC-1)

of the NB Components shall satisfy requirements for Class 2 components defined in Section 2 – Materials in RCC-MR 2007 where it is applicable.
It is noted from RM 0115, applicable for RCC-MR Class 2 components and from RH 2200, applicable for RCC-MR Class S1 components that the manufacturer (in this case IO, as the NB components) may propose materials outside the scope of Reference Material Specifications (Section 2 of RCC-MR). This is currently the case for the NiCr19Fe19Nb5Mo3 material procurement specification.

The manufacturer shall comply to Procurement Specification of NiCr19Fe19Nb5Mo3: [30]

The manufacturer can propose **an alternative material** of the NiCr19Fe19Nb5Mo3 that fulfil the requirements defined in [30].

The main requirements can be summarized as follow:

- Chemical composition of the material shall content Cobalt max of 0.20 wt. % due to radioprotection requirement.
- Mechanical properties requirements shall meet, at least, the values given in Table 1 below or equivalent (to be validated by IO):

Table 1: Mechanical properties

Test temperature, °C	**Tensile Strength, Rm, MPa, min**	**Yield Strength $Rp_{0.2}$, MPa, min**	**Elongation after fracture, A (5d), % min**	**Impact energy (ISO-V) at 20°C KV_2 J min**	**Brinell Hardness, min**
Room	1230	1030	14	20	340
200	-	934	-		

- ***Note:*** *Percentage of reduction of area and proof strength, 1% plastic extension at room temperature and elevated temperature, tensile strength, elongation at elevated temperature and shall be given for information purposes*

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6.3 Chemical Composition and Mechanical Properties Reporting

All materials shall be fully traceable to their respective sources. IO requires that full disclosure of the materials and their compositions used is given and that all material test certification is provided in the QA documentation. An EN 10204 Type 3.1 Certificate [16] or IO approved equivalent is required. If an alternative to the Type 3.1 certificate is proposed then this shall be stated in the Supplier's offer for acceptance by IO.
Due to the possible irradiation levels that will be encountered during the bolts' end use special care must be taken to ensure no long lived residual activity is induced in the components.

Specific limits of impurities and certain materials are restricted in their use. These are specified in [17] and the values in Table 2 shall be applied for these bolts and shall be reported with the Type 3.1 Certificate.

If it is not possible to comply with Table 2 due to some overriding technical constraint the IO shall be notified at the time of quotation.
Approval of the Material shall be a hold point by IO prior to manufacture of the bolts.

Table 2: Mechanical properties

Element Name – Symbol	Maximum Weight %
Cobalt [Co]	0.2
Niobium [Nb]	0.01
Tantalum [Ta]	0.01

6.4 Vacuum requirements

The NBV Bolts could be used in the Primary vacuum. They shall also be compliant with section 14.2 of [32]:

- Bolts should be of rolled thread (see section 6.6) and supplied with certification in accordance with EN 1024, 3.1.
- For all VQC, threaded fixings (e.g. bolts), shall be treated to prevent seizing. (see section 6.5)
- Approved solid (dry) lubricants, aluminium bronze inserts or coatings are preferred. Lubricants for each class are listed in Appendix [33]. The use of any other lubricant is subject to prior acceptance.

6.5 Anti-Seize Coating

All bolts shall have a MICROFRAL™ 200 (MoS_2) coating[1] . The supplier may propose an alternative MoS_2 dry film coating equivalent or other equivalent coating at the time of quotation for acceptance by the IO.

[1] *Available from : FLUOROTECHNIQUE AQUITAINE 9, Rue Vert Castel – ZI du Vert Castel 33700 MÉRIGNAC France*

6.6 Thread Form

The thread form shall be rolled, free from defects and conform to the tolerance of the drawing if stated. Otherwise it shall be to ISO 286 g6 [19] tolerance for external threads in both the pitch and major diameters.

6.7 Tests

Tests of the Bolts shall be performed in accordance of the section 7 of [15].

6.8 Item numbering

Each batch of bolts shall be given a unique Serial Number [20]. This must be placed in a clearly visible location of the manufacture's discretion. The mark should be either stamped or scribed in letters at least 3 mm high. If this is not possible due to the small size of the item or other overriding considerations then the articles' packing should be clearly identified with any serial number to full identify the component and its material grade.

6.9 Cleaning and Packaging

Each bolt shall be clean, swarf and burr free, packed to protect from any damage and contamination during transport and storage. The thread of each bolts shall be especially protected from damage using a net sleeve or similar thread protection.

7 Responsibilities

7.1 The Supplier's Responsibilities

1. The Supplier shall ensure that they shall satisfy the technical requirements in this Technical Specifications.
2. The Supplier shall appoint a Responsible Officer who represents the Supplier for all matters related to this work and who shall:
    a. Coordinate the planning and performance of the work including any work assigned to subcontractors.
    b. Maintain schedules and issue monthly progress reports.
    c. Verify that the quality systems are consistently followed during the performance of the contract.
    d. Assess and oversee quality in any subcontractors' premises
    e. Liaise with the ITER-RO throughout the work to ensure a collaborative approach
3. The Supplier shall ensure that all input information provided to perform the work remains the property of IO and shall not be used for any other activity than the one specified in this Technical Specification.
4. The Supplier shall ensure to maintain an organization and facilities suitable to perform the scope of the works as described in this Technical Specification.
5. The Supplier shall provide to the IO representative or the applicable ITER Domestic Agency or any applicable regulatory authorities full access to its work premises, to permit the follow up of work progress, if requested by the IO.
6. The Supplier shall submit all documentation, information and deliverables in English.
7. The Supplier shall include with his response any intention to subcontract any parts of the work.
8. The Supplier shall ensure that the work is carried out by suitably qualified and experienced personnel.
9. All external packaging shall be marked or labelling in both French and English.
10. All reporting and measurement shall use SI units as the primary units.

7.2 The IO's Responsibilities

1. IO shall appoint a Responsible Officer (ITER-RO) who represents the IO for all technical matters related to this work and who shall closely collaborate with and make available all the necessary technical information required by the Supplier to perform the scope of work.
2. The IO RO shall assess the performance and quality of the work by the Supplier.
3. The IO RO shall review and accept the deliverables provided by the Supplier. In case of rejection, the IO TRO shall provide the justification for rejection and/or provide the comments for improvements if required.

4. For D1, to D3, the IO TRO shall review and accept the deliverables within 14 days after the receipt(s). If the comments are not provided within 14 days, the deliverable(s) are deemed to be accepted by the IO TRO.
5. For D4 to D5 the IO TRO shall review and accept the deliverables within 14 days after the receipt(s). If the comments are not provided within 14 days, the deliverable(s) are deemed to be accepted by the IO TRO.

8 List of deliverables and due dates

The Supplier shall deliver the following:

Table 3 Deliverables

Milestone	Deliverable Number	Applicable Lot or items	Deliverable Description	Quantity	Due Date
M1			KoM		T0
	D1	All Lots	Quality Plan	1 original	T0 + 2 weeks
	D2	All Lots	Manufacturing and Inspection Plan	1 original	T0 + 2 weeks
	D3	All Lots	Materials Test Certs for Bolt Raw Materials (3.1 Cert see Section6.3)	1 original	T0 + 2 weeks
M2	HP		IO Approval of D1,D2 & D3	1 original	
	D4	All Lots	Inspection Report for Dimensions marked CTF	1 original	4 weeks before T-End
	D5		Delivery of Lot A, B, C to the IO	1 original	T-End
	D6		Monthly Progress Report	1 original	Each month
	D7		Manufacturing Dossier and Contractor Release Note [21] in accordance with Section 12	1 original	T-End
M3			Final Acceptance by IO All deliverables above made and approved by IO	1 original	T-End + 2W

D: Deliverables to be submitted by the Supplier.
M: Milestone to be initiated or completed by the Supplier, and or the IO as appropriate.
T0: The date of the Contract entering into force.
T-End: Expected Contract End date.

Definition of the Lots:

Lot A: 768 NBV Bolts (HNB1 & HNB2) + 38 spares (≈5%) NBV Bolts
Lot B: 384 NBV Bolts (HNB3) + 19 spares (≈5%) NBV Bolts
Lot C: 120 NB FEC Bolts + 6 spares (≈5%) NB FEC Bolts

9 Acceptance Criteria

1. All deliverables shall satisfy the relevant technical requirements in this Technical
2. Specifications, and shall be accepted by the IO TRO.
3. All required documents shall be delivered and approved.
4. The Contractors Release Note approved by IO
5. The delivery of all bolts to the IO.

10 Quality Assurance (QA) requirements

10.1 Quality management

The Supplier's Quality Assurance Programme (QAP) is subject to approval by the IO in accordance with the ITER QA Programme or an ISO 9001 accredited quality system and shall

be applied to all work carried out as a result of any contract arising from this specification. If an alternative quality system, such as ASME NQA-1 is used by the Supplier then this shall be stated in the Suppliers offer. The use of an alternative quality system requires approval by IO. The ITER QA Programme is based on IAEA Safety Standard GS-R-2 and on conventional QA principles and integrates the requirements of the French Order dated 7th February 2012 [5] on the quality of design, construction and operation of Licensed Nuclear Installations. For this purpose, the Supplier shall ensure that any subcontractors carrying out work placed under the prime contract are in compliance with the QA requirements under the relevant QA classifications [22].

10.2 Quality plan

Prior to commencement of the work, a Quality Plan [23]must be submitted for IO approval giving evidence of the above and describing the organisation for this task; the qualification and experience of the workers involved including named individual(s) who will act as Independent Reviewer(s) and Checkers(s) and any anticipated sub-contractors.

10.3 Manufacturing and Inspection

Prior to the commencement of any manufacturing, a Manufacturing and Inspection Plan [24] must be approved by ITER who will mark up any planned interventions. Prior to the delivery of any manufactured items to the IO Site, a Release Note must be signed in accordance with [21].

10.4 Protection Important Components

For the Protection Important Components, structures and systems, a specific management system must be implemented by the Supplier and any subcontractor working on protective important activities, on the basis of activities defined and executed by the Supplier and Subcontractor.
The use of computer software to perform a safety based task or activity such as analysis or modelling or both shall be reviewed and approved by the IO prior to its use, in accordance with [25].

10.5 Additional Surveillance Requirements

ITER Organisation is the Nuclear Operator and has the ultimate responsibility for the application of the INB Order [5] within the IO and in its chain of suppliers. IO must undertake additional surveillance for those components which are classified as Protection Important Components as described in Section 3.
The Supplier shall therefore grant access to the IO and ASN representatives to its facilities and records and those of its subcontractors for the purposes of surveillance of defined requirements during the design, construction, manufacturing, commissioning, assembly, maintenance and surveillance of a PIC. This surveillance shall also include the examination of all protective important activities and follow-up and verification of any remedial and corrective actions which are to be implemented.

10.6 Documentation

All documentation related to the design, construction, manufacturing, commissioning, assembly, maintenance and surveillance of a PIC shall be provided to the IO as part of Table 3 D7 Deliverables..

11 References

[1] ITER Abbreviations ITER_D_2MU6W5.
[2] Environmental Code. Ordinance 2000/914 dated 18 September 2000. As amended. Available: http://www.legifrance.gouv.fr.
[3] Surveillance Plan for PBS 31 - Vacuum Systems (ITED_D_QEL38Hv1.2).
[4] Surveillance Plan PBS 31 : Annex 2 (ITER_D_T3FCQRv1.5).
[5] Order dated 7 February 2012 relating to the general technical regulations applicable to INB (ITER_D_7M2YKFv1.7).
[6] Safety Important Functions and Components Classification Criteria and Methodology (ITER_D_347SF3v1.8).
[7] Decree No.2012-1248 dated 9 November 2012 authorising IO to create a licensed nuclear facility called “ITER” (ITER_D_CZK7M5v.1).
[8] 065971 - BI-HEX_FASTENER-M36_SPHERE_BLV ITER_D_86ACBG
[9] ISO 10303 Standards for the Exchange of Product Model Data.
[10] ISO 14579 Hexalobular socket head cap screws.
[11] ISO 4762 Hexagon socket head cap screws.
[12] ASTM A540 / A540M - 06 Alloy-Steel Bolting Materials for Special Applications.
[13] EN 10269 Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties.
[14] Standard Specification for High-Temperature Bolting Materials ASTM A453/A453M -99 Grade 660 / UNS S66286.
[15] ISO 3506-1 Mechanical properties of corrosion-resistant stainless steel fasteners.
[16] EN 10204:2005 Metallic products - Types of inspection documents.
[17] Chemical composition and impurity requirements for Materials (ITER_D_REYV5Vv2.3).
[18] International Union of Pure and Applied Chemistry (IUPAC).
[19] ISO 286-1 ISO System of Limits and Fits.
[20] ITER Numbering System for Components and Parts (ITER_D_28QDBSv3.2).
[21] Requirements for Producing a Contractors Release Note (ITER_D_22F52F v5.0).
[22] Quality Classification Determination (ITER_D_24VQES v5.2).
[23] Requirements for Producing a Quality Plan (ITER_D_22MFMW v4.0).
[24] Requirements for Producing an Inspection Plan (ITER_D_22MDZD v3.7).
[25] Quality Assurance for ITER Safety Codes (ITER_D_258LKL v3.1).
[26] ISO 898 Mechanical properties of fasteners made of carbon steel and alloy steel Part 1.
[27] Procedure for management of Nonconformities (ITER_D_22F53X v7.1).
[28] Procedure for the management of Deviation Request (ITER_D_2LZJHB v5.5).
[29] ITER Style Flange Drawing Folder in SMDD (YUR2QY).
[30] ITER D7XHYN5 Procurement Specification for_supply_NiCr19Fe19Nb5Mo3_NB_Bolts
[31] 065397 - BI-HEX_FASTENER-M20X130_7_20 ITER_D_38AL4Y
[32] ITER_D_2EZ9UM - ITER Vacuum Handbook
[33] ITER_D_27Y4QC - Appendix 3 Materials

Appendix A (TNR, Bold, 16pt)

Your text.