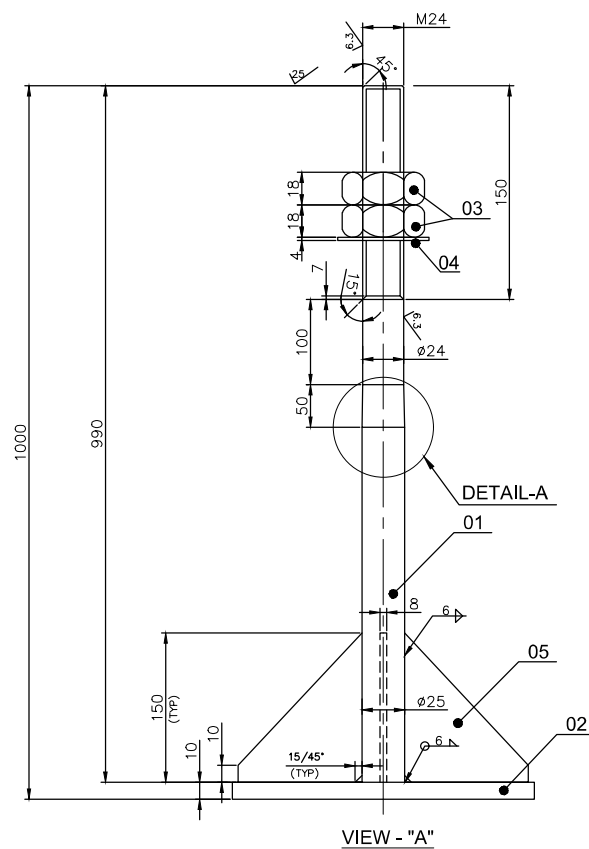


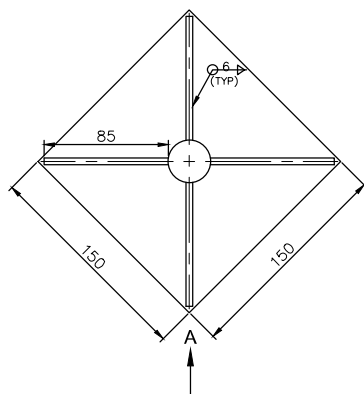
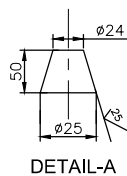
DRAWING NO: 2-39-010-010803

FOR TOLERANCES OF UNTOLERANCED
DIMENSIONS DURING MANUFACTURE
REFER PLANT STD. NO TP 023 0299



NOTES: -

- FOUNDATION BOLT SHOULD NOT BE PAINTED.
- THREAD ENDS OF BOLT TO BE COATED WITH RUST PROOF OIL AND PROTECTED AGAINST CORROSION.
- MANUFACTURING REQUIREMENTS SHALL BE AS PER APPLICABLE Q.C.P.
- MATERIALS AND OTHER REQUIREMENTS ARE GIVEN PER BOILER ONLY.
- SA-105-ROD CAN BE SUBSTITUTED WITH IS2062 ROD AND VICE-VERSA.

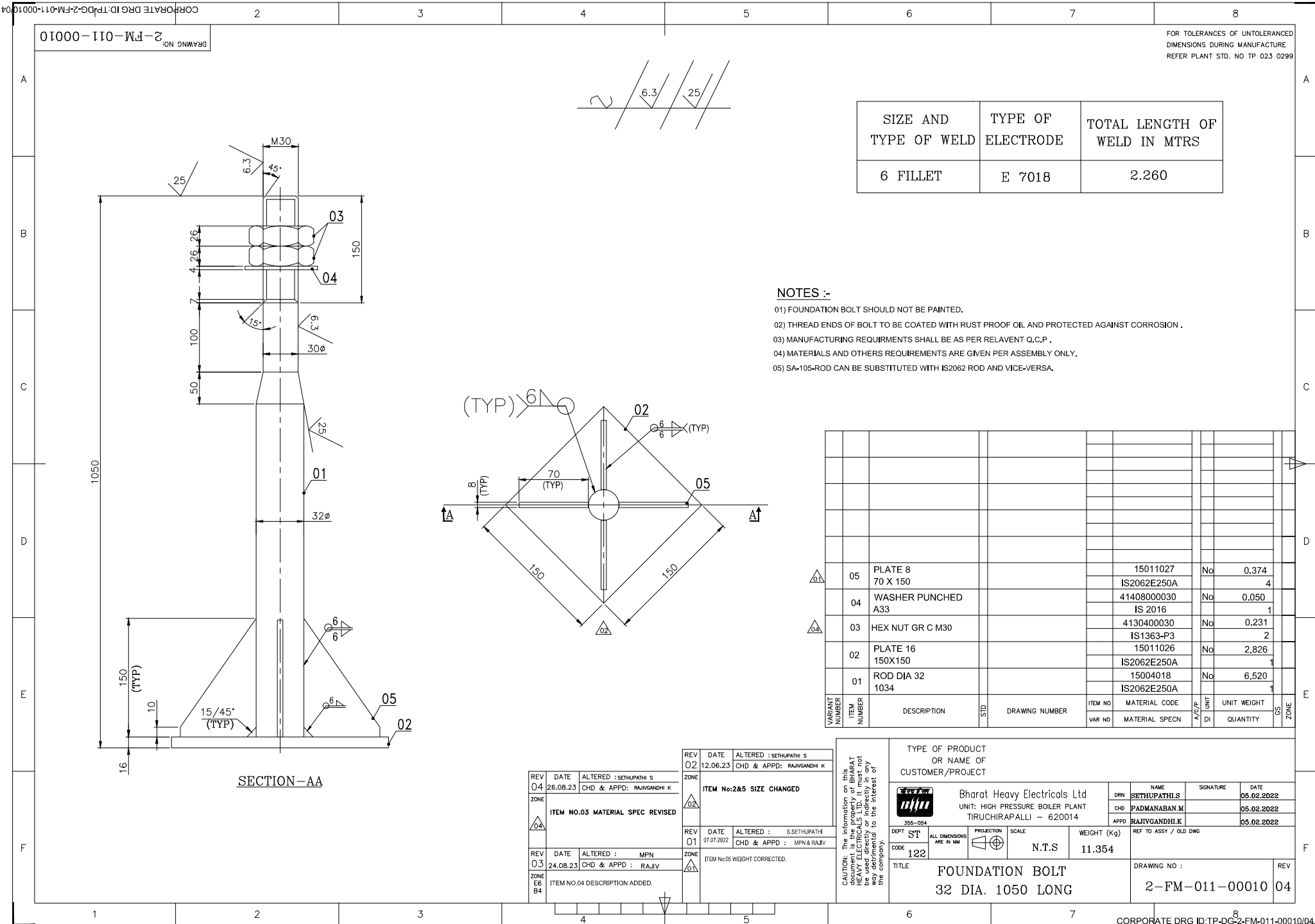


SIZE AND TYPE OF WELD	TYPE OF ELECTRODE	TOTAL LENGTH OF WELD IN MTRS.
6 FILLET	E7018	2.280

ITEM NO	DESCRIPTION	STD	DRAWING NUMBER	ITEM NO	MATERIAL CODE	UNIT	UNIT WEIGHT	ZONE
05	PL 150X85X8			15011027	IS2062Fe410A	0.427		
04	WASHER PUNCHD.A24			41408-00024	IS2016-A	0.031		
03	NUT HEX Gr C M24			41304-00024	IS1363P3-CL4	0.110		
02	PL 150X150X10			15211098	IS2062Fe410A	1.766		
01	ROD DIA 25; 990			15004027	IS2062Fe410A	3.814		

REV	DATE	ALTERED :	MPN
03	24.08.23	CHD & APPD :	RAJIV
02	27.04.17	CHD & APPD :	SOMU.J
01	22.12.16	CHD & APPD :	SOMU.J

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT		Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI - 620014		DRN	NAME S.JOHN	SIGNATURE	DATE 21.04.98
DEPT ST		ALL DIMENSIONS ARE IN MM		PROJECTION N.T.S	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG 2-35-010-01223
CODE 122		TITLE FOUNDATION BOLT 25 DIA. 1000 LONG		DRAWING NO : 2-39-010-010803		REV 03	



SIZE AND TYPE OF WELD	TYPE OF ELECTRODE	TOTAL LENGTH OF WELD IN MTRS
6 FILLET	E 7018	2.260

- NOTES :-
- 01) FOUNDATION BOLT SHOULD NOT BE PAINTED.
 - 02) THREAD ENDS OF BOLT TO BE COATED WITH RUST PROOF OIL AND PROTECTED AGAINST CORROSION .
 - 03) MANUFACTURING REQUIRMENTS SHALL BE AS PER RELAVENT Q.C.P .
 - 04) MATERIALS AND OTHERS REQUIREMENTS ARE GIVEN PER ASSEMBLY ONLY.
 - 05) SA-105-ROD CAN BE SUBSTITUTED WITH IS2062 ROD AND VICE-VERSA.

ITEM NUMBER	DESCRIPTION	STD	DRAWING NUMBER	ITEM NO	MATERIAL CODE	UNIT	UNIT WEIGHT	QTY	ZONE
05	PLATE 8 70 X 150				15011027 IS2062E250A	No	0.374	4	
04	WASHER PUNCHED A33				41408000030 IS 2016	No	0.050	1	
03	HEX NUT GR C M30				41304000030 IS1363-P3	No	0.231	2	
02	PLATE 16 150X150				15011026 IS2062E250A	No	2.826	1	
01	ROD DIA 32 1034				15004018 IS2062E250A	No	6.520	1	

REV 04	DATE 26.08.23	ALTERED : SETHUPATHI S CHD & APPD: RAJIVGANDHI K	ZONE 04
ITEM NO.03 MATERIAL SPEC REVISED			
REV 03	DATE 24.08.23	ALTERED : MPN CHD & APPD : RAJIV	ZONE 03
ITEM NO.04 DESCRIPTION ADDED.			
REV 02	DATE 12.06.23	ALTERED : SETHUPATHI S CHD & APPD: RAJIVGANDHI K	ZONE 02
ITEM No:2&5 SIZE CHANGED			
REV 01	DATE 07.07.2022	ALTERED : S.SETHUPATHI CHD & APPD : MPN & RAJIV	ZONE 01
ITEM No:05 WEIGHT CORRECTED.			

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014

DRN NAME SETHUPATHI S
CHD PADMANABAN M
APPD RAJIVGANDHI K

DATE 05.02.2022
DATE 05.02.2022
DATE 05.02.2022

DEPT ST
CODE 122

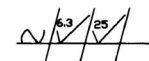
ALL DIMENSIONS ARE IN MM
PROJECTION SCALE N.T.S
WEIGHT (Kg) 11.354

REF TO ASSY / OLD DWG

TITLE FOUNDATION BOLT
32 DIA. 1050 LONG

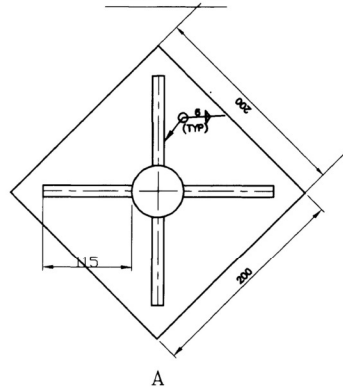
DRAWING NO : 2-FM-011-00010

REV 04



SIZE AND TYPE OF WELD	TYPE OF ELECTRODE	TOTAL LENGTH OF WLD IN MTRS.
6 FILLET	E7018	2.260

1. FOUNDATION BOLT SHOULD NOT BE PAINTED.
2. THREAD ENDS OF BOLT TO BE COATED WITH RUST PROOF OIL AND PROTECTED AGAINST CORROSION.
3. MANUFACTURING REQUIREMENTS SHALL BE AS PER APPLICABLE Q.C.P
4. MATERIALS AND OTHER REQUIREMENTS ARE GIVEN PER ASSEMBLY ONLY.

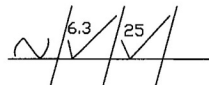
[illegible]

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	 355-054	Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI - 620014		DRN	NAME	SIGNATURE	DATE
				CRN	S. JOHN	<i>S. John</i>	21.04.98
				APPO	MBKRAJA	<i>MBKRAJA</i>	22/04/98
				R. JEYAKUMAR		<i>R. Jeyakumar</i>	22/04/98
DEPT	ST	ALL DIMENSIONS ARE IN MM	PROJECTION	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	
CODE	122					2-35-010-01224	
TITLE					DRAWING NO :		REV
FOUNDATION BOLT 32 DIA. 1200 LONG					2-39-010-01081		

2-35-010-01246
DRAWING NO.

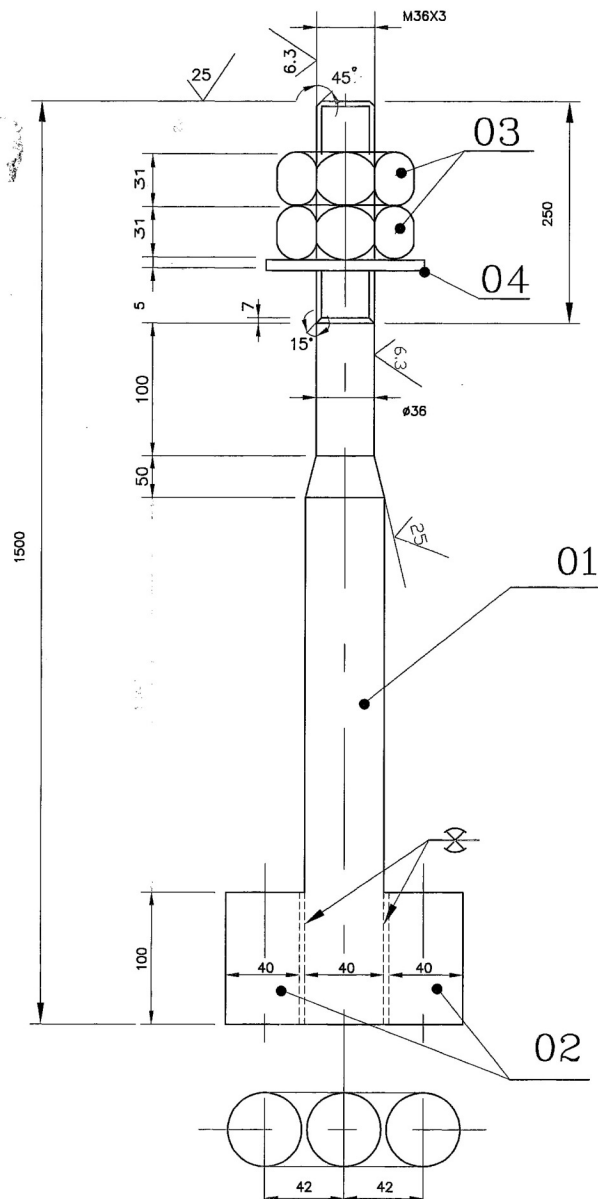
FOR TOLERANCES OF UNTOLERANCED
DIMENSIONS DURING MANUFACTURE
REFER PLANT STD. NO TP 023 0299

SIZE AND TYPE OF WELD	TYPE OF ELECTRODE	TOTAL LENGTH OF WELD IN MTRS.
8	E 7018	0.400



NOTES :

- FOUNDATION BOLT SHOULD NOT BE PAINTED.
- THREAD ENDS OF BOLT TO BE COATED WITH RUST PROOF OIL AND PROTECTED AGAINST CORROSION.
- MANUFACTURING REQUIREMENTS SHALL BE AS PER APPLICABLE Q.C.P.
- MATERIALS AND OTHER REQUIREMENTS ARE GIVEN PER ASSEMBLY ONLY.



VARIANT NUMBER	ITEM NUMBER	DESCRIPTION	STD	DRAWING NUMBER	ITEM NO	MATERIAL CODE	UNIT	UNIT WEIGHT	ZONE
	04	WASHER PUNCHD.A36			41408-00036		0.087		
	03	NUT HEX GR C M36X3			41304-00036		0.396		
	02	ROD DIA 40 ; 100			15-004-007		0.985		
	01	ROD DIA 40 ; 1500			IS2062Fe410A		14.774		
					IS2062Fe410A				
VAR NO	MATERIAL SPECN	ASP	DI	QUANTITY	CS	ZONE			

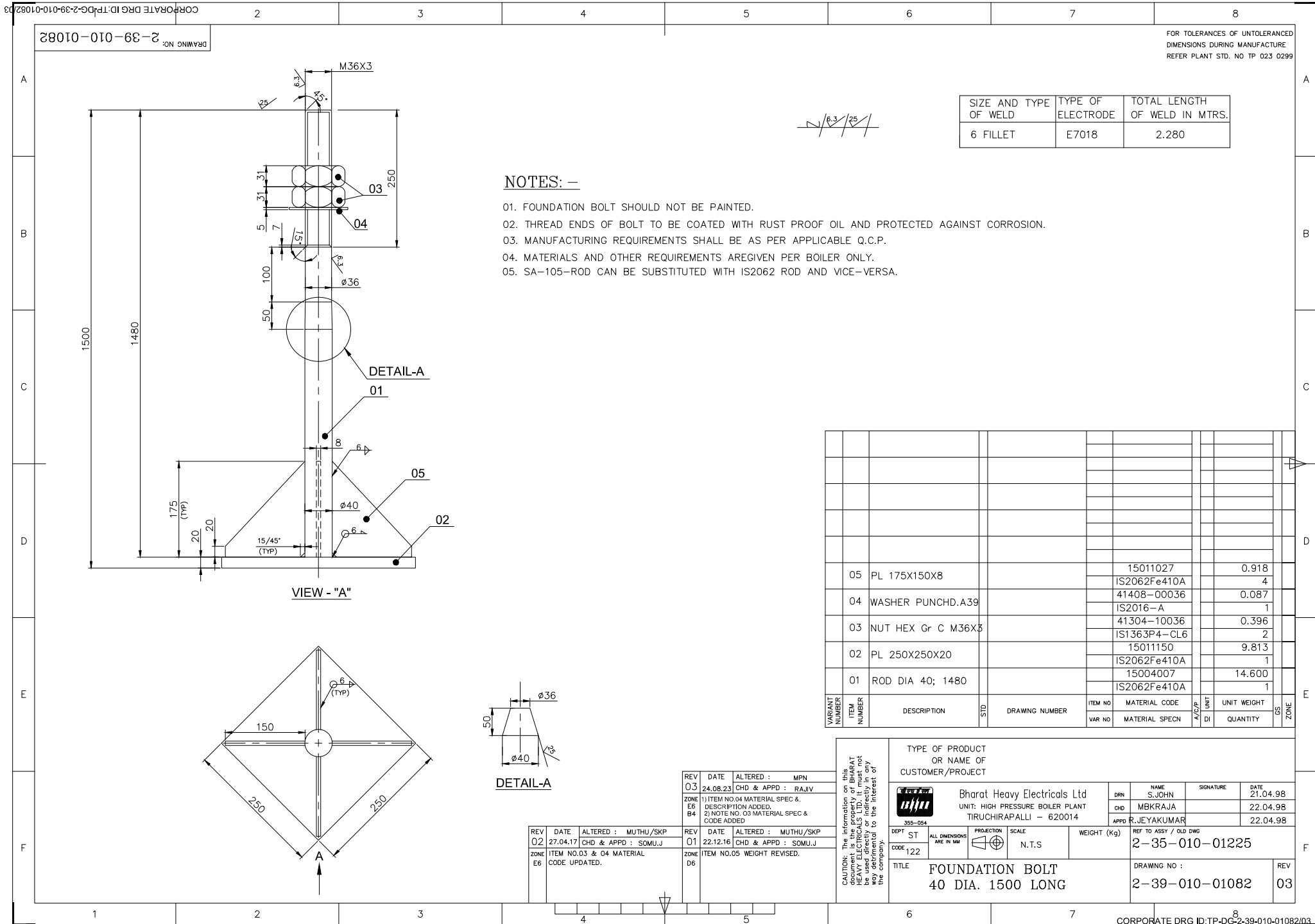
TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT		Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI - 620014		DRN NAME M.B.K.RAJA	SIGNATURE <i>[Signature]</i>	DATE 23.04.98
DEPT ST	ALL DIMENSIONS ARE IN MM	PROJECTION 	SCALE NTS	WEIGHT (Kg)	REF TO ASSY / OLD DWG	
CODE 122	TITLE FOUNDATION BOLT 40 DIA. 1500 LONG			DRAWING NO : 2-35-010-01246		REV 01

REV	DATE	ALTERED	CHD & APPD
01	5.2.99		

WELDING DETAIL
ALTERED

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SCANNED



2-39-010-01082

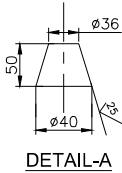
FOR TOLERANCES OF UNTOLERANCED
DIMENSIONS DURING MANUFACTURE
REFER PLANT STD. NO TP 023 0299

SIZE AND TYPE OF WELD	TYPE OF ELECTRODE	TOTAL LENGTH OF WELD IN MTRS.
6 FILLET	E7018	2.280

NOTES: -

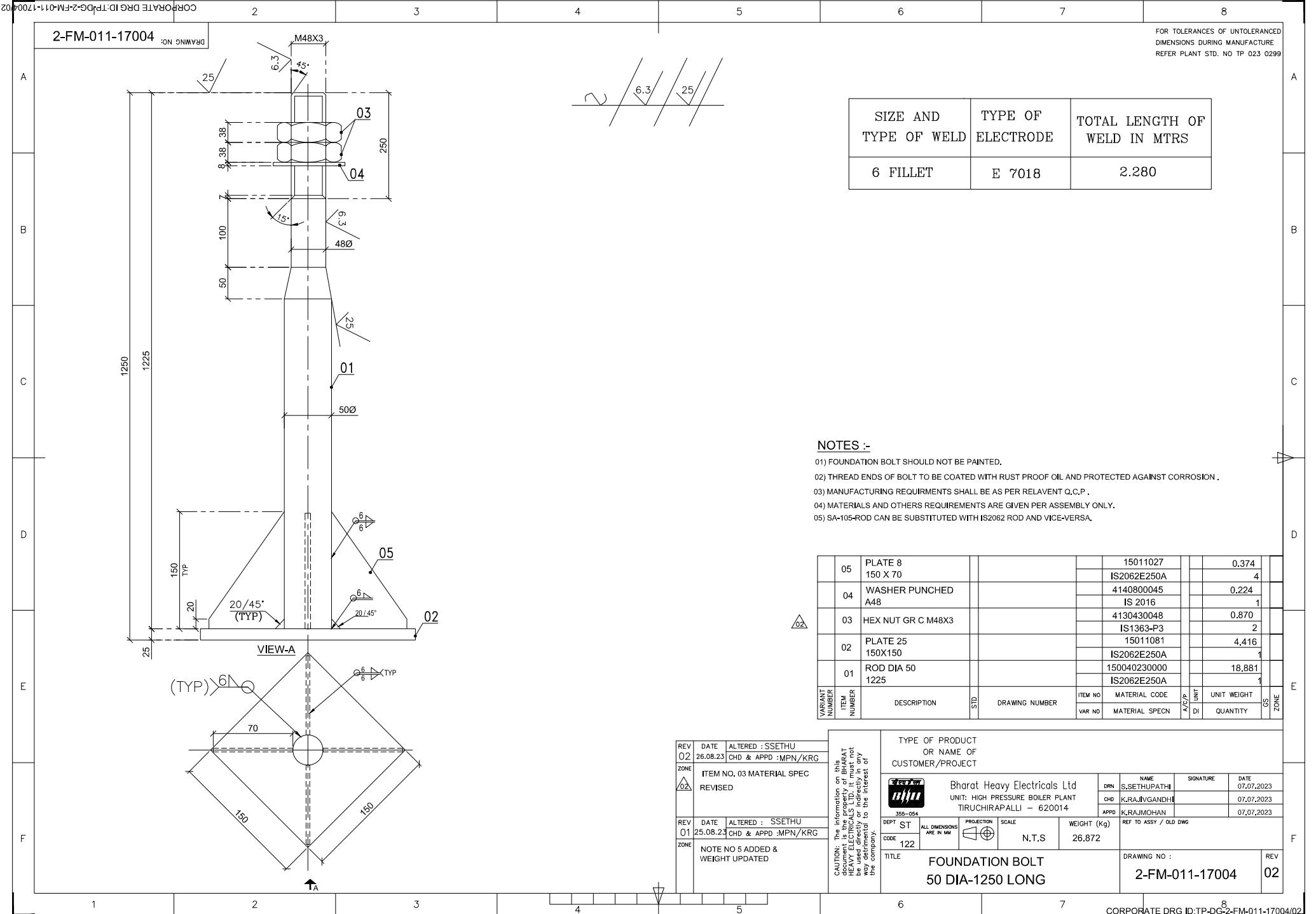
01. FOUNDATION BOLT SHOULD NOT BE PAINTED.
02. THREAD ENDS OF BOLT TO BE COATED WITH RUST PROOF OIL AND PROTECTED AGAINST CORROSION.
03. MANUFACTURING REQUIREMENTS SHALL BE AS PER APPLICABLE Q.C.P.
04. MATERIALS AND OTHER REQUIREMENTS ARE GIVEN PER BOILER ONLY.
05. SA-105-ROD CAN BE SUBSTITUTED WITH IS2062 ROD AND VICE-VERSA.

ITEM NUMBER	DESCRIPTION	STD	DRAWING NUMBER	ITEM NO VAR NO	MATERIAL CODE MATERIAL SPECN	A/C/P	UNIT DI	UNIT WEIGHT QUANTITY	CS ZONE
05	PL 175X150X8				15011027 IS2062Fe410A			0.918 4	
04	WASHER PUNCHD.A39				41408-00036 IS2016-A			0.087 1	
03	NUT HEX Gr C M36X3				41304-10036 IS1363P4-CL6			0.396 2	
02	PL 250X250X20				15011150 IS2062Fe410A			9.813 1	
01	ROD DIA 40; 1480				15004007 IS2062Fe410A			14.600 1	



REV	DATE	ALTERED :	MPN	REV	DATE	ALTERED :	MPN
03	24.08.23	CHD & APPD :	RAJUV	01	22.12.16	CHD & APPD :	SOMUJ
ZONE E6 B4		1) ITEM NO.04 MATERIAL SPEC & DESCRIPTION ADDED.		ZONE D6		ITEM NO.05 WEIGHT REVISED.	
02	27.04.17	CHD & APPD :	SOMUJ				
ZONE E6		ITEM NO.03 & 04 MATERIAL CODE UPDATED.					

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT			
Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI - 620014			
DRN	NAME S.JOHN	SIGNATURE	DATE 21.04.98
CHD	MBKRAJA		22.04.98
APPD	R.JEYAKUMAR		22.04.98
DEPT	350-004	SCALE	REF TO ASSY / OLD DWG
ST	ALL DIMENSIONS ARE IN MM	PROJECTION N.T.S	WEIGHT (Kg)
CODE	122		2-35-010-01225
TITLE FOUNDATION BOLT 40 DIA. 1500 LONG			DRAWING NO : 2-39-010-01082
			REV 03



SIZE AND TYPE OF WELD	TYPE OF ELECTRODE	TOTAL LENGTH OF WELD IN MTRS
6 FILLET	E 7018	2.280

NOTES :-

01) FOUNDATION BOLT SHOULD NOT BE PAINTED.

02) THREAD ENDS OF BOLT TO BE COATED WITH RUST PROOF OIL AND PROTECTED AGAINST CORROSION .

03) MANUFACTURING REQUIRMENTS SHALL BE AS PER RELAVENT Q.C.P .

04) MATERIALS AND OTHERS REQUIREMENTS ARE GIVEN PER ASSEMBLY ONLY.

05) SA-105-ROD CAN BE SUBSTITUTED WITH IS2062 ROD AND VICE-VERSA.

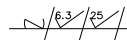
05	PLATE 8 150 X 70				15011027		0.374		
					IS2062E250A		4		
04	WASHER PUNCHED A48				4140800045		0.224		
					IS 2016		1		
03	HEX NUT GR C M48X3				4130430048		0.870		
					IS1363-P3		2		
02	PLATE 25 150X150				15011081		4.416		
					IS2062E250A		1		
01	ROD DIA 50 1225				150040230000		18,881		
					IS2062E250A		1		
VARIANT NUMBER	ITEM NUMBER	DESCRIPTION	STD	DRAWING NUMBER	ITEM NO	MATERIAL CODE	A/C/P	UNIT WEIGHT	CS ZONE
					VAR NO	MATERIAL SPECN	DI	QUANTITY	

REV 02	DATE 26.08.23	ALTERED : SSETHU
ZONE 02	CHD & APPD :MPN/KRG	REVISD
REV 01	DATE 25.08.23	ALTERED : SSETHU
ZONE	CHD & APPD :MPN/KRG	NOTE NO 5 ADDED & WEIGHT UPDATED

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT			
Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI - 620014			
DRN	NAME S.SETHUPATHI	SIGNATURE	DATE 07.07.2023
CHD	K.RAJIVGANDHI		07.07.2023
APPD	K.RAJUMOHAN		07.07.2023
DEPT 355-054	ALL DIMENSIONS ARE IN MM	PROJECTION SCALE N.T.S	WEIGHT (Kg) 26.872
TITLE FOUNDATION BOLT 50 DIA-1250 LONG	DRAWING NO : 2-FM-011-17004		REV 02

DRAWING NO:

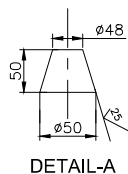
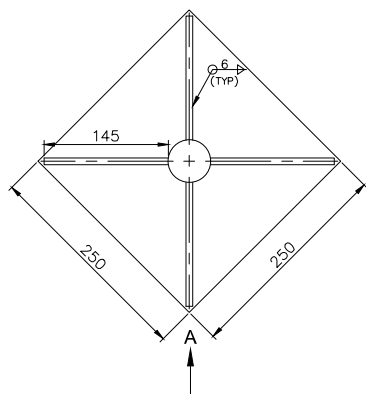
FOR TOLERANCES OF UNTOLERANCED
DIMENSIONS DURING MANUFACTURE
REFER PLANT STD. NO TP 023 0299



SIZE AND TYPE OF WELD	TYPE OF ELECTRODE	TOTAL LENGTH OF WELD IN MTRS
6 FILLET	E7018	2.280

NOTES: —

01. FOUNDATION BOLT SHOULD NOT BE PAINTED.
02. THREAD ENDS OF BOLT TO BE COATED WITH RUST PROOF OIL AND PROTECTED AGAINST CORROSION.
03. MANUFACTURING REQUIREMENTS SHALL BE AS PER APPLICABLE Q.C.P.
04. MATERIALS AND OTHER REQUIREMENTS ARE GIVEN PER BOILER ONLY.
05. SA-105-ROD CAN BE SUBSTITUTED WITH IS2062 ROD AND VICE-VERSA.

[illegible]

REV 02	DATE 24.08.23	ALTERED : CHD & APPD :	MPN RAJIV
ZONE E6 B4	1) ITEM NO.03&04 MATERIAL SPEC ADDED.		
REV 01	DATE 22.12.16	ALTERED : CHD & APPD :	MUTHU/SKP SOMUJ
ZONE D6	ITEM NO.05 WEIGHT REVISED.		

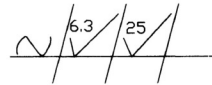
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TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT					DRN	NAME S.JOHN	SIGNATURE	DATE 21.04.98
 Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI - 620014					CHD	MBKRAJA		22.04.98
					APPD	R.JEYAKUMAR		22.04.98
DEPT ST	ALL DIMENSIONS ARE IN MM	PROJECTION 	SCALE N.T.S	WEIGHT (Kg)	REF TO ASSY / OLD DWG 2-35-010-01226			
CODE 122								
TITLE FOUNDATION BOLT 50 DIA. 2000 LONG					DRAWING NO : 2-39-010-01083			REV 02

2-35-010-01247

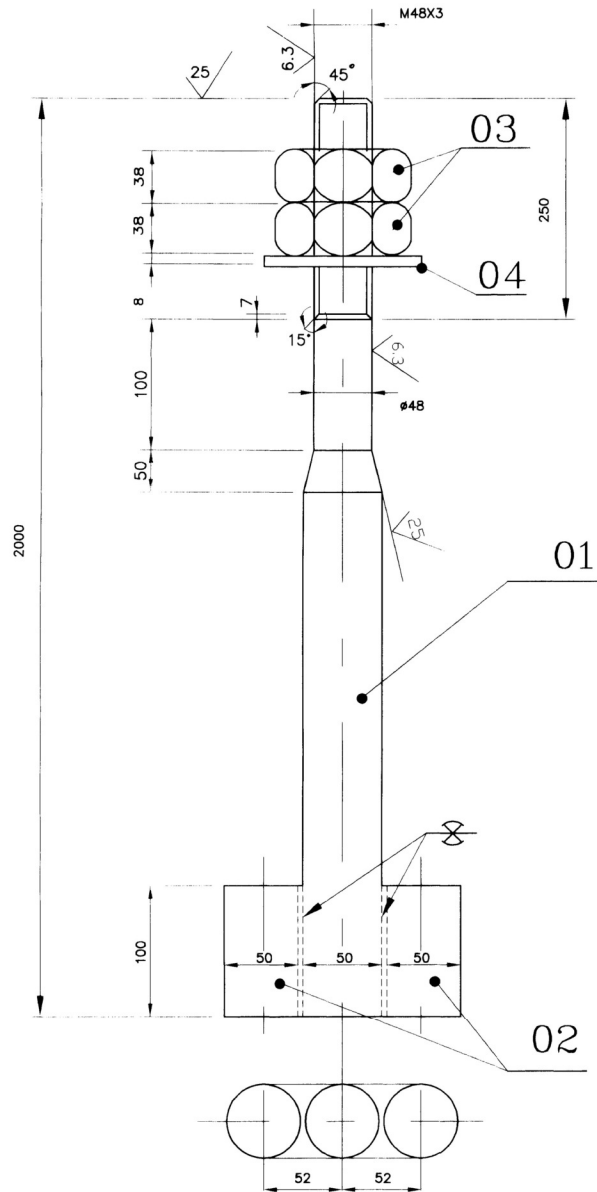
FOR TOLERANCES OF UNTOLERANCED
DIMENSIONS DURING MANUFACTURE
REFER PLANT STD. NO. TP 023 0299

SIZE AND TYPE OF WELD	TYPE OF ELECTRODE	TOTAL LENGTH OF WELD IN MTRS.
12 $\times$	E 7018	0.400



NOTES :

- FOUNDATION BOLT SHOULD NOT BE PAINTED.
- THREAD ENDS OF BOLT TO BE COATED WITH RUST PROOF OIL AND PROTECTED AGAINST CORROSION.
- MANUFACTURING REQUIREMENTS SHALL BE AS PER APPLICABLE Q.C.P.
- MATERIALS AND OTHER REQUIREMENTS ARE GIVEN PER ASSEMBLY ONLY.

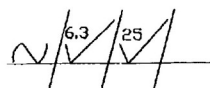


VARIANT NUMBER	ITEM NUMBER	DESCRIPTION	STD	DRAWING NUMBER	ITEM NO VAR NO	MATERIAL CODE MATERIAL SPECN	UNIT DI	UNIT WEIGHT QUANTITY	CS	ZONE
	04	WASHER PUNCHD.A48				41408-00048		0.284		
	03	NUT HEX GR C M48X3				41304-00048		0.928		
	02	ROD DIA 50 ; 100				15-004-023		1.540		
	01	ROD DIA 50 ; 2000				IS2062Fe410A		2		
						IS2062Fe410A		30.800		
								1		

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DEPT 355-054	ST 122	ALL DIMENSIONS ARE IN MM	PROJECTION SCALE NTS	WEIGHT (Kg)	REF TO ASSY / OLD DWG	CHD	M.B.K.RAJA	26/09/99	
TITLE FOUNDATION BOLT 50 DIA. 2000 LONG				DRAWING NO : 2-35-010-01247		REV			

REV 01	DATE	ALTERED : CHD & APPD :
ZONE		

SIZE AND TYPE OF WELD	TYPE OF ELECTRODE	TOTAL LENGTH OF WELD IN MTRS.
8 	E 7018	0.800

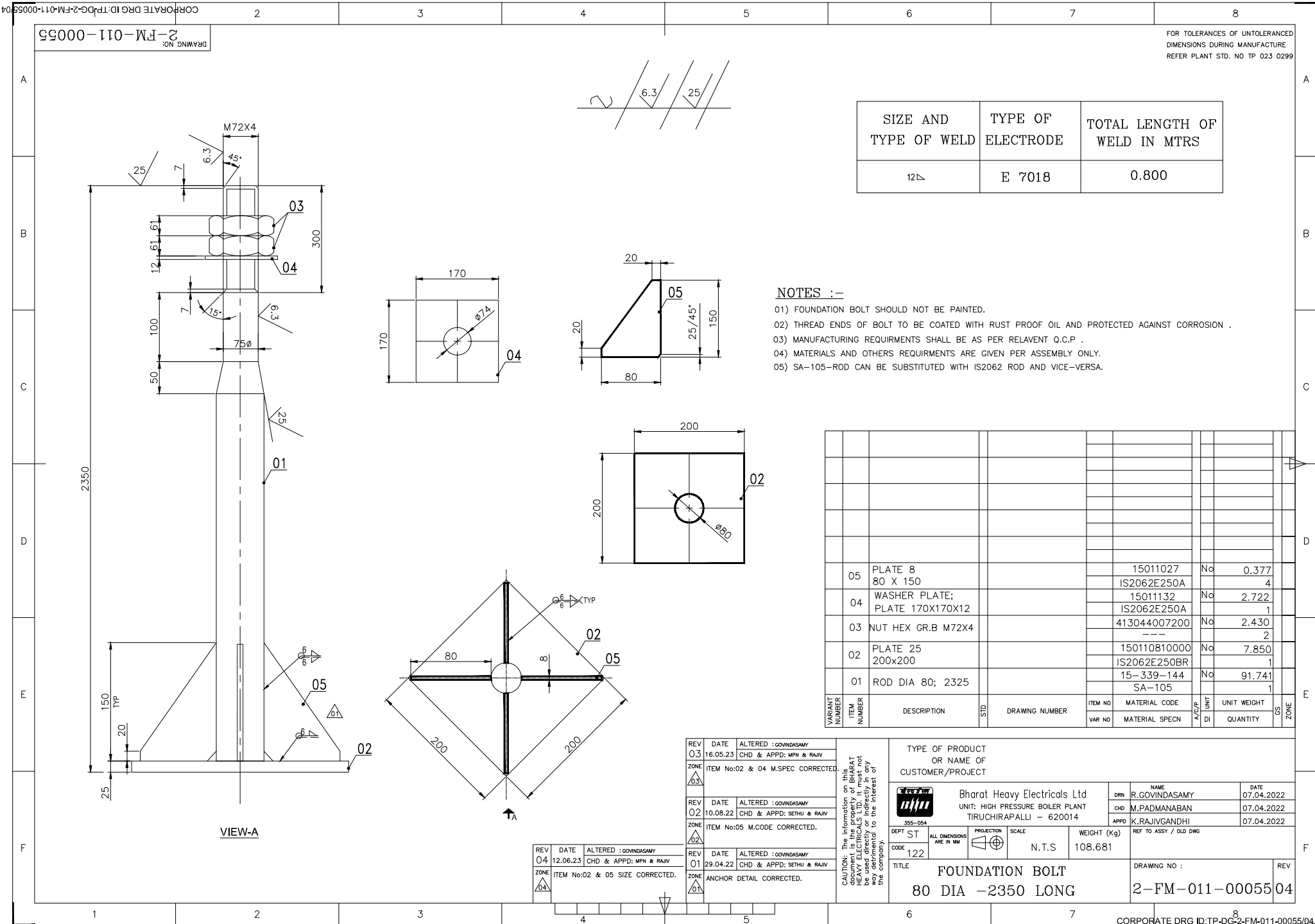


1. FOUNDATION BOLT SHOULD NOT BE PAINTED.
2. THREAD ENDS OF BOLT TO BE COATED WITH RUST PROOF OIL AND PROTECTED AGAINST CORROSION.
3. MANUFACTURING REQUIREMENTS SHALL BE AS PER APPLICABLE Q.C.P.
4. MATERIALS AND OTHER REQUIREMENTS ARE GIVEN PER ASSEMBLY ONLY.
5. THIS ROD DIA. 63 MAY BE SUBSTITUTED WITH HIGHER GRADE SA-105

[illegible]

REV 02	DATE 08-10-07	ALTERED: C. SURESH CHD. & APPD: D.V.-N	REV 01	DATE 08-09-03	ALTERED: <i>see Ref. 1</i> CHD & APPD: <i>(Signature)</i>
ITEM, 01 & 02. NCODE, REVISED			WELDING DETAIL, ALTERED.		

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			NAME S. A. BABU	SIGNATURE 
			ORN 3-A-98	DATE 27.04.98
			CHD PRAVIN DRANI	26.11.98
			APD R. J. JAYAKUMAR	27/1/98
DEPT ST CODE 122		ALL DIMENSIONS ARE IN MM	PROJECTION 	SCALE NTS
TITLE FOUNDATION BOLT 63 DIA. 2250 LONG		WEIGHT (Kg) REF TO ASSY / OLD DWG		DRAWING NO : 2-35-010-01249
				REV 02



FOR TOLERANCES OF UNTOLERANCED
DIMENSIONS DURING MANUFACTURE
REFER PLANT STD. NO TP 023 0299

SIZE AND TYPE OF WELD	TYPE OF ELECTRODE	TOTAL LENGTH OF WELD IN MTRS
12L	E 7018	0.800

NOTES :-

- 01) FOUNDATION BOLT SHOULD NOT BE PAINTED.
- 02) THREAD ENDS OF BOLT TO BE COATED WITH RUST PROOF OIL AND PROTECTED AGAINST CORROSION .
- 03) MANUFACTURING REQUIRMENTS SHALL BE AS PER RELAVANT Q.C.P .
- 04) MATERIALS AND OTHERS REQUIRMENTS ARE GIVEN PER ASSEMBLY ONLY.
- 05) SA-105-ROD CAN BE SUBSTITUTED WITH IS2062 ROD AND VICE-VERSA.

VARIANT NUMBER	ITEM NUMBER	DESCRIPTION	STD	DRAWING NUMBER	ITEM NO VAR NO	MATERIAL CODE MATERIAL SPECN	X/C/P	UNIT DI	UNIT WEIGHT QUANTITY	CS	ZONE
	05	PLATE 8 80 X 150				15011027 IS2062E250A	No	0.377 4			
	04	WASHER PLATE; PLATE 170X170X12				15011132 IS2062E250A	No	2.722 1			
	03	NUT HEX GR.B M72X4				413044007200 ---	No	2.430 2			
	02	PLATE 25 200x200				150110810000 IS2062E250BR	No	7.850 1			
	01	ROD DIA 80; 2325				15-339-144 SA-105	No	91.741 1			

REV	DATE	ALTERED : GOVINDASAMY
03	16.05.23	CHD & APPD: MPN & RAJIV
ZONE	03	ITEM No:02 & 04 M.SPEC CORRECTED.
REV	DATE	ALTERED : GOVINDASAMY
02	10.08.22	CHD & APPD: SETHU & RAJIV
ZONE	02	ITEM No:05 M.CODE CORRECTED.
REV	DATE	ALTERED : GOVINDASAMY
01	29.04.22	CHD & APPD: SETHU & RAJIV
ZONE	01	ANCHOR DETAIL CORRECTED.
REV	DATE	ALTERED : GOVINDASAMY
04	12.06.23	CHD & APPD: MPN & RAJIV
ZONE	04	ITEM No:02 & 05 SIZE CORRECTED.

TYPE OF PRODUCT
OR NAME OF
CUSTOMER/PROJECT

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014

DRN: R.GOVINDASAMY
CHD: M.PADMANABAN
APPD: K.RAJIVGANDHI

DATE: 07.04.2022
DATE: 07.04.2022
DATE: 07.04.2022

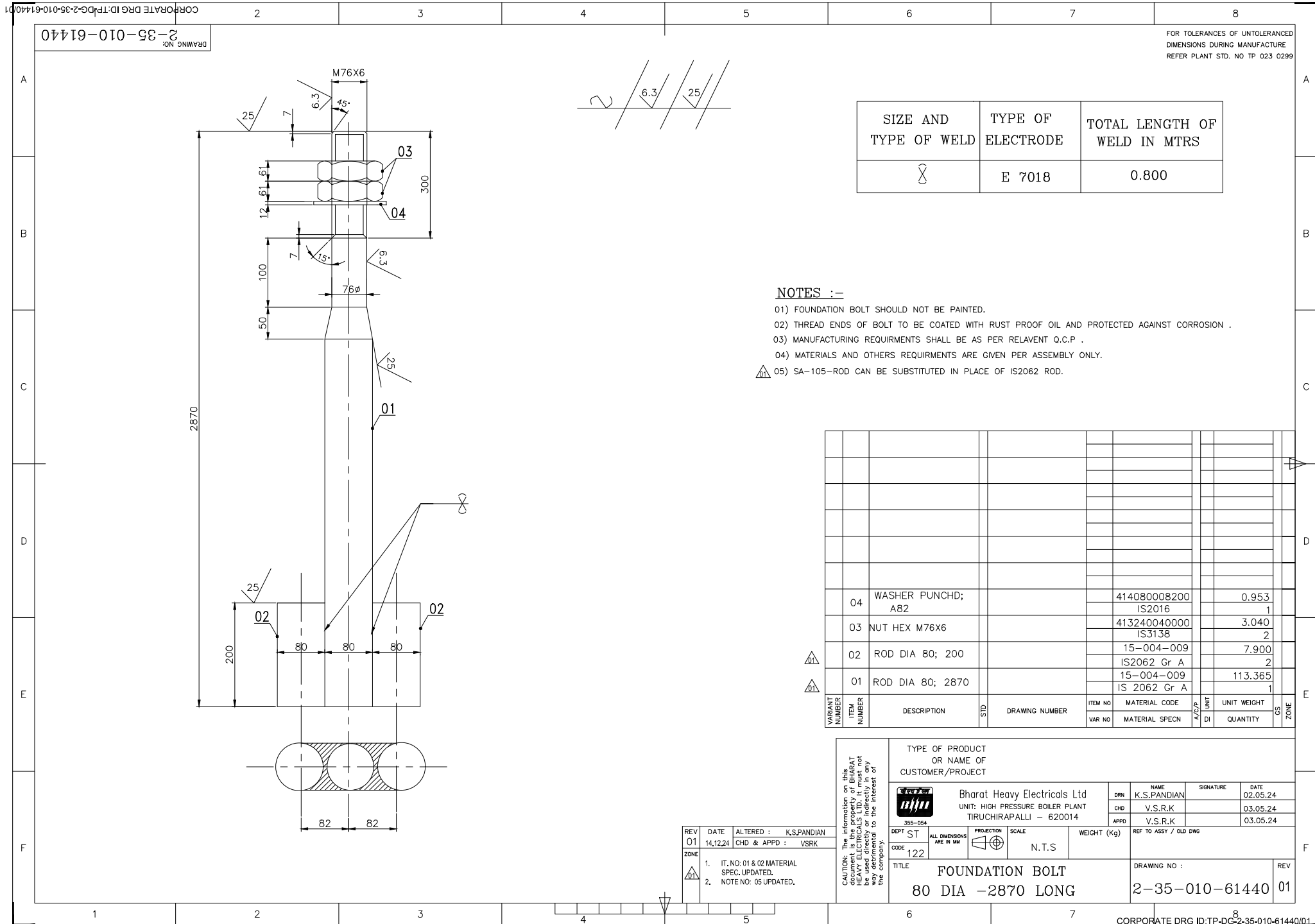
REF TO ASSY / OLD DWG

DEPT: ST
CODE: 122
ALL DIMENSIONS
ARE IN MM
PROJECTION
SCALE: N.T.S
WEIGHT (Kg): 108.681

TITLE: **FOUNDATION BOLT**
80 DIA -2350 LONG

DRAWING NO : **2-FM-011-0005504**

REV



SIZE AND TYPE OF WELD	TYPE OF ELECTRODE	TOTAL LENGTH OF WELD IN MTRS
8	E 7018	0.800

NOTES :-

- 01) FOUNDATION BOLT SHOULD NOT BE PAINTED.
02) THREAD ENDS OF BOLT TO BE COATED WITH RUST PROOF OIL AND PROTECTED AGAINST CORROSION .
03) MANUFACTURING REQUIRMENTS SHALL BE AS PER RELAVANT Q.C.P .
04) MATERIALS AND OTHERS REQUIRMENTS ARE GIVEN PER ASSEMBLY ONLY.
05) SA-105-ROD CAN BE SUBSTITUTED IN PLACE OF IS2062 ROD.

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REV	DATE	ALTERED :	K.S.PANDIAN
01	14.12.24	CHD & APPD :	VSRK
ZONE			
01			
		1. IT, NO: 01 & 02 MATERIAL SPEC. UPDATED.	
		2. NOTE NO: 05 UPDATED.	

CAUTION: The information on this document is the property of BHARAT Heavy Electricals Ltd. It is not to be used directly or indirectly in any way detrimental to the interest of the company.		TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT					
		Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI - 620014					
DEPT ST		NAME K.S.PANDIAN		SIGNATURE		DATE 02.05.24	
CODE 122		CHD V.S.R.K		APPD V.S.R.K		03.05.24	
ALL DIMENSIONS ARE IN MM		PROJECTION N.T.S		SCALE N.T.S		WEIGHT (Kg)	
TITLE FOUNDATION BOLT 80 DIA -2870 LONG		DRAWING NO : 2-35-010-61440		REV 01			

BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI - 620 014
QUALITY ASSURANCE DEPARTMENT

AMENDMENT TO QUALITY WORK INSTRUCTIONS (QWI)

QWI NO: QCP:002 REV: 05

AMENDMENT SL NO: A2 DATE: 27-07-2024

DESCRIPTION: QUALITY CONTROL PROCEDURE FOR NON- PRESSURE PARTS

Clause No.	Amended as...	Remarks / Basis for Amendment
------------	---------------	-------------------------------

4.2.8

4.2.8

Heat Treatment Parameters:

4.2.8.1

The temperatures shall be as per relevant SQP/CQP.

4.2.8.2

Rate of Heating:

Hot Working/Normalizing/ Solution Annealing	For t ≤ 100mm, 200°C/hour max.
	For t > 100mm, 150°C/hour max.
SR(PWHT)/Tempering	As per Clause 4.6.9

4.2.8.3

Soaking

during heating / Post forming heat treatment / SR (or PWHT) shall be as per below guidelines:

HT Cycle	Soaking Time
Hot Working/ Normalizing	For P5B, P-15E Gr1 (Gr.91) & Gr.92: ½ hour per inch of "t" or 30 minutes min whichever is greater & for all others ½ hour per inch of "t" or 15 minutes min whichever is greater.
SR(PWHT)/ Tempering – Carbon Steels	1 hour per inch of "t" for "t" upto 2 inches with an additional 15 minutes for every inch above 2 inches (15 minutes minimum).
SR(/PWHT)/ Tempering – Alloy Steels	1 hour per inch of "t" with below mentioned minimum soaking times:
	(P3, P4 & P5) - 30 minutes minimum.
	(P5B, P-15 E Gr 1 and Gr.92) - 60 minutes minimum
Solution Annealing	1 hour per inch of "t" (15 minutes minimum)

New clause added for clarity

	where " t " is maximum thickness for plates, pipes and diameter for bar stock or weld metal thickness (as applicable), whichever is higher. 4.2.8.3.1 In case of mixed loads of materials not covered under simulation HT, the maximum soaking time for Hot working/ Normalising of any item shall not exceed twice the minimum calculated as above. For Tempering/SR(/PWHT), this shall be as per Cl. 4.6.9. 4.2.8.4 Rate of Cooling Normalizing, Tempering : Air Cooling Stress Relieving/PWHT : As per Clause 4.6.9 Sol. Annealing : Air Blast / Water Cooling 4.2.8.5 All heat treatment shall be applied only after the component temperature falls below 200 deg. C (below 100 deg. C for P5B, Gr.91 & Gr.92). Temperature of the furnace during loading shall be below 315 deg. C.	
NOTE	The above-mentioned changes will be incorporated in the QWI during the next revision of the document.	
Prepared by: A Sakthi Ganesh		Reviewed & Approved by: M Jeyaram
 Signature & Dt: 27-07-2024		 Signature & Dt: 27-07-2024

BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI - 620 014
QUALITY ASSURANCE DEPARTMENT

AMENDMENT TO QUALITY WORK INSTRUCTIONS (QWI)

QWI NO: QCP:002 REV: 05

AMENDMENT SL NO: A1 DATE: 15.09.2018

DESCRIPTION: **QUALITY CONTROL PROCEDURE FOR NON- PRESSURE PARTS**

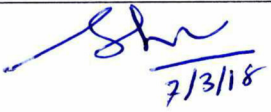
Clause No.	Existing...	Amended as...	Remarks / Basis for Amendment
4.1.7	Heat treatment shall be done after shearing for P3 materials for $t > 12.5\text{mm}$ and for P4 and P5 materials of all thickness with a holding time of 15 minutes minimum	Heat treatment shall be done after shearing for P3,P4 materials $t > 12.5\text{mm}$ and for P5 materials $t > 10\text{mm}$.	Standard practice of BHEL is retained.
NOTE	The above-mentioned changes will be incorporated in the QWI during the next revision of the document.		
Prepared by: M.Jeyaram		Approved by: J V V Aruna Kumar	
 Signature & Dt: 15.09.18		 Signature & Dt: 15.09.18	

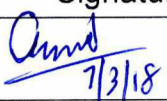
**BHARAT HEAVY ELECTRICALS LIMITED,
TIRUCHIRAPPALI 620 014**

QUALITY ASSURANCE DEPARTMENT

**QUALITY CONTROL PROCEDURE FOR
NON- PRESSURE PARTS**

QCP: 002 / 05

Prepared by Quality Assurance	M.Jeyaram  07/3/18
REVIEWED BY	SIGNATURE
ENGINEERING (M. Shanmugam)	 07/03/2018
OUT SOURCING (M. Arunmozhi Devan)	 7/3/18
QUALITY CONTROL (A.Rajasekar)	 7/3/18
QUALITY ASSURANCE (J V V Aruna kumar)	 7/3/2018

Revision No.	Date	Approved by	Signature
05	07/03/18	AGM / QA&BE	 7/3/18
04	08/12/11	DGM/QA	-----
03	10/06/10	SM/QA	
02	24/04/04	SDGM/QA	
01	01/01/95	SM/QA	
00	01/04/93	SM/QA	

Proprietary Data – For Internal Use only

RECORD OF REVISIONS

Rev No...	Clause No	Details of revision
00	--	This document consolidates all the general requirements and technical disciplines covered in the various previous
01	--	All amendments issued has been regularized and editorial correction made for better clarity. Scope of machining added in this document.
02		Editorial correction made for better clarity. Scope of machining added in this document.
03		Shaded clauses & Type of joints for base plates incorporated. PWHT temperature for P4 material revised.
04		P91 & 92 Bar process requirements added.
05	1.0	Scope modified
	3.0	New materials added.
	3.6.3	TC added.
	4.1.7	Minimum holding time specified.
	4.1.8	P3 and P5 material requirements added.
	4.1.8.1	Alternate method of grinding for gas cut edges included
	4.3.1.3	Newly added
	4.3.2.2	Root gap for SAW defined.
	4.3.3.3	Preheat area defined.
	4.3.13	1:2.5 taper specified
	4.5.3	Hot correction temperatures given for alloy steels
	4.6.7	Table added
	4.6.8.1	Thickness for soaking time defined
	4.6.8.2	Effective thickness for combination of groove and fillet defined as per AWS D1.1 2015
	4.6.11	Width of heat band defined
	4.6.11.1	Width of insulation band defined
	8.1	Machined/bolted surface painting defined
		Fig-1 added
		Annexure A and B added for better clarity

1.0 SCOPE

- 1.1 This procedure details out the process control and quality requirements for manufacture of Non Pressure Parts **in addition to the requirements specified in SQPs and SIPs of the respective products/projects.**

2.0 REFERENCE DOCUMENTS

- 2.1 AWS D.1.1, D1.6, IS 7215 and **GE:M&P 5.11.2.3(b), 5.11.2.1(e) & 5.11.2.2(e)** as guidelines.

3.0 MATERIALS

- 3.1 CLASSIFICATION OF MATERIALS (commonly used):

<u>P No. Group</u>	<u>Specifications</u>
P1 - Group 1 -	Carbon steel : IS 2062/E250A & E250B0,BR& C ,
P1 - Group 2 -	SA 515 Gr 60,SA106 GrB,A36, A53 GrB,
P3 - Group 1	H.Strength CS :SA105, SA 515 Gr 70, SA 299, SA 516 Gr 70,
P3- Group 2	SA 588
P4 -	SA 204 Gr B
P5 A- Gr 1(LAS),	SA 387 Gr 11 & Gr 12, SA 182 Gr F 11 & F 12.
P5 B- Gr1(LAS)	SA 387 Gr 22 Cl.1&CL.2, SA 182 Gr F 22
P15E Gr1	SA387 Gr5 CL.1 &SA387 Gr.9 CL.2
	SA182 F91,F92,SA387 Gr91,Gr92, SA 335 P91,P92
	SA213 T91,T92 ,SA234 WP91,WP92 & SA 336 F91,F92
P6 -	SA 240-410,429
P8 - Stainless steel	SA 240 - 304 ,309,310, 316, 321, 347 & 253MA
IS	IS 2062/E350A,B0,BR& C, E450BR, Fe410, IS3589,IS1079 ,
	IS513 TYPE D , IS 1239, IS 1161 YST 240.
EN	BS EN10025-2, EN10025-3

Any other materials as specified in the drawings.

- 3.2 Raw materials used shall conform to the relevant specification as given in drawings and applicable TDC/PO. Any substitution of materials shall be done only with prior approval of engineering through applicable documents. Where subcontractors procure the raw materials, the same shall have valid test certificates.
- 3.3 Raw materials shall be free from visual defects like cracks, seams, laps, laminations, heavy pitting etc. When defects are noticed in visual inspection the same shall be confirmed using appropriate NDE techniques and repaired using applicable approved process .
- 3.4 All materials are procured with permitted dimensional tolerances of the material specifications and / or TDC. Wherever required, the raw materials shall be corrected prior to fabrication to achieve the required product tolerances.
- 3.5 Customer supplied materials are to be verified as per SP 0626.
- 3.6 The requirements of material traceability shall be as indicated in the respective drawings.
- 3.6.1 Product Attest "P" items indicated as in drawings are traceable to the test certificates and identified with material Specification, grade and melt number by stamping.
- 3.6.2 CERTIFIED items indicated as "C" in drawings are traceable to material Specification / grade only and identified by stamping / engraving / stenciling / painting.

- 3.6.3 Raw materials not covered by the above shall be identified by its W.O.No / Material code / Specification / grade by painting / stenciling / engraving. **The Test certificates for raw materials shall be maintained by OVM vendors.**
- 3.6.4 All subdeliveries shall be identified by its material code by painting or through name plates / tags.
- 3.7 When materials (including stock) are to be upgraded for special contract requirements QC shall ensure that the respective specification, **CQR** and contract TDC (as applicable) are complied.

4.0 FABRICATION

4.1 MARKING, CUTTING AND PREPARATION

- 4.1.1 Raw material shall be marked and cut to size by shearing, machining, saw cutting, flame or plasma (for SS materials) cutting. Flame cut edges shall be cleaned to remove slag. Uneven edges shall be dressed by grinding. Gas cutting notches shall be filled up by grinding the notches smoothly for welding using compatible electrodes and ground before taking up for further fabrication.
- 4.1.2 Wherever raw materials supplied / available are not sufficient for the sizes required, the same can be built up using the splicing either by groove weld/fillet weld sufficient to hold the parts in place instructions given in the respective SQPs/ Drawings/DCN (Incl. Production Notes)
- 4.1.3 Layout for size and shape shall be marked before cutting (for other than CNC applications) The tolerance for marking shall be maintained within + 2mm unless otherwise specified. The diagonal difference shall be within 3 mm.
- 4.1.4 The markings shall be punched at convenient intervals and bordered with white paint.
- 4.1.5 Stainless Steel (SS) materials shall be cut using plasma cutting or shearing only. Any further dressing/ grinding of cut surfaces should be done with separate and clean abrasive wheels.
- 4.1.5.1 The cut edges should be smoothly ground.
- 4.1.5.2 Notches above 3 mm or 20 % 'T' shall be thoroughly cleaned and welded by using a qualified WPS and examined visually and by LPI . The repaired surfaces are to be cleaned to bright metal surface.
- 4.1.6 Clip / Cleat angles of carbon steel above **12** mm thick used for beam connections which are sheared to length shall require heat treatment. Shearing /Flame/gas cutting is prohibited on Gr 91 and Grade 92 materials. Use only bandsaw for cutting of Gr91&92 materials. However for plates use plasma/waterjet/ bandsaw only
- 4.1.7 Heat treatment shall be done after shearing for **P3** materials for $t > 12.5\text{mm}$ and for P4 and P5 materials of **all thickness with a holding time of 15 minutes minimum.**
- 4.1.8 The requirements of preheat for gas cutting are as follows:
- | | | |
|----------------------------------|------------------------|----------------|
| Carbon steel | $t \leq 50\text{mm}$: | : Nil |
| Carbon steel | $t > 50\text{mm}$: | : 100 ° C.min. |
| Alloy steel (P3&P4) | $t \leq 25\text{mm}$: | : Nil |
| Alloy steel (P3&P4) | $t > 25\text{mm}$: | : 150 ° C |

Alloy steel (P5)

Sl no	P5 Material- thickness	Preheat temperature
1	t<13mm	120 °C.
2	For t=13 upto 25mm	150 °C.
3	t>25mm	200 °C.

Stainless steel

Not applicable

- 4.1.8.1 Stress relieving for gas cut edges shall be as follows. **Alternatively, the cut surface can be ground / machined upto 3 mm to remove HAZ and checked by LPI/MPI.**

Material	Thickness	Heat treatment cycle
P1	> 50 mm	600 ° - 650 ° C for 15 minutes
P3	> 16 mm	620-650 ° C for 15 minutes.
P4	> 16 mm	650 ° – 700 ° C for 15 minutes. Furnace cool
P5	All	680 ° - 730 ° C for 15 minutes. Furnace cool
SS (plasma)	Any	Not required

For materials other than P5, P15E Gr 1(Grade 91) and Grade 92 this heat treatment may be clubbed with the final heat treatment of the product.

- 4.1.9 The prepared plates shall be visually inspected and repaired if required as per SIP:NP:06.
- 4.1.10 The raw materials after cutting shall be identified with relevant WO No., DU No., Part No. and Material Spec / Grade (transferred).

4.2 FORMING

- 4.2.1 Before forming , proper cutting plan (Drawing dimensions with process allowances) shall be prepared and cleared by the concerned agency. Forming shall be done using proper tooling free from damages. Method of forming and work centre shall be identified in OPS / relevant QWI referred in PO.
- 4.2.2 Built up (Forming) operations for Beams and columns shall be done by suitable Fixtures, Machines , WPS & other accessories required for forming. All the Forming operations of sheets / plates shall be done by rolling / pressing. For shell formed components Circularity of rolled shells shall be checked using templates (of length > ¼ of ID).
- 4.2.3 Suitable nonmetallic padding shall be provided while forming of stainless steels to avoid contamination.
- 4.2.4 All formed /Built up components shall be checked for orientation, angle, and other dimensions as per drg. All formed parts shall have smooth finish and shall be free from bends, folds and sudden transitions.
- 4.2.5 Minimum thickness after forming shall be ensured whenever specified in drg.
- 4.2.6 **Forming of U-ROD(Gr91&92)**
- 4.2.6.1 Identify, mark and cut the rod using bandsaw to a length of equivalent to the arc length indicated in the drawing with two arm length(upto butt joint) +20mm.

- 4.2.6.2 Mark the centre of the rod with a heat resistant chalk to be visible after heating. For temperature and other details refer the SQP:NP:15(Latest)
- 4.2.6.3 Remove the “U”rod and air cool to room temperature.
- 4.2.6.4 Visually inspect the bend surface and check dimensions and ensure no surface imperfections.
- 4.2.6.5 Normalizing and tempering of “U”Rods to be done within 72 hours after pressing/bending operation.(Ref.SQP:NP:15(latest)
- 4.2.6.6 Shot blast the “U”Rod to remove scaling and check the dimension. Conduct LPI/Wet MPI and ensure no surface indications.
- 4.2.6.7 Mark and cut the limbs of “U” rods such that the straight portion shall be as per drawing from the tangent point.
- 4.2.6.8 Edge prepare the “U”rod s for butt joint preparation as shown in the drawing by machining No gouging and grinding is allowed.
- 4.2.6.9 For Detailed operation of cold and hot forming of Gr 91 &Gr 92 materials refer SQP:NP:15(latest)

4.2.7 **Threading of “U”Rods**

- 4.2.7.1 Mark and cut the rods equivalent to the straight portions as shown in the drawings.
- 4.2.7.2 Threading to be done on one end of the rod to thread size as mentioned in the drawing/ SQP:NP15(latest).
- 4.2.7.3 Edge prepare the other end of the rods by machining for butt welding as shown in the drawing.
- 4.2.7.4 Tolerances for formed components when not specified in drg. Shall be as follows
 - a) St.Length / Dia, : + 1 mm/M, 5 mm Max
Width & Height
 - b) Verticality : 1 mm / M, 5 mm Max
 - c) Squareness : 1 mm / M of length / Dia
 - d) Straightness : 1 mm / M, 5 mm Max
 - e) Radius : + 5 mm
 - f) Bend Angle : + 2°
 - g) Ovality : 1%
 - h) E.P Angle : + 5° / - 2.5°
 - i) Diagonal diff : 3 mm

4.3 **WELDING**

4.3.1 **WELDING CONSUMABLES**

- 4.3.1.1 Welding consumables conforming to the qualified welding procedures shall be used. However the following guide lines are provided.

- 4.3.1.2 Unless specified otherwise in the WPS, basic coated electrodes E7018 shall be used for SMAW of all structural components involving materials of IS2062 E250 grade.
- 4.3.1.3 All the electrodes are to be procured using Welding consumable procurement instruction (WCPI) issued by WTC.
- 4.3.1.4 For duct welds, rutile electrodes (E6013) shall be used.
- 4.3.1.5 All low hydrogen electrodes shall be dried in the baking oven at 250-300 deg.C for 2 hours and the electrodes shall be held at 100-150 °C until they are used. Electrodes shall not be re-baked more than once and use of electrodes in wet condition is prohibited.
- 4.3.1.6 All rutile electrodes (EXX 13) shall be dried at 100-150 °C deg. C for 1 hour min. and held at 100-150 °C deg.C till use.
- 4.3.1.7 Fluxes for SAW shall be dried at 250 °C for 1 hour min. before use. Height of flux bed while drying in pan or oven, shall not be more than 100mm.
- 4.3.1.8 Unless otherwise specified, SS consumable shall be baked as per Electrode manufacturer's recommendations and stored at 100 ° - 150 ° C until use.
- 4.3.1.9 The type of welds employed in the structural fabrications (Girders, Columns, Beams & Base plates etc) are identified in the annexure –A along with sketch for better clarity and under standing. For further details the fabricator can ref the engg.drg. no.3-35-110-00995/00

4.3.2 FIT UP

- 4.3.2.1 Proper fit up shall be ensured before welding as per Drawing. Tack welding or mechanical clampings shall be used to maintain the fit up requirements before and during welding. Bridge pieces used during fit up shall be of ferritic for ferritic materials and stainless for stainless steel materials. However for P15E Gr.1.(F91 & F92) prepare a fixture for fit-up of butt joint of „U“ rod with Straight rods
- 4.3.2.2 Dimensions of the cross sections of groove welded joint shall be within the following tolerances w.r.t . drawing requirements:

	Root not back gouged	Root back gouged
1. Root face of joint(land)	± 2 mm	Not limited
2. Root opening of joint (with out backing)	± 2 mm	+ 2 mm - 3 mm
Root opening of joint* with backing)	+ 6 mm - 2 mm	Not Applicable
3. Groove angle of of joint	+ 10° - 5°	+ 10° - 5°

*(NOTE): Root opening wider than permitted by above tolerances but not greater than twice the thickness of the thinner part or 20mm, whichever is less may be corrected by edge buildup to acceptable dimensions prior to welding. Such build up edge shall be MPI / LPI checked. For SAW process, the maximum root opening variation (minimum to maximum opening as fit-up) may not exceed 3 mm.

- 4.3.2.3 For C. S. fillet welds, the parts shall be as close as practicable and gap shall be limited to 5 mm (If gap exceeds 2 mm, the leg of fillet shall be increased by the amount of gap but in no case shall exceed 4.8 mm). For thickness 75 mm and above gap up to 8 mm can be permitted provided suitable backing is used.
- 4.3.2.4 For S. S. fillet welds, the parts shall be as close as practicable. Gaps 2 mm and above upto 5mm are acceptable if the fillet size is increased by an amount equal to the gap.
- 4.3.2.4 Parts to be joined by butt welds shall be properly aligned. An offset not exceeding 10% of the thickness of the thinner part joined can be permitted, but in no case more than 3 mm, is permitted.
- 4.3.2.5 The types of weld joints indicated in the fabrication of structural components are identified with symbols in ANNEXUR -A & B .For further details refer the Engg standard drawing no.3-35-110-00995 (Latest)

4.3.3 PRE HEATING

- 4.3.3.1 Pre heating requirements for welding shall be as per Clause 4.6.7 and controls shall be exercised as detailed below. No preheating is required for stainless steels.
- 4.3.3.2 Preheating shall be maintained during the entire process of welding.
- 4.3.3.3 Preheating is to be done using gas burner or induction / resistance heating. The temperature must be uniform and verified using thermal chucks or thermocouples prior to start of welding as well as during welding for a width of 1.5 times the base metal thickness or 75 mm whichever is more, around the point of welding (not less than 25mm in case of tack welding in all directions).
- 4.3.3.4 Where interpass temperature control is required during welding, the temperature must be ensured using thermal chucks / thermocouples with recorder . Inter pass nitrogen / air cooling can be adopted to maintain inter pass temperature in case of stainless steels.
- 4.3.3.5 Wherever post heating is specified after welding, the preheating shall be continued till attaining the post heat temperature and maintained for the required time and cooled slowly by wrapping suitable insulating blankets like asbestos.
- 4.3.4 Welding shall be performed using qualified procedures and qualified personnel. Edge preparation and welding details shall be as per drawing.
- 4.3.5 For items to be manufactured at subcontractor's works (including away centre fabrication) , for requirements of procedure and personnel qualification SIP:NP: 07 (Latest) shall be followed.
- 4.3.6 When double bevel welding is adopted, back gouging and grinding is to be done. Back gouged groove shall be checked with PT / MT before welding from second side. However for P15E Gr.1.(F91 & F92) Only back grinding to be done after interstage PWHT.
- 4.3.7 Proper sequence of welding shall be adopted to minimise distortion. The distortion of the finished jobs, if any may be corrected by mechanical means / hot correction.

- 4.3.7.1 For welding of SS extreme care is to be taken in weld sequencing to minimize the weld distortion and shrinkage. For complex weldments a weld sequence instructions may be prepared by contractor prior to work commencement. Weld joints likely to have high shrinkage should be welded (with minimum restraints) before welding other joints providing allowance for shrinkage. For further details ref.SQP:NP:20
- 4.3.7.2 While cutting long web plates suitable camber may be provided /required to compensate for the distortion during cutting and welding.
- 4.3.8 All butt welds of divider plate and guide vanes in ducts shall be flush ground inside.
- 4.3.9 The use of jigs and fixtures is recommended where ever practicable. Suitable allowances shall be provided for weld shrinkage. Proper sequence of welding shall be followed to control the distortion during welding.
- 4.3.10 All temporary attachments shall be welded with the required preheat. After their removal welded spots shall be ground flush and LPI checked.
- 4.3.11 Groove welds shall preferably be made with minimum reinforcement unless and otherwise specified in drawing / SQP. In case of butt welds, reinforcement shall not exceed 3.2 mm. and shall have gradual transition to the plane of the base material surface.
- 4.3.12 The surface of the welds shall be free from coarse ripples, overlaps, undercuts and abrupt ridges to avoid stress raisers.
- 4.3.13 Where parts of different thicknesses are welded or surface offset is more, the transition shall be made gradual by grinding / machining with **1: 2.5 taper unless specified in the drawing.**
- 4.3.14 Stray arcs shall be avoided to the extent possible. Arc spots if noticed shall be ground and checked by LPI / MPI. Thickness requirements shall be ensured after grinding.
- 4.3.15 Pre heating of Gr 91 & Gr 92 shall be 220 °C .For other process parameters refer the applicable WPS

4.4 WELD REPAIRS

- 4.4.1 Removal of defective weld / portions of the base material may be done by machining, grinding, chipping, gas cutting, oxygen gouging or carbon arc gouging. Defective portions of the weld shall be removed without substantial removal of sound base metal.
- 4.4.2 For under sized welds additional weld metal shall be deposited using an electrode preferably smaller than that used for making original weld limited to 4mm in diameter. The surfaces shall be cleaned thoroughly before deposition.
- 4.4.3 Defective welds/base metal shall be repaired by removing or/and rewelding as follows:
- 4.4.3.1 Overlap / excess weld metal shall be removed by grinding.
- 4.4.3.2 For excess concavity, crater, undersize & undercuts, deposit additional weld metal after cleaning the weld surface.
- 4.4.3.3 For Cracks in weld or base metal, ascertain the extent of crack by suitable NDE /acid etching, remove the crack to sound metal upto each end of the crack by arresting the ends for further propagation and reweld.

- 4.4.3.4 For weld porosity, slag inclusions & lack of fusion remove defective portions & reweld.

4.5 HOT CORRECTION

- 4.5.1 Members which require hot correction are to be supported at suitable locations and mark the locations for heating.
- 4.5.2 Heat the locations marked by using neutral flame. Torches used for heating shall be moved continuously & uniformly over selected area to avoid localised over heating.
- 4.5.3 For Carbon steels the maximum temperature shall not exceed 650 ° C and shall be ensured using thermal chinks / thermocouples.

The temperatures for alloy steels shall not cross for P3 -649 ° C, P4 – 704° C , P5 – 732° C during hot corrections.

- 4.5.3.1 For Austenitic stainless steels the maximum temperature shall not exceed 430 ° C and shall be made known to inspection authorities . Otherwise , after hot correction solution annealing at 1050 – 1100 deg C is to be done.
- 4.5.3.2 For Ferritic/Martensitic/Duplex stainless steels the maximum temperature shall not exceed 315° C and shall be made known to inspection authorities . The temperature shall be ensured using thermal chinks / thermocouples.
- 4.5.4 Additional dead weights may be placed over the positive side of the bend depending upon the requirement to accelerate hot correction.
- 4.5.5 Allow for natural cooling. Accelerated cooling shall not be adopted. Remove the dead weights used after cooling.
- 4.5.6 Wherever the correction for distortion affects the weld joints, applicable NDE shall be repeated after the correction.

4.6 POST WELD HEAT TREATMENT (PWHT)

- 4.6.1 The process controls (temperature control and recording) for heat treatment shall cover the activities before, during and after heat treatment.
- 4.6.2 The weldment shall be cleaned to free of grease, oil etc. prior to heat treatment.
- 4.6.3 PWHT shall be done in a furnace or by local heating a band (including the entire weld and adjacent area of the base metal) .
- 4.6.4 The thermocouples and recording instruments shall be calibrated as per applicable standards and records maintained. The furnace shall have been qualified and calibrated.
- 4.6.5 All materials to be heat treated in furnace shall be loaded in such a way that they shall not be subjected to direct flame impingement. Jobs shall be preferably loaded on raised plat forms so that no material projects into the plane of burners. Alternatively flame deflectors may be provided in front of the burners to avoid direct flame impingement. Ensure loading of test coupons wherever applicable. The furnace temperature shall not exceed 315 ° C at the time of loading material / weldment.
- 4.6.6 Number of thermocouples and their location shall be decided covering maximum and minimum thickness and covering all the zones. The temperature variation within 5 meters shall not exceed 140 ° C during heating period (above 315 ° C).

4.6.7 The **temperature requirements** for Pre heating, Post Weld Heat Treatment(PWHT) & temperatures **for welding** are given as below.(Unless otherwise specified in WPS.)

Material	Pre heating	PWHT	Remarks
Butt/groove welds:			
P1	For t> 38mm , 150 ° C	For t> 50 mm, 600-650 ° C	
P3	All thickness, 150 ° C	All welds when t >16 mm, 620-650 ° C.	For all butt welds in tension members, PWHT to be done.
P4	All thickness, 150 ° C	All welds when t >16 mm, 650-680 ° C.	For all butt welds in tension members, PWHT to be done.
P5	150 ° C (Note2)	680-710 ° C	All welds
P8	120 ° C, 300 type 205 ° C, 400 type	- -	
Fillet welds :			
P1	For t> 38mm , 150 ° C	-	
P3	All thickness, 150 ° C	if throat thickness>13mm, 620-650 ° C.	
P4	All thickness, 150 ° C	if throat thickness>13mm, 650-680 ° C.	
P5	150 ° C (Note2)	All thickness, 680-710 ° C	
P8	120 ° C,300 type 205 ° C ,400 type	-	

Note 1 All welds on P5 material shall be post heated at 250 ° C for 2 hrs or 150 ° C for 4 Hrs, immediately following welding.

4.6.7.1 The soaking time shall be as follows:

- For P1 materials the soaking time shall be 1 hr/inch of thickness(t) (2.5 mts / mm) upto 2" and 2 hrs + 15 minutes for each additional inch for t > 2".
- For P3, P4 & P5 materials the soaking time shall be 1 hr/inch of thickness (2.5 mts/ mm) upto 5" and 5 hrs + 15 minutes for each additional inch for t > 5".
- For combination cycles mentioned above, calculate the minimum soaking time for individual components as 2.5 minutes/mm of the thickness of weld/material whichever is applicable. Soaking time selected for the cycle shall not exceed the limits given below:

Material	Thickness (mm)	Max. soaking time (minutes)
P1 (A,B,C), P4,P5A,	Up to 25 mm	125
P1 (A,B) + P4	26 - 50 mm	200
P1C + P4, P1 + P3	51 - 80 mm	250
P4 + P5A	81 - 150mm	375
P15E Gr1		

4.6.7.2 Unless otherwise specified, in case of mixed loads of materials not covered under simulation HT, the following heat treatment temperatures shall be followed. In such cases, guidelines for soaking can be taken from Clause 4.6.9.

For components having butt joint between P1 & P4, or P3 & P4, the cycle shall be 630 – 670°C.

Where a component has a butt joint between P4 & P5A, the cycle shall be 680 - 720° C.

Where a component has a butt joint between P1 & P3, the cycle shall be 620-660 °C

For P1+P5A material combination, follow the WPS requirements

The following jobs shall not be combined in the same cycle during PWHT.

i. separate jobs of P1 and P4 ii. separate jobs of P4 and P5.

4.6.8 The following rules shall apply to establish the thickness to be used in determining the soaking time for PWHT.

4.6.8.1 For Butt welds, the thickness shall be **weld metal thickness**. For bar stock, the thickness shall be the diameter. **The holding time is based on the weld metal thickness even though some material in the weldment is thicker than the weld.**

4.6.8.2 For fillet welds, the thickness shall be the throat thickness. **The effective throat of a combination PJP bevel groove weld and a fillet weld shall be the shortest distance from the joint root to the weld face of the diagrammatic weld minus 1/8 in [3 mm] for any groove detail requiring such deduction as shown in Fig-1**

4.6.8.3 For partial penetration branch welds, the thickness shall be the depth of the groove prior to welding.

4.6.8.4 For repairs, thickness shall be the depth of the groove as prepared for repair welding.

4.6.8.5 For combination of different welds in a component, maximum thickness of weld shall govern.

4.6.9 Requirements of Rate of Heating (ROH) above loading temperature 315 ° C and Rate of Cooling (ROC) are as given below. During heating and cooling, variation in temperature between thermocouples shall be 85 ° C maximum, unless otherwise specified.

Thickness	ROH / ROC (Max) Above / upto 315 ° C
Up to 25mm	220 ° C / hour
26 - 50 mm	110 ° C / hour
50 – 75 mm	75° C / hour
Above 75 mm	55 ° C
For S.S Matl	200 ° C / hour min (Forced air cooling)

- 4.6.10 In case of interruption during Heat treatment the following action has to be taken depending on the stage of occurrence:

Type of Heat treatment	Stage of interruption	Action
Annealing & stress relieving	Heating	Heat treat subsequently as specified
	Soaking	Heat treat subsequently for balance soaking with minimum 15 minutes.
	Cooling	If the ROC during interruption period meets the specified rate, cool subsequently at required rate upto 400° C. Otherwise, reheat to the soaking temperature, hold for 15 minutes and then cool at the specified rate
Normalising(N) Tempering (T) & Soln. annealing (S)	Heating	Heat treat subsequently as specified
	Soaking	Heat treat subsequently for full soaking(N,S) / Balance soaking (T)
	Cooling	Not applicable

- 4.6.11 Local heat treatment can be carried out by Resistance heating or Induction heating. For local heat treatment of weld joints, width of the heated band on either side of the weld must be **at least 3 times the width of the widest part of the weld groove but not less than twice the thickness of the thicker part welded.**
- 4.6.11.1 **The width of the insulation band on either side shall be at least twice the width of the heating band.**
- 4.6.11.2 A minimum of three thermocouples shall be placed such that at least one is on the weldment /HAZ and the other two on the base material on either side of the weldment.
- 4.6.11.3 The winding arrangement shall be established to attain the required temperature. The initial rate of heating shall be minimum such that it stabilises at the required rate of heating before reaching 400 deg C.
- 4.6.12 After heat treatment, the charts shall be correlated with the job and cleared by QC. The chart shall contain cycle no, Date, W.O and DU details. Temperature, ROH, ROC and soaking time shall be calculated, entered in the chart and signed off by QC.
- 4.6.13 Wherever applicable the test coupons shall be tested and reports obtained to complete the clearance of heat treatment operation.

5.0 NON-DESTRUCTIVE TESTING

- 5.1 The requirement of NDE, extent and type of examination shall be as per respective product SQP and / or CQP .Wherever product SQP is not existing the following requirements shall apply.
- 5.2 Visual inspection shall be performed as per SIP:NP:06 latest
- 5.3 RADIOGRAPHY.
- All Butt welds of Carbon steel for thickness $t > 32\text{mm}$
 - All butt welds of alloy steels for thickness $t > 12\text{mm}$ for P5 and $t > 16\text{mm}$ for P4&P3.
 - All butt welds in monorails.
 - SS butt welds of $t > 16\text{mm}$ unless otherwise specified.

5.3.1 All radiographic films shall possess Firm code, RT agency, Cust. No, Part No, RT reference Number. and weld location reference number. The job shall be numbered with Radiograph number.

5.4 MPI / LPI BEFORE PWHT

- a. All flame cut edges of Carbon steel for $t \geq 38$ mm and alloy steels for $t > 12$ mm.
- b. All butt welds joining plate members in which one of the plate member is over 25 mm thick for Carbon steel and over 12 mm thick for alloy steel.
- c. All fillet welds between tension flange and web.
- d. All fillet welds joining plate members in which both the plate members are over 25 mm thick for Carbon steel and over 12 mm thick for alloy steel.
- e. For all butt welds of CS & AS weld groove after back chipping prior to welding from second side.
- f. All main fillet welds for SS require LPI
- g. MPI/LPI for all fillet welds & HAZ of SA387 Gr.22 materials after HT.

5.5 All NDE shall be carried out by qualified personnel as per BHEL NDT procedures. Where subcontractors use their own procedures for NDE the same shall have the approval of BHEL NDTL.

6.0 MACHINING

6.1 GENERAL

6.1.1 Ensure of raw material identification throughout the machining process. Traceability to the contract shall be ensured by stamping or marking / painting or by tags(WO No.and DU / Part no.)

6.1.2 Where the material identification is likely to be removed during cutting or machining, the transfer of material identification shall be ensured.

6.1.3 In case of components / part processed items received from Subcontracting / other shops, ensure the completeness and clearance by QC / Customer Inspector through Inspection Reports / OPS.

6.1.4 Proper care shall be taken during handling of materials at all stages of manufacture. Items stored in the shop floor shall be properly identified and preserved to prevent mixup and damages / rusting / warpages.

6.1.5 All Machined surfaces shall be properly protected and stored. Wherever long storage is envisaged, they shall be preserved with grease / rust preventive oils and protected suitably with polythene / gunny bag or plastic peel off coatings.

6.2 MARKING

6.2.1 The marking on machined components shall be in such a location which will not be detrimental to the surface finish requirements of the component.

6.2.2 Purpose of marking is to:

- 1. Ensure availability of machining allowance.
- 2. Identify locations for machining.
- 3. Provide reference for setting and inspection.

6.3 PROCESS CONTROLS

- 6.3.1 The following shall be ensured for selection of work centers, tools, jigs and fixtures:
- The work centre for machining shall be identified in OPS / loading sheet based on the process capability of the machine or Machine accuracy established to suit the tolerances.
 - Test hardware (Jigs, Fixtures and Templates) used as a means of inspection / process control shall have been qualified through first off trials and shall be regulated through valid number. The same shall be reflected in the OPS / loading sheet .
 - Softwares used in case of CNC / NC machines shall have been validated through trials or inspection of similar components produced and accepted.
 - All cutting tools shall have been ensured for its correctness before use. In case of regrinding of tools they shall be verified after regrinding.
- 6.3.2 The following shall be ensured before setting the job on the machine, during processing and after completion of machining:
- Ensure the verticality and flatness of the job after clamping by using the reference markings or dialing the surfaces. Ensure the adequacy of clamping.
 - Ensure proper clamping of the correct tool in to the tool holders.
 - After machining the machined surfaces shall be cleaned and all corners shall be deburred. After removing from the machine they shall be properly stored.
 - Before starting reaming ensure proper material allowance for finish operation.
 - During drilling, reaming and tapping the removal of chips shall be done periodically to prevent clogging of chips. For deep drilling ensure that run out and drill travel are verified in free condition and ensure proper clamping of the tools.

6.4 INSPECTION

- 6.4.1 Ensure completeness of all final machining operations. Dimensional inspection shall be done with relevant drawings. Ensure use of calibrated instruments / gauges.
- 6.4.2 Unless otherwise specified in the drawing or SQP, the following tolerances can be used for untoleranced dimensions.

1. Linear Tolerance (:millimeters) - Medium

PERMISSIBLE DEVIATIONS FOR BASIC SIZE RANGE						
Up to 6	From 6 TO 30	from 30-120	From 120-400	From 400-1000	From 1000-2000	Above 2000
± 0.1	± 0.2	± 0.3	± 0.5	± 0.8	± 1.2	± 2.0

2. Angular Tolerance

- Assembly characteristics ± 0.5°
- Other characteristics ± 1°

7.0 FINAL INSPECTION

- 7.1 All dimension shall be inspected as per relevant drawings. Tolerances for fabricated items when not specified in drawings shall be as per clause 4.0.

8.0 CLEANING AND PAINTING

- 8.1 All the temporary cleats, bridge pieces shall be removed carefully so as to avoid damage to parent material. Temporary tack welds shall be ground smooth. Complete assembly shall be cleaned to remove mill scales, spatter, slag, rust, oil or grease. Surfaces shall be prepared and painted as per SIP:PP:22 (latest). Site EPs shall be applied with weldable primer. All site EP shall be protected suitably from mechanical damage. **The machined/bolted surfaces shall be applied with rust preventive oil coating and painting shall not be done on these surfaces. All the machined and bolted surfaces should be suitably masked to avoid handling damages.**
- 8.2 All temporary stiffeners / attachments used for transportation and handling that are removed after site assembly shall be painted with yellow paint.
- 8.3 Match marking and flow direction for applicable components shall be as per the respective product SQP./Drawing
- 8.4 The following details shall be clearly marked with relevant details by paint, bordered and covered by one coat of transparent varnish

Project Name :
 Work order number :
 Component / Assly. Designation :
 DU Number :
 Weight :
 Sub-contractor Name / Code :

- 8.5 Tension flanges in girders are to be identified by hard punching indicating 'TENSION FLANGE'.
- 8.6 Apply grease on the threaded portion of "U" rod and protect the threaded portion from damage with suitable plastic end caps.
- 8.7 For subcontracted items the firm code shall be punched and bordered with white paint.

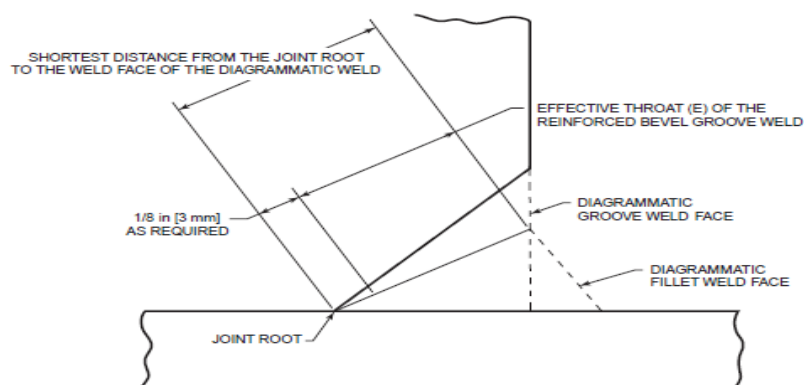
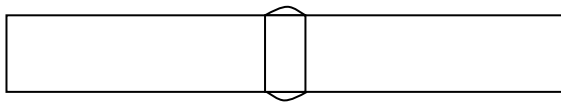
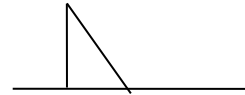
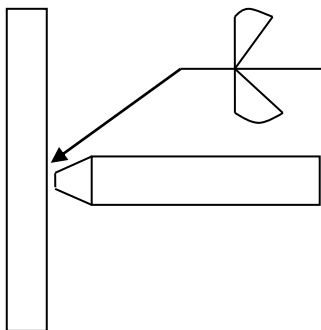
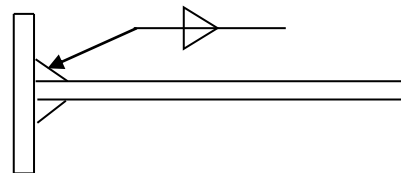
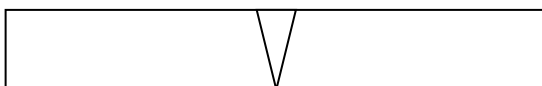
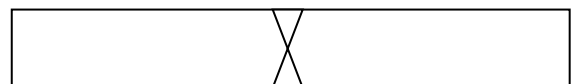


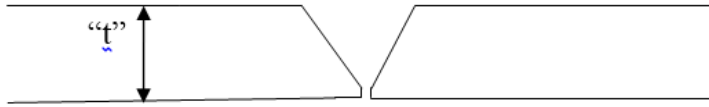
Fig-1

ANNEXURE - A**SQUARE BUTT WELD****BEVEL WELD****K WELD****FILLET WELD****SINGLE V JOINT****DOUBLE V JOINT**

ANNEXURE-B

Examples illustrated with sketch for P1 materials.

Sketch-1 (Full penetration weld joint)



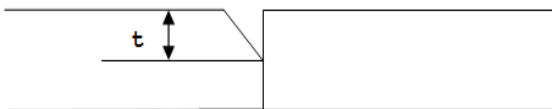
Where "t" is base metal thickness. If "t" is $> 50\text{mm}$ PWHT to be done. RT is applicable and to be carried out as per Cl 5.3 and CQP.

Sketch:2 (Full penetration weld joint double V)



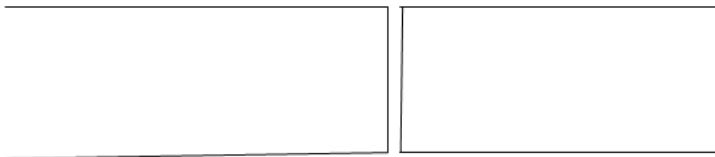
If " $t1/t2$ " $> 50\text{mm}$, PWHT to be done. RT is applicable and to be carried out as per Cl 5.3 and CQP.

Sketch:3 (Partial penetration weld joint bevel)



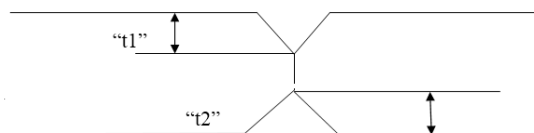
Where "t" is weld metal thickness. If weld depth is $> 50\text{mm}$ PWHT to be done, RT is not applicable, MPI to be done.

Sketch:4 (Partial penetration weld joint)

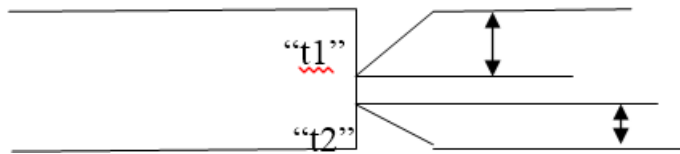


PWHT & RT is not applicable in this case, since only seal welding is required and the weld thickness does not exceed 50 mm. MPI to be done.

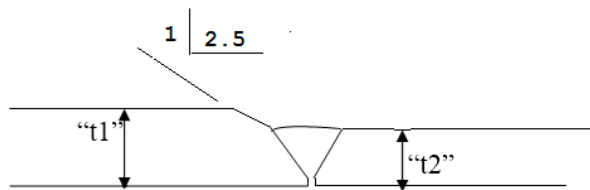
Sketch:5 (Partial penetration weld joint double V)



Where "t" is equal to $t1+t2$. If "t" is $> 50\text{mm}$ PWHT to be done. RT is not applicable. MPI to be done

Sketch:6 (K connection Partial penetration weld joint)

Where "t" is equal to $t_1 + t_2$. If "t" is $> 50\text{mm}$ PWHT to be carried out. RT is not applicable. MPI to be done.

Sketch: 7 (Bi thickness joint)

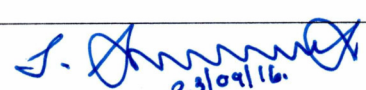
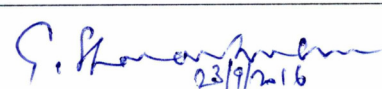
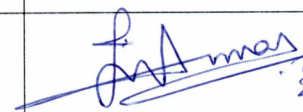
If t_2 is $> 50\text{mm}$ PWHT to be carried out and if $t_2 > 32\text{mm}$ RT is to be carried out as per Cl 5.3 and CQP. Chamfering in t_1 shall be taken with taper 1:2.5 (Unless specified in drawing)

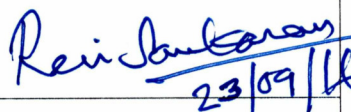
BHARAT HEAVY ELECTRICALS LIMITED,
TIRUCHIRAPPALI 620 014
QUALITY ASSURANCE DEPARTMENT

STANDARD QUALITY PLAN FOR
General Structural

SQP: NP: 07/04

Page 1 of 10

Prepared by	Jeyaram M
Quality Assurance	 23/09/16
REVIEWED BY	SIGNATURE
ENGINEERING (J.Somsasundaram)	 23/09/16
OUT SOURCING (G.Sharavanan)	 23/9/2016
QUALITY CONTROL (N. Ramasamy)	 23/9/16
QUALITY ASSURANCE (J V V Aruna kumar)	 23/09/2016

Revision No.	Date	Approved by	Signature
04	23/09/16	AGM / QA&BE	 23/09/16
03	01/12/07	SDGM/QA	-----
02	14/04/01	DGM/QA	
01	15/07/96	SM/QA	
00	01/04/93	SM/QA	

Proprietary Data – For Internal Use only

RECORD OF REVISIONS

Rev. Clause		Details of revision
No.	No.	
00	--	This document consolidates all requirements of various previous SQPs.
01	--	All amendments issued has been regularised and editorial corrections made for better clarity.Latest applicable TDC numbers incorporated.
02		SIP numbers updated
	2.4.1	Deleted. Cl.2.4.2 to 2.4.5 renumbered.
	Note 2	
	Note 3	Deleted. Consequently, Note 4 to Note 7 renumbered as Note 3 to Note 6.
	3.2 & 3.2.1 in Note 3	Modified in line with QCP:002
	4.1.7 in Note 4	Out of straightness revised in line with AWS D1.1 (2002 edition)
	4.1.7.10(7)	Twist included
03.	Note-1	Matl. IS 2062 Re-designated & IS 8500 replaced with new designation
	NOTE-3	3.2 & 3.2.1 is Re-worded
		3.2.3 Cl. Added
	Note-4	4.1.10 new sub clause no added.
	Note-5	Clause no. 5 SR Temp changed.
04.	Cl 2.1, 2.4.3,2.4.4	Latest revision of NDE procedures updated.
	Cl 2.3	RT/UT included
	Note-1	E350 material added.IS 8500 removed.
Note	2.4.5	Material substitution details given.
	3.2.1	Removed
	3.1.1,3.2.3	10% scope added.
	3.1.2.3	Newly added.
	3.2.4	Newly added.
	4.1.9	Monorail trial assembly added. Amendment A1 incorporated
	5.1,5.2&5.3	SR details added.

 Tiruchirappalli		QUALITY ASSURANCE		STANDARD QUALITY PLAN					QP NO. : SQP:NP: 07 REV.: 04 DATE : 23-09-2016 PAGE : Page 3 of 10				
GENERAL STRUCTURALS - Welded Design													
SL. NO.	COMPONENT AND OPERATION	CHARECTERISTICS	CI.	TYPE OF CHECK	Quantum	REF.DOCUMENT/ ACCEPTANCE STD.	TYPE OF RECORD	Agency *			REMARKS		
							D	M	c	n			

1.0	MATERIAL Plates, Sheets & Rolled Sections	Chemical & Mechanical Properties	A	Review of documents	100%	TDC/Matl. Spec. Note 1	TC	P	W		
2.0	INPROCESS CONTROL		(Refer QCP 002 for details)								
2.1	Marking, Cutting, Edge Preparation	Shape, Size, EP, Diagonal Straightness Gas cut edges	B	Measurement	100%	Drawings & Note 2	R	P	V		
				MPI/LPI	Note-3	BHE:NDT:PB:MT 01, latest, BHE:NDT:PB:PT 01, latest	R	P	W		
2.2	Welding	Procedure Qlfn. Personnel Qlfn.	A	Review of Documents	100%	BHEL Procedure SIP:NP:07 latest	WPS	P	V		
				Review of Documents	100%	SIP:NP:07 latest	R	P	V		

LEGEND : CI: Class (A: Critical B: Major , C: Minor) * M : Manufacturer C :BHEL QC/TPI N : CUSTOMER QC :Quality Control ND: NDT Lab., PL: Plant lab, R : Record

 Tiruchirappalli		QUALITY ASSURANCE		STANDARD QUALITY PLAN					QP NO. : SQP:NP: 07 REV.: 04						
					GENERAL STRUCTURALS –Welded Design					DATE : 23/09/16					
										PAGE : Page 4 of 10					
SL. NO.	COMPONENT AND OPERATION			CHARECTERISTICS	CI.	TYPE OF CHECK	Quantum	REF.DOCUMENT/ ACCEPTANCE STD.		TYPE OF RECORD		Agency *			REMARKS
										D	M	c	n		

2.3	Weld Inspection	Weld size & finish	B	Visual/ Measurement	100%	Drawing		-	P	W		*Review of films
	Butt welds	Soundness		RT/UT	Note 3	SIP:NP:06 latest BHE:NDT:SS:RT 05 latest BHE:NDT:PB:MT		R	P	V*		
	T.Butt Joints	Soundness		RT/UT	Note 3	01,latest, BHE:NDT:PB:PT 01,latest		R	P	V*		
	Fillet welds	Soundness		LPI/MPI	Note 3			R	P	W		
2.4	DIMENSIONAL INSPECTION											
2.4.1	Ladder	Length, Step position,Ends	B	Visual & Measurement	100%	Drawing		--	P	W		
2.4.2	Buck stay beams	Corner piece,plate,pin connection,link-arrangements. Dimns. Soundness	A	Visual & Measurement	100%	Drawings		R	P	W		
						NOTE-4						
						BHE:NDT:PB:MT 01,latest,BHE:NDT:PB:PT 01latest BHE:NDT:SS:RT 05 latest		R	P	W		
								R	P	W		
2.4.3	Roof beams: Profile beam / rolled section	Shape,Size,profile Straightness Verticality	B	Visual & Measurement Plumb	Note-3 100%			R	P	W		
2.4.4	Built up beams/bracings & Monorails	Shape,size length, verticality Match mark, Straightness Soundness		measurement visual	100%	Drawing Note 4, BHE:NDT:PB:MT01latest BHE:NDT:PB:PT01latest, BHE:NDT:SS:RT 05,latest		R	P	W		
					Note-3			R	P	W		

 Tiruchirappalli		QUALITY ASSURANCE		STANDARD QUALITY PLAN					QP NO. : SQP:NP: 07 REV.: 04 DATE : 23/09/16 PAGE : Page 5 of 10				
GENERAL STRUCTURALS –Welded Design													
SL. NO.	COMPONENT AND OPERATION	CHARECTERISTICS	CI.	TYPE OF CHECK	Quantum	REF.DOCUMENT/ ACCEPTANCE STD.	TYPE OF RECORD	Agency *			REMARKS		
							D	M	c	n			

2.5	POST WELD HEAT TREATMENT(PWHT)	Temp,soaking Time,ROH/ROC		Review of HT chart	100%	Note 5		R	P	V		
3.0	Final inspection	Alignment, Matching, Orientation, & Inclination		Visual Measurement/	100%	SIP:NP: 09 latest		R	P	W		
3.1	Trial assembly			Water level		Note 4 Drawing						
3.2	Match marking Reference line,	Identification		Visual Measurement	100%			R	P	V		
3.3	Identification	WO.No.,DU No.& S/C code		Visual	100%	Drawings &QCP 002 latest		-	P	V		
3.4	Painting and Preservation	Surface preparation, DFT		Visual	100%	SIP:PP:22 latest		R	P	W		
				Check	Random							
3.5	Packing and Protection	Stability Cover/Shimplates		Visual	100%	Drawings SIP:PP:22 latest& NOTE-6		-	P	V		

Refer SQP:NP:027 rev03 for bolted design structures

NOTE-1

MATERIAL	MATERIAL SPEC.	TDC No.
Rolled sections	IS 2062 E250A/BR, E350 A, BR, BO&C ASTM A36, BSEN10025	0:301. as per specification
Plates and sheets	IS 2062 E250A/BR, ASTMA36, E350A, BR, BO&C	
	DIN 17100 St 52.3	0:302
	SA387 Gr 12	-P4 0:202
	SA387 Gr 22	-P5 0:202
	SA 515 Gr 60&70	-P1 0:202

NOTE-2

2.0 MARKING

- 2.1 Wherever applicable the squareness shall be ensured by checking Diagonals and reference lines shall be marked and punched.
- 2.2 For Rolled Beams dimensional tolerances shall be as given below.

1) Depth of section

- a) Upto 1 M : ± 3 mm
- b) 1M to 2M : ± 4.5 mm
- c) Above 2 M : + 7.5 mm, - 4.5 mm
- 2) Flange width : ± 3 mm
- 3) Web shift : 2 mm
- 4) Length : 1 mm / M. Max.5mm

2.3 CENTER LINE MARKING

- 2.3.1 All I section columns/Beams shall be marked with center lines, one on flange and other on one side of web. Box section columns will be marked on the web side. L section column shall be marked on the middle of leg.
- 2.3.2 Flange center line shall be obtained by joining the center point of web thickness at both ends.
- 2.3.3 Web center line shall be obtained by joining the mid points of the section depth at both ends.
- 2.3.4 After marking, the center line shall be identified by legible center punching to the length of 25mm with 5 dots and of size of dia. 2mm at the interval of 2 meters. The punched portion of center line shall be bordered with white paint.

2.4 MARKING AND PREPARATION OF ATTACHMENT PLATES

- 2.4.1 The length/width variation shall be within ± 2 mm, diagonal difference within 3 mm.
- 2.4.2 The flatness shall be checked and shall not exceed 2mm for plate size 50mm & below and 3mm above 50mm.

BHEL		SQP:NP:07/04	Page 7 of 10
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2.4.3 The bolt holes and grout holes shall be marked and drilled as per drawing. Wherever specified in the drawing, match drilling shall be done with the mating part. The tolerance for finished holes are as follows:

1. Hole dia for friction grip bolts :+0.5 /-0 mm
2. Hole dia for other holes :+1 mm /- 0 mm
3. Individual pitches :±1 mm max.
4. Cumulative pitch :±2 mm max.

2.4.4 Where splicing of rolled sections are envisaged, it shall be ensured that the rolled section is straightened and meets the requirements given below:

1. Out of Straightness : 5 mm max.
2. Splicing edge : Square to surface
3. Web centre line offset : 1.5 mm max

2.4.5 Shop joint for rolled sections/plates shall be followed as per drg No:3-35-110-00686-Latest, Production notes drg. No: 4-35-110-00347/latest, 3-35-110-00995/latest.

NOTE-3

3.0 TYPE AND EXTENT OF NDE unless additional NDE is specified in CQPs.

3.1 BUTT WELDS - MPI

3.1.1 100 % M P I. for thickness above 25 mm upto and Including 32 mm.
10 % MPI per DU for thickness less than 25 mm.

3.1.2.0 MPI ON FLAME CUT EDGES

3.1.2.1 100% MPI-P3,P4&P5 - Flame cut edges t>12 mm
10% MPI- P1 - Flame cut edges t>20mm and below 38mm
100% MPI-P1 - For all flame cut edges t>=38mm
100%MPI- All beveled edges for t> 20mm for all materials.

3.1.2.2 100% LPI- Root groove areas after back chipping prior to welding second side for all groove plate butt weld and all spliced joint for rolled section.

3.1.2.3 Wherever Heat treatment is applicable required MPI/LPI shall be done after HT.

3.2 BUTT WELDS -RT

3.2.1 100% RT for carbon steel for t>32 mm.
For P3,P4 if t > 16 mm
For P5 if t > 12 mm

BHEL		SQP:NP:07/04	Page 8 of 10
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- 3.2.2 100% RT on flange butt joint for mono rail beams of all sizes.
- 3.2.3 10% RT per DU for web butt joint in all built up monorail beams.
- 3.2.4 Wherever RT is not feasible UT shall be carried out with the discretion of BHEL/QC.
- 3.3 FILLET WELDS
 - 3.3.1 100 % MPI, if both plate thickness over 25 mm.
 - 3.3.2 10% MPI/LPI per DU all other fillet welds.
 - 3.3.3 100% MPI/LPI on fillet welds of spliceplates for all thickness built up beams and rolled sections
 - 3.3.4 100% MPI on all fillet welds of mono rail beam.

NOTE-4

4.0 FABRICATION TOLERANCES

- 4.1 The tolerances for fabrication shall be as per the relevant product drawing. However the following tolerances can be adopted, where not specified.
 - 4.1.1 Length:
 - a) For members where ends are free: $\pm 1 \text{ mm/M}$ subject to 5mm max
 - b) Members connecting between : $+0 \text{ mm} - 3\text{mm}$
two structural members
 - 4.1.2 Web shift : 2mm
 - 4.1.3 Out of squareness : 2mm
 - 4.1.4 Combined warpage and tilt of flange of welded beams shall not exceed 1/100 of total width of flange or 6 mm whichever is greater.
 - 4.1.5 The twisting of the beams or members shall not exceed $0.005h / 5\text{M}$ length subject to a maximum of 10 mm.
(where "h" is the height of beam)
 - 4.1.6 Out of Straightness
 - Length upto 15 Mtr. : 1 mm/Mtr and max. 10mm.
 - Length over 15 mtr. : 10mm + 1mm/M for the
length in excess of 15M.
 - 4.1.7 For Frames of General Structures the following tolerances shall apply:
 - Length and width : $\pm 1.5 \text{ mm/M}$ max. 6 mm
 - Difference between : 2 mm/M max. 8 mm
diagonals
 - Height : $+ 1.5 \text{ mm/M}$ max. 6 mm
 - Spacing of inter- : $\pm 3 \text{ mm}$
mediate members
 - 4.1.8 For handrails the variation permitted in length is $\pm 3\text{mm}$ and bow is $\pm 2\text{mm}$ per meter subject to a maximum of 10mm.

4.1.9 For monorail beams the following tolerances shall apply
(clause Nos. 1 & 2 applies for all other beams also)

1.Depth of section	:±3 mm
2.Flange width	:+/- 3 mm
3.Flange width	:+2 mm, for monorail (+2, -0mm)
4.Web shift	: 2 mm
5.Length:	
Runways connected in between two structures (Span upto 12m)	: +0 mm, -2 mm
6.Mono rails	: +/-5mm.
7.Combined Warpage and tilt	: 3 mm max.
8.Sweep/Camber	: 5 mm max.

Monorail beams shall be checked for trial assembly as per Clause 7.0 of SIP :NP:02

NOTE:5

PWHT shall be performed for:

5.1 **Butt welds/Groove welds**

P1 All butt welds when $t > 50\text{mm}$ and web stiffeners at end bearing locations along with stool plate (except web to flange fillet & groove weld)	600-650°C
P3 All butt welds in tension members and all welds when $t > 16\text{mm}$	620-650°C
P4 All butt welds in tension members and all welds when $t > 16\text{mm}$	650-680°C
P5 All welds	680-710°C

5.2 **Fillet welds**

P1- Not required	
P3 -if throat thickness $> 13\text{mm}$	620-650°C
P4 -if throat thickness $> 13\text{mm}$	650-680°C
P5 -All thickness	680-710°C

Where t =plate thickness in case of butt welds and weld thickness in case of groove welds for P1 materials .In case of combination of groove and fillet welds both weld depth and throat thickness are to be considered.

The load carrying members shall be heat treated for flame cut edges prior to welding as per Table -2. Alternatively for flame cut edges, the cut edges shall be ground or machined upto 3mm to remove HAZ.

For Local PWHT, general guidelines shall be as per QCP:002 (latest) and SIP:NP:11 (latest) shall be followed.

Table -2

scope	Material	Thickness	Heat treatment cycle
Flame cut edges	P1	> 50 mm	600°- 650°C for 30 minutes.
	P3	> 16 mm	620°- 650°C for 30 minutes.
	P4	> 16 mm	650°- 680°C for 30 minutes.
	P5	all thickness	680°- 710°C for 30 minutes.
Shear cut edges	P1	> 50 mm	600°- 650°C for 30 minutes.
	P3	> 13 mm	620°- 650°C for 30 minutes.
	P4	> 13 mm	650°- 680°C for 30 minutes.
	P5	>10mm	680°- 710°C for 30 minutes.

For materials other than P5, this heat treatment may be clubbed with the final heat treatment of the product

5.3 The preheat for welding and gas cutting shall be followed as per table -3. Preheat and post heat temperature referred in Table-3 shall be followed unless otherwise specified in WPS

Table:3

Scope	Material	Preheat	Post heat
Welding	P1-IS2062	t>38mm, 150°C	-
	E250	t>63mm, 150°C	-
	P1-IS2062	t>25mm, 150°C	-
	E350		
	P3&P4	allthickness, 150°C	-
	P5	allthickness, 150°C	250°C for 2 hours
Flame cutting	P1	t>50mm, 150°C	-
	P3&P4	t>16mm, 150°C	-
	P5	t<13mm, 120°C	-
		t=13to25mm, 150°C	
		t>25mm, 200°C	

5.4 Refer QCP 002 for process controls and other details

NOTE-6

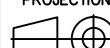
- 6.1 While stacking of beams, ensure that the flange portion of the beam is kept horizontal and parallel to the firm ground. Adequate supports shall be provided so as to avoid sagging or distortion.
- 6.2 Storage, preservation, shipping shall be as per the relevant packing instruction.

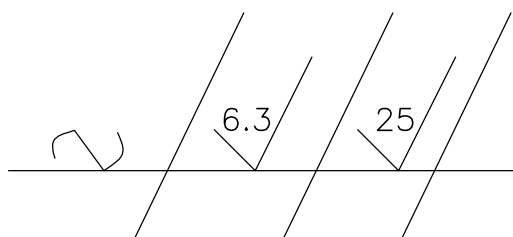
- 01) FOUNDATION BOLT SHOULD NOT BE PAINTED.
- 02) THREAD ENDS OF BOLT TO BE COATED WITH RUST PROOF OIL AND PROTECTED AGAINST CORROSION.
- 03) MANUFACTURING REQUIREMENTS SHALL BE AS PER RELEVANT Q.C.P .
- 04) MATERIALS AND OTHERS REQUIREMENTS ARE GIVEN PER ASSEMBLY ONLY.

[illegible]

REV 04	DATE 07-09-2022	ALTERED : P.S.PANDIAN CHD & APPD : VSRK	REV 02	DATE 29-04-2022	ALTERED : P.S.PANDIAN CHD & APPD : VSRK
ZONE IT.NO:03 MATERIAL CODE REVISED			ZONE IT.NO:02 QTY. REVISED		
REV 04	DATE 07-09-2022	ALTERED : P.S.PANDIAN CHD & APPD : VSRK	REV 01	DATE 25-04-2022	ALTERED : P.S.P/K.S.P CHD & APPD :T.HARI/VSARK
ZONE IT.NO:03 MATERIAL CODE REVISED			ZONE IT.NO:01&02 MATERIAL CODE REVISED		

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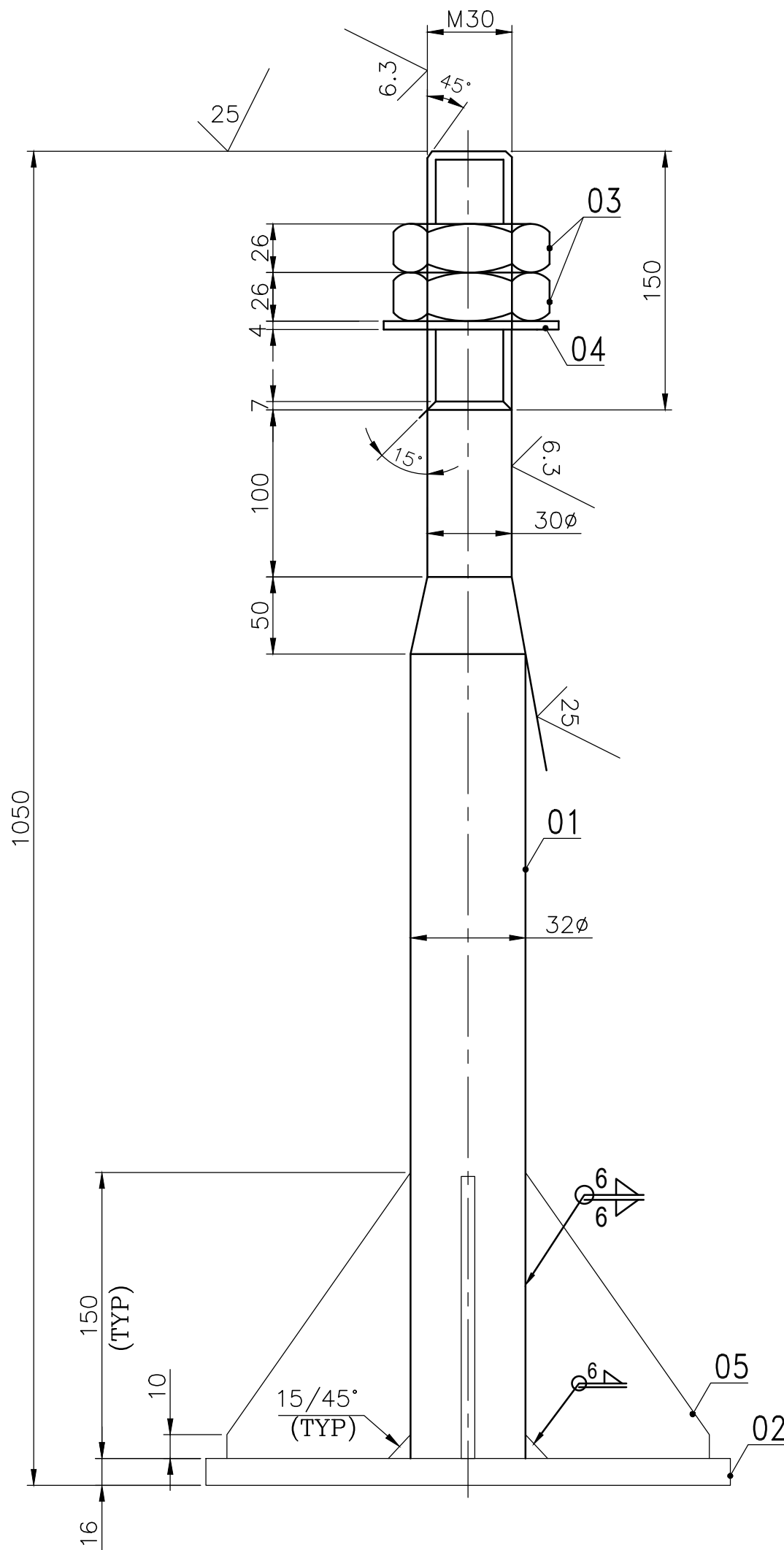
TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT							
		Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI – 620014		DRN	NAME K.S.PANDIAN	SIGNATURE	DATE 23-12-2021
				CHD	T.HARI		23-12-2021
				APPD	VSRK		24-12-2021
355-054							
DEPT ST	ALL DIMENSIONS ARE IN MM		SCALE N.T.S	WEIGHT (Kg)	REF TO ASSY / OLD DWG		
CODE 122							
TITLE FOUNDATION BOLT 50 DIA-1700 LONG					DRAWING NO : 2-FM-011-00003		REV 04



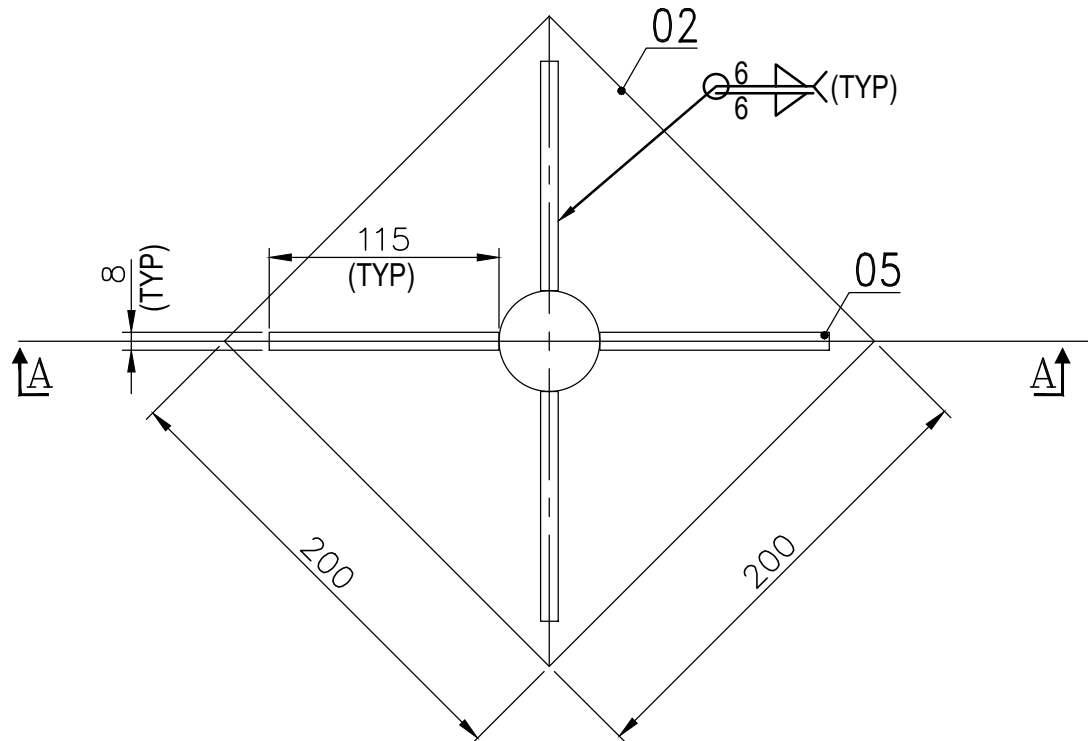
SIZE AND TYPE OF WELD	TYPE OF ELECTRODE	TOTAL LENGTH OF WELD IN MTRS
6 FILLET	E 7018	2.260

NOTES :-

- 01) FOUNDATION BOLT SHOULD NOT BE PAINTED.
- 02) THREAD ENDS OF BOLT TO BE COATED WITH RUST PROOF OIL AND PROTECTED AGAINST CORROSION.
- 03) MANUFACTURING REQUIRMENTS SHALL BE AS PER RELAVENT Q.C.P .
- 04) MATERIALS AND OTHERS REQUIREMENTS ARE GIVEN PER ASSEMBLY ONLY.

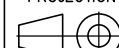


SECTION-AA



01													
	05	PLATE 8 115 X 150				15011027		No		0.577			
						IS2062E250A				4			
	04	WASHER PUNCHED A30				41408000030		No		0.050			
						IS 2016				1			
	03	HEX NUT GR C M30				41304000030		No		0.231			
						IS1364 P3				2			
	02	PLATE 16 200X200				15011026		No		5.024			
						IS2062E250A				1			
	01	ROD DIA 32 1034				15004018		No		6.520			
						IS2062E250A				1			
VARIANT NUMBER	ITEM NUMBER	DESCRIPTION	STD	DRAWING NUMBER	ITEM NO	MATERIAL CODE	A/C/P	UNIT	UNIT WEIGHT				
					VAR NO	MATERIAL SPECN		DI	QUANTITY			GS	ZONE

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TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT									
 355-054 Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI - 620014			DRN	NAME	SIGNATURE		DATE		
			CHD	PADMANABAN.M			05.02.2022		
			APPD	RAJIVGANDHI.K			05.02.2022		
DEPT	ST	ALL DIMENSIONS ARE IN MM	PROJECTION	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG			
CODE	122			N.T.S	14.366				
TITLE						DRAWING NO :		REV	
FOUNDATION BOLT 32 DIA. 1050 LONG						2-FM-011-00010		01	

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REV 01	DATE 07.07.2022	ALTERED : S.SETHUPATHI CHD & APPD : MPN & RAJIV
ZONE 	ITEM No:05 WEIGHT CORRECTED.	



01. FOUNDATION BOLT SHOULD NOT BE PAINTED.
02. THREAD ENDS OF BOLT TO BE COATED WITH RUST PREVENTIVE LUBRICANT AND COVERED BY TAR IMPREGNATED GUNNY CLOTH.
03. FOUNDATION BOLT THREAD PITCH IS TO BE FOLLOWED IN LINE WITH THE NUT.
04. BOLT AND NUT ARE TO BE SHOP ASSEMBLED.
05. MANUFACTURING REQUIREMENT SHALL BE AS PER APPLICABLE Q.C.P.
06. MATERIAL AND OTHER REQUIREMENTS ARE GIVEN PER ASSEMBLY ONLY.

						No				
						No				
						No				
						No				
						No				
						No				
	05	HEX NUT M24			413040002400	No	0.110			
					CL4-IS1363P3		2			
	04	PUNCHED WASHER M24			414080002400	No	0.030			
					IS2016-A		1			
	03	PLATE 8 85x150			15011027	No	0.471			
					IS2062Fe410A		4			
	02	PLATE 10 150X150			152110980000	No	1.766			
					IS2062Fe410A		1			
	01	ROD DIA.25 910			150040270000	No	3.507			
					IS2062Fe410A		1			
VARIANT NUMBER	ITEM NUMBER	DESCRIPTION	STD.	DRAWING NUMBER	ITEM NO	MATERIAL CODE	A/C/P	UNIT WEIGHT	GS	ZONE
					VAR NO	MATERIAL SPECN	DI	QUANTITY		

CAUTION: The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in any way detrimental to the interest of the company.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT							
 355-054	Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI - 620014						
DRN	R.GOVINDASAMY	SIGNATURE	DATE 08.04.2022				
CHD	M.PADMANABAN		08.04.2022				
APPD	K.RAJIVGANDHI		08.04.2022				
DEPT PE/FB	ALL DIMENSIONS ARE IN MM		SCALE N.T.S.	WEIGHT (Kg) 7.404	REF TO ASSY / OLD DWG		
CODE 122					---		
TITLE FOUNDATION BOLT 25 DIA. 900mm LONG					DRAWING NO : 2-FM-011-00053		REV 00

DRAWING NO:

SIZE AND TYPE OF WELD	TYPE OF ELECTRODE	TOTAL LENGTH OF WELD IN MTRS
6 FILLET	E 7018	2.280

01) FOUNDATION BOLT SHOULD NOT BE PAINTED.

02) THREAD ENDS OF BOLT TO BE COATED WITH RUST PROOF OIL AND PROTECTED AGAINST CORROSION.

03) MANUFACTURING REQUIRMENTS SHALL BE AS PER RELAVENT Q.C.P .

04) MATERIALS AND OTHERS REQUIREMENTS ARE GIVEN PER ASSEMBLY ONLY.

[illegible]

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TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT									
 355-054		Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI — 620014			DRN	NAME K.S.PANDIAN	SIGNATURE	DATE 23-12-2021	
					CHD	T.HARI		23-12-2021	
					APPD	VSRK		24-12-2021	
DEPT ST	ALL DIMENSIONS ARE IN MM		SCALE N.T.S	WEIGHT (Kg)	REF TO ASSY / OLD DWG				
CODE 122									
TITLE FOUNDATION BOLT 40 DIA-1350 LONG					DRAWING NO : 2-FM-011-00002				REV 01

REV 01	DATE 13-07-2022	ALTERED : K.S.PANDIAN
		CHD & APPD : T.HARI
ZONE	IT NO: 02 QTY REVISED.	

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TYPE OF PRODUCT
OR NAME OF
CUSTOMER/PROJECT



Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI – 620014

DRN	NAME K.S.PANDIAN	SIGNATURE	DATE 23-12-2021
CHD	T.HARI		23-12-2021
APPD	VSRR		24-12-2021

355-054

DEPT CT

CODE 12

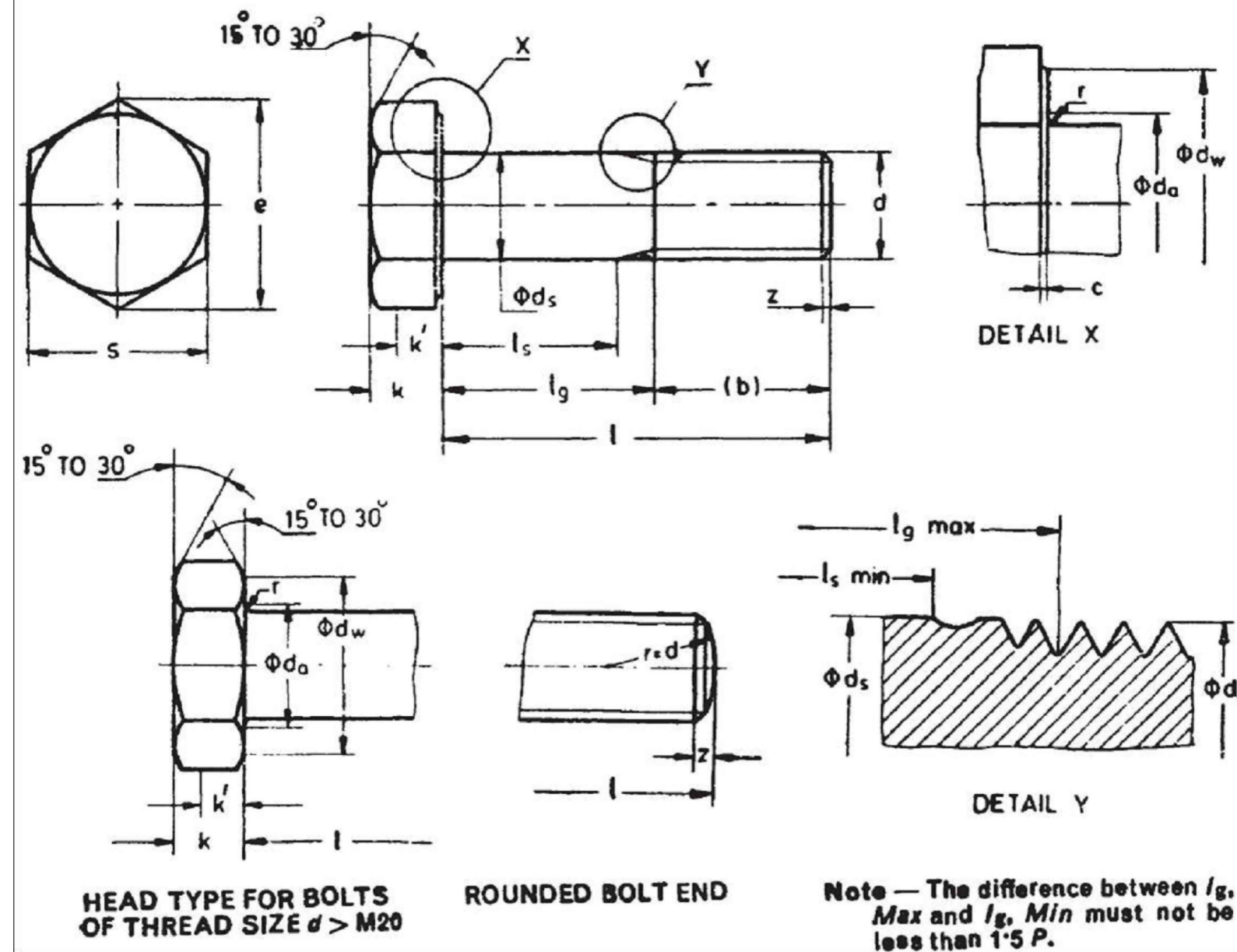
ALL DIMENSIONS
ARE IN MM

FOUNDATION BOLT
40 DIA-1350 LONG

DRAWING NO :
2-FM-011-00002

REV
01

CORPORATE DRG ID:TP-DG-2-FM-011-00002/01



HSFG BOLT FIGURE AS GIVEN IN IS-3757 STANDARD

Sl.No	Bolt Variant	l (mm)	b (mm)	l _g (mm)	Bolt head color
1	M24X70-Extended	70	65	5	Red
2	M24X90-Extended	90	70	20	Green
3	M24X130-Extended	130	80	50	Orange
4	M24X170-Extended	170	80	90	Blue

NOTES:

1. THE THREADED PORTION AND SHANK LENGTH ARE TO BE FOLLOWED AS PER TABLE
2. OTHER DIMENSIONS ARE AS PER IS-3757 STANDARD
3. BOLTS PROPERTY CLASS 8.8.

REV	DATE	ALTERED : K.PRAKASH
04	01.11.2019	CHD & APPD: YUVARAJ.S
TABLE UPDATED WITH COLOR REQUIREMENT ON BOLT HEAD		

REV	DATE	ALTERED : K.S.PANDIAN
03	25-04-2019	CHD & APPD: MUTHU.S
SKETCH RESIZED		
REV	DATE	ALTERED : SHAILESH
02	16.08.2018	CHD & APPD: MPN/MUTHU.S
NOTES NO.03 ADDED.		

REV	DATE	ALTERED : MUTHU
01	21.07.2018	CHD & APPD: SARAVANA
DIMENSIONS UPDATED IN FIGURE		

CAUTION: The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in any way detrimental to the interest of the company.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT			
 355-055	Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI - 620014		
	DRN	NAME SHAILESH	SIGNATURE
	CHD	MPN/MUTHU	DATE 08.06.18
DEPT ST	ALL DIMENSIONS ARE IN MM	PROJECTION	SCALE
CODE 122			WEIGHT (Kg)
TITLE M24X70,90,130 170-EXTENDED THREAD-HSFG BOLTS		REF TO ASSY / OLD DWG	
DRAWING NO : 3-35-700-06802			REV 04

Revision record:

Rev 00: 18/10/2011 Fresh Issue released and Test Sampling Plan Rev 00

Rev 01: 19/04/2012 Cl 2: Requirement if the Carbon content is below 0.6% - Added for Bolts; Mn for Nuts: limited to 0.25 min instead of 0.25 max. Cl 5: Hardness of Bolt & Nut: Acceptance values changed. Cl 7: Preservation and Packing added and Test Sampling Plan Rev 01

Rev 02: 28/10/2014 Property class Bolt 10.9 and Nut 10 and its requirements added (for Neyveli 2x500MW Tower boiler) in all clauses and Test Sampling Plan Rev 02

1. SCOPE:

This technical delivery condition covers the requirements for the High strength structural steel bolts, Nuts and Washers applicable for boiler structures and shall be procured from the BHEL approved manufacturers only. The mandatory requirements, test methods and procedures from the applicable IS standards to confirm a product to its relevant latest IS standard shall be met with. TDC is in addition to specification.

Size, Specification and Qty: As per the BHEL Purchase order (PO) / BHEL Drawing. The bolts, nuts and washers shall be supplied in the dull black heat treated condition with residual coating of light oil.

For Bolts: IS: 3757 (Latest) Property class: 8.8 or 10.9. Product Grade C of IS Specification IS: 1367 Part 2 (Latest).

For Nuts: IS: 6623 (Latest) Property class: 8 or 10, Product Grade B

For Washers: IS: 6649 (Latest) Material: 45C8, Type-A: Plain hole Circular Washers. Grade: Ordinary

2. RAW MATERIAL:

- Bolts and Nuts: Rolled/Forged bar of Carbon steel. Washer: as per IS 1571 Part 2 (Latest)
- Chemical composition:** Shall be checked on receipt of raw material at supplier works for every heat
Bolts: Plain Carbon Steel, Carbon steel with additives (eg Br, Mn or Cr) – As per Table 2 of IS: 1367 Part 3 (Latest)
Nuts: As per Table 4 of IS 1367 Part 6 (Latest)
Washers: As per IS 1570 Part 2 and Sulphur, Phosphorous <0.06% in check analysis

3. DIMENSIONS AND TOLERANCES:

- Process: Cold/Hot Forging with Dies and tools clean of loose scale and sheet particles.
- Threads on the bolts shall be checked with a properly calibrated ring gauge with a tolerance class 6g. Threads on the nuts shall be checked with a properly calibrated plug gauge with tolerance class 6H (in an NABL accredited LAB).
- Dimensions of the Bolts shall be as per the table given in IS 3757 (Latest)
- Dimensions of the Nuts shall be as per the table given in IS: 6623 (Latest)
- Dimensions of the Washers shall be as per the table given in IS 6649 (Latest)

Note: The washers shall be flat with a maximum deviation not exceeding 0.25 mm from the straight edge laid along a line passing through the center of the hole. The hole of the washer shall be concentric with the outside dimensions within 0.50 mm. washers are required to be clipped to provide clearance, the clipped edge shall not be closer to the center of the washer than 0.9 of the bolt diameter.

4. Post Forming Heat Treatment (HT):

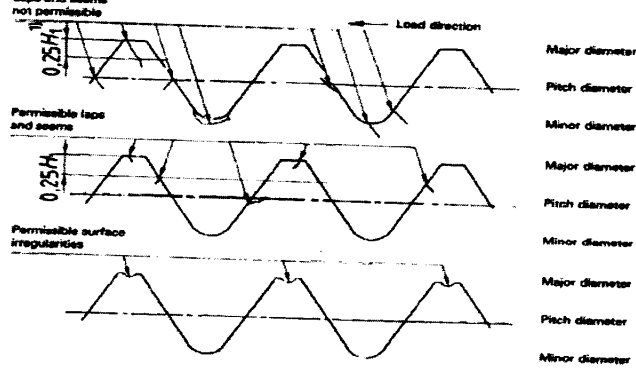
- Bolt: After forming shall be quenched (HT at AC 3 temperature, with soaking time 30minutes per inch followed by quenching) and tempered (at 425°C min, 60 minutes per inch). There should be a sufficient hardenability to ensure a structure consisting of approximately 90 % martensitic in the core of the threaded sections for the fasteners in the as-hardened condition before tempering.
- Nut: Shall be hardened and then tempered (at a temperature of 425°C minimum).
- Washer: Shall be hardened and tempered. Carburized washers are not permitted.

5. CHEMICAL & MECHANICAL & NDE: (on Heat Treated finished product)

Sample Size for Mechanical test: & NDE: As per Sampling Plan

BOLT :

Sl	Test	Test Method - As per Table 3 of IS: 1367 Part 3 (Latest)	Acceptance
1	Chemistry	Spectro / Wet Analysis Method – One sample for every heat Of raw material and One sample/HT batch on product	As per Cl 2.0 of this TDC
2	Hardness Test	Note: Surface hardness shall not be more than 30 Vickers above the measured core Hardness on the product when readings of both surface and core are carried out at HV 0.30. For property class 10.9, any increase in hardness at the surface which indicates that the surface hardness exceeds 390 HV is not acceptable.	8.8 – Min 255 HV Max 335 HV 10.9 – Min 320HV, Max 380HV
3	Minimum Tensile Strength, %Elongation on 5.65√A, % Reduction in Area after fracture	*if wedge load test is satisfactory the axial tensile test is not required	8.8 – 830N/mm ² , 12 min, 52% min 10.9 – 1040 N/mm ² , 9 min, 48% min
4	Proof Load Test	8.8 – Proof Load of M16(91KN), M20 (147KN), M24 (212KN), M30 (337KN), M36 (490KN); 10.9 – Proof Load of M16(130KN), M20 (203KN), M24 (293KN), M30 (466KN), M36 (678KN) shall be applied axially to the bolt in a calibrated tensile testing machine for 15sec.	Length of the bolt after loading shall be the same as before loading within a tolerance of ± 12.5 µm allowed for measurement error.
5	Strength under Wedge load test	IS: 1367 Part 3 (Latest)	8.8 – ≤ 830N/mm ² 10.9 – ≤ 1040 N/mm ²
6	Decarburization Test at 200X min magnification	Determination of the following by MICROSCOPIC Method a)Minimum Height of non decarburized thread zone – E b)Maximum depth of complete decarburization – G	E = 2/3 H1 G = 0.015 mm
7	Hardness after Retempering	IS: 1367 Part 3 (Latest) # test not mandatory, to be applied in case of dispute only	Reduction of hardness 20 HV max.
8	NDE for Surface Integrity	before machining – For bar Diameter ≥ 40 mm: UT as per ASTM A388. For bar Diameter < 40 mm: MPI as per ASTM E 709 After machining – MPI as per ASTM E 709 or as per ISO 6157 Part 3 (Latest)	UT – ASME SEC-VIII. Div-II Part: 3.3.4 (Latest). MPI – Linear indications like cracks, folds & other injurious defects are not acceptable.

9	Micro Examination for Surface Integrity – Laps at threaded region. If any defectives found in visual and NDE examinations, the extent of defect can be determined by micro examination. 	Max depth of laps in thread = 0.41 mm Laps of any depth or length are not permitted in the following places: - at the root of the thread - at the loaded flank of screw thread below the pitch diameter, even if they start beyond the pitch diameter. The following laps are permissible : - laps in the crest of the threads of 0.25 H1 max.; - crest of the threads not entirely rolled out, maximum half a turn on one thread; - laps below the pitch diameter, if they run on the non-loaded flank towards the major diameter and not deeper than 0.25 H1 and not longer than half a turn on one thread.
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NUT: (on Heat Treated finished product)

Sl	Test	Test Method	Acceptance Value
1.	Chemistry	Spectro / Wet Analysis Method – For every heat Of raw material and, One sample/HT batch on product	As per CI 2.0 of this TDC
2.	Hardness Test	Hardness of the test mandrel shall be minimum 45 HRC.	8S – Min 188 HV Max 372 HV 10S – Min 272 HV Max 372 HV
3.	Proof Load Test	Proof Load of 8S – M16(168.9KN), M20 (263.4KN), M24 (379.5KN), M30 (603.1KN), M36 (878.3KN) 10S – M16(195.5KN), M20 (305KN), M24 (439.5KN), M30 (698.4KN), M36 (1017.2KN) shall be applied axially to the nut in a tensile testing machine for 15sec.	The nut shall resist the load without failure by stripping or rupture, and shall be removable by the fingers after the load is released.
4.	NDE for Surface Integrity	Before coating, as per IS 1367 Part 10 Cl 4.2 (Latest)	Linear indications like cracks, folds & Other injurious defects are not acceptable.

WASHER: As per IS 5369. The washers shall be free from cracks, burrs, pits and other defects. All sharp edges shall be removed. **(on Heat Treated finished product)**

Sl	Test	Test Method	Acceptance Value
1.	Chemistry	Spectro / Wet Analysis Method – For every heat Of raw material and One sample/HT batch on product.	As per CI 2.0 of this TDC
2.	Hardness Test	IS 1586 (latest)	Min 35 HRC Max 45 HRC

6. MARKING, PRESERVATION AND PACKING:

The following to be hot stamped or embossed on the top surface of the bolt and nut:

Bolt – Manufacturer's Identification Symbol and 8.8S/10.9S

Nut – Manufacturer's Identification Symbol and 8S/ 10S

Washers – Shall be identified by – the provision of 2 nibs and manufacturers identification symbol being placed as near to the outer edge as possible.

The following details shall be clearly indicated in the tags tied to the bundle:

1) Customer Name 2) Manufacturer's Name 3) Vendor Code 4) Purchase Order No and Supplier internal W.O No 5) Quantum and Weight

6) BHEL Material Code 7) Item Description with diameter, length

Shall be packed in bituminous coated Polythene lined Hessian Cloth/Bag. Each bag shall contain only the same size of bolts/ nuts/ washers respectively and the same shall be indicated in the tags.

7. INSPECTION AND CERTIFICATION:

All the finished components shall be visually and dimensionally inspected as per sampling plan. All the test results shall be documented and maintained. Products to be inspected at works & test certificates (in English) shall be submitted with the following details counter signed by BHEL/BHEL Authorized Inspection agency as indicated in the PO. Manufacturers Test certificate (MTC) shall contain the following:

- Purchase Order No. (BHEL), TDC No, Specification and Grade.
- Name of raw material bar supplier.
- Forming process
- Dimensional reports for each product.
- Chemistry including incidental elements on the raw material and final product checked in NABL lab/ suppliers own lab.
- HT details of materials temperature, soaking time, ROH/ROC medium etc.
- All Mechanical test result report including hardness.
- MPI, Micro examination and decarburization test report with the reference & acceptance standard.
- TC of raw material, UT/MPI report done on raw material shall accompany the MTC.

8. AUDITS AT BHEL:

BHEL reserve the right to reject any item found to be not meeting the requirements during tests at supplier works or during subsequent processing at BHEL.

Haritha.C QA	Venkanna Rupani QA	Kalyanaraman.V QA	Viswanathan.D Engineering	Sekar.S QC	Balachandran.K.S MM	Revisankaran.U QA
Prepared By			Reviewed By			Approved By

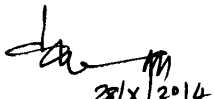
BHEL: TRICHY – 14

TEST SAMPLING PLAN FOR HSFG BOLTS, NUTS & WASHERS AS PER BHEL TDC: 5:211 Rev 02

Lot Size (In nos.)	SAMPLE SIZE										Remarks
	Visual (nos.)	Dimensional (nos.)	MPI (nos.)	Physical Tests							
				Total nos.	Hardness (nos.)	Hardness after Re-tempering (nos.)	Proof Load (nos.)	Wedge Load (nos.)	Min Tensile Strength (nos.)	Decarb (nos.)	
Upto 100	20	8	15	5	5	5	2	2	2	1	
101 to 300	32	13	15	5	5	5	2	2	2	1	
301 to 500	50	20	15	5	5	5	2	2	2	1	
501 to 1000	80	32	15	5	5	5	2	2	2	1	
1001 to 3000	125	50	25	8	8	8	2	4	2	1	Upto 1500 nos. 15 nos. for MPI
3001 to 10000	200	80	50	13	13	13	2	6	2	1	Upto 5000 nos. 25 nos. for MPI
10001 to 35000	315	125	75	20	20	20	4	10	4	2	Upto 15000 nos. 50 nos. for MPI
Above 35000	500	200	100	32	32	32	6	15	6	3	Upto 50000 nos. 75 nos. for MPI
Inspection by BHEL/BHEL AIA	W	W	W		W	W	W	W	W	W	

Remarks:

- Acceptance Number is zero. If the sample is having deviations in Visual, Dimensional and MPI then the entire lot shall be 100% inspected. In case of deviations in Physical tests a second sample of twice the sample size of initial sample shall be taken. The lot will get rejected if the second sample fails.
- Preservation & Packing: The bolts shall be supplied in the dull black heat treated condition with a residual coating of light oil. Finished products shall be packed in a bituminous coated Polythene lined Hessian cloth/bag. Each bag shall contain only the same size of bolts/nuts/washers respectively and the same shall be indicated in the tags.
- Inspection by BHEL / BHEL AIA shown as "W" shall be witnessed for the sample size indicated against the lot size.

				
Haritha.C QA	Venkanna Rupani QA	Kalyanaraman.V QA	Sekar.S QC	Revisankaran.U QA
Prepared By		Reviewed By		Approved By

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:5:215 Rev: 00 Effective Date: 14/11/2019 Page: 1 of 3
Product: Extended Thread High Strength Friction Grip Fasteners For Structurals (Property class Bolt 8.8/ Nut 8)		

Revision record:

Rev 00: 14/11/2019 – Fresh issue

1. SCOPE:

This technical delivery condition covers the requirements for the High strength structural steel bolts, Nuts and Washers applicable for boiler structures and shall be procured from the BHEL approved manufacturers only. The mandatory requirements, test methods and procedures from the applicable IS standards to confirm a product to its relevant latest IS standard shall be met with. TDC is in addition to specification.

Size, Specification and Qty: As per the BHEL Purchase order (PO) / BHEL Drawing. The bolts, nuts and washers shall be supplied in the dull black heat treated condition with residual coating of light oil.

For Bolts: As per BHEL drawing no. 3-35-700-06802 (Latest revision applicable on the date of Purchase order) and IS: 3757 (Latest) Property class: 8.8. Product Grade C of IS Specification IS: 1367 Part 2 (Latest).

For Nuts: IS: 6623 (Latest) Property class: 8, Product Grade B

For Washers: IS: 6649 (Latest) Material: 45C8, Type-A: Plain hole Circular Washers. Grade: Ordinary

2. RAW MATERIAL:

- **Bolts and Nuts:** Rolled/Forged bar of Carbon steel. Washer: as per IS 1571 Part 2 (Latest)
- **Chemical composition:** Shall be checked on receipt of raw material at supplier works for every heat
Bolts: Plain Carbon Steel, Carbon steel with additives (e.g. Br, Mn or Cr) – As per Table 2 of IS: 1367 Part 3 (Latest)
Nuts: As per Table 4 of IS 1367 Part 6 (Latest)
Washers: As per IS 1570 Part 2 and Sulphur, Phosphorous <0.06% in check analysis

3. DIMENSIONS AND TOLERANCES:

- **Process:** Cold/Hot Forging with Dies and tools clean of loose scale and sheet particles.
- Threads on the bolts shall be checked with a properly calibrated ring gauge with a tolerance class 6g. Threads on the nuts shall be checked with a properly calibrated plug gauge with tolerance class 6H (in an NABL accredited LAB).
- Dimensions of the Bolts shall be as per BHEL drawing no. 3-35-700-06802 (Latest revision applicable on the date of Purchase order).
- Dimensions of the Nuts shall be as per the table given in IS: 6623 (Latest)
- Dimensions of the Washers shall be as per the table given in IS 6649 (Latest)

Note: The washers shall be flat with a maximum deviation not exceeding 0.25 mm from the straight edge laid along a line passing through the center of the hole. The hole of the washer shall be concentric with the outside dimensions within 0.50 mm. washers are required to be clipped to provide clearance, the clipped edge shall not be closer to the center of the washer than 0.9 of the bolt diameter.

4. Post Forming Heat Treatment (HT):

- **Bolt:** After forming shall be quenched (HT at AC 3 temperature, with soaking time 30minutes per inch followed by quenching) and tempered (at 425°C min, 60 minutes per inch). There should be a sufficient hardenability to ensure a structure consisting of approximately 90 % martensitic in the core of the threaded sections for the fasteners in the as-hardened condition before tempering.
- **Nut:** Shall be hardened and then tempered (at a temperature of 425°C minimum).
- **Washer:** Shall be hardened and tempered. Carburized washers are not permitted.

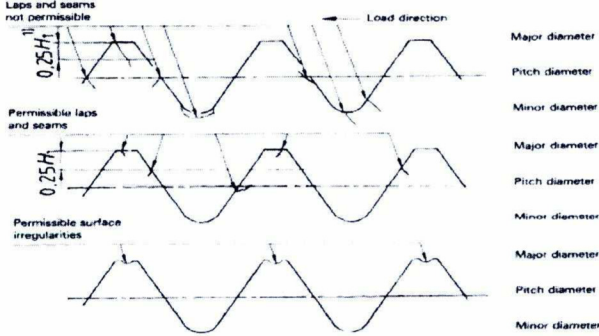
5. CHEMICAL & MECHANICAL & NDE: (on Heat Treated finished product)

Sample Size for Mechanical test: & NDE: As per Sampling Plan

BOLT :

Sl	Test	Test Method - As per Table 3 of IS: 1367 Part 3 (Latest)	Acceptance
1	Chemistry	Spectro / Wet Analysis Method – One sample for every heat Of raw material and One sample/HT batch on product	As per Cl 2.0 of this TDC
2	Hardness Test	Note: Surface hardness shall not be more than 30 Vickers above the measured core Hardness on the product when readings of both surface and core are carried out at HV 0.30.	8.8 – Min 255 HV Max 335 HV

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:5:215 Rev: 00 Effective Date: 14/11/2019 Page: 2 of 3
Product: Extended Thread High Strength Friction Grip Fasteners For Structurals (Property class Bolt 8.8/ Nut 8)		

3	Minimum Tensile Strength, %Elongation on 5.65 $\sqrt{A}$, % Reduction in Area after fracture	*if wedge load test is satisfactory the axial tensile test is not required	8.8 – 830N/mm ² , 12 min, 52% min
4	Proof Load Test	8.8 – Proof Load of M20 (147KN), M24 (212KN), M30 (337KN), M36 (490KN)	Length of the bolt after loading shall be the same as before loading within a tolerance of $\pm 12.5 \mu\text{m}$ allowed for measurement error.
5	Strength under Wedge load test	IS: 1367 Part 3 (Latest)	8.8 – $\nless 830\text{N/mm}^2$
6	Decarburization Test at 200X min magnification	Determination of the following by MICROSCOPIC Method a) Minimum Height of non decarburized thread zone – E b) Maximum depth of complete decarburization – G	E = 2/3 H1 G = 0.015 mm
7	Hardness after Retempering	IS: 1367 Part 3 (Latest) # test not mandatory, to be applied in case of dispute only	Reduction of hardness 20 HV max.
8	NDE for Surface Integrity	before machining – For bar Diameter ≥ 40 mm: UT as per ASTM A388. For bar Diameter < 40 mm: MPI as per ASTM E 709 After machining – MPI as per ASTM E 709 or as per ISO 6157 Part 3 (Latest)	UT – ASME SEC-VIII. Div-II Part: 3.3.4 (Latest). MPI – Linear indications like cracks, folds & other injurious defects are not acceptable.
9	Micro Examination for Surface Integrity – Laps at threaded region.	If any defectives found in visual and NDE examinations, the extent of defect can be determined by micro examination. 	Max depth of laps in thread = 0.41 mm Laps of any depth or length are not permitted in the following places: - at the root of the thread - at the loaded flank of screw thread below the pitch diameter, even if they start beyond the pitch diameter. The following laps are permissible : - laps in the crest of the threads of 0.25 H1 max.; - crest of the threads not entirely rolled out, maximum half a turn on one thread; - laps below the pitch diameter, if they run on the non-loaded flank towards the major diameter and not deeper than 0.25 H1 and not longer than half a turn on one thread.

NUT: (on Heat Treated finished product)

Sl	Test	Test Method	Acceptance Value
1.	Chemistry	Spectro / Wet Analysis Method – For every heat Of raw material and, One sample/HT batch on product	As per Cl 2.0 of this TDC
2.	Hardness Test	Hardness of the test mandrel shall be minimum 45 HRC.	Min 272 HV Max 372 HV
3.	Proof Load Test	Proof Load of M20 (305KN), M24 (439.5KN), M30 (698.4KN), M36 (1017.2KN) shall be applied axially to the nut in a tensile testing machine for 15sec.	The nut shall resist the load without failure by stripping or rupture, and shall be removable by the fingers after the load is released.
4.	NDE for Surface Integrity	Before coating, as per IS 1367 Part 10 Cl 4.2 (Latest)	Linear indications like cracks, folds & Other injurious defects are not acceptable.

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:5:215 Rev: 00 Effective Date: 14/11/2019 Page: 3 of 3
Product: Extended Thread High Strength Friction Grip Fasteners For Structurals (Property class Bolt 8.8/ Nut 8)		

WASHER: As per IS 5369. The washers shall be free from cracks, burrs, pits and other defects. All sharp edges shall be removed.
(on Heat Treated finished product)

Sl	Test	Test Method	Acceptance Value
1.	Chemistry	Spectro / Wet Analysis Method – For every heat Of raw material and One sample/HT batch batch on product.	As per Cl 2.0 of this TDC
2.	Hardness Test	IS 1586 (latest)	Min 35 HRC Max 45 HRC

6. MARKING, PRESERVATION AND PACKING:

The following to be hot stamped or embossed on the top surface of the bolt and nut:

Bolt – Manufacturer's Identification Symbol and 8.8S

Nut – Manufacturer's Identification Symbol and 8S

Washers – Shall be identified by – the provision of 2 nibs and manufacturers identification symbol being placed as near to the outer edge as possible.

The following details shall be clearly indicated in the tags tied to the bundle:

1) Customer Name 2) Manufacturer's Name 3) Vendor Code 4) Purchase Order No and Supplier internal W.O No 5) Quantum and Weight 6) BHEL Material Code 7) Item Description with diameter, length

Colour coding: To be done only on bolt head as per BHEL drawing no. 3-35-700-06802 (Latest revision on the date of Purchase order).

Shall be packed in bituminous coated Polythene lined Hessian Cloth/Bag. Each bag shall contain only the same size of bolts/ nuts/ washers respectively and the same shall be indicated in the tags.

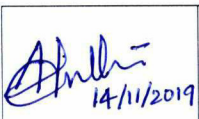
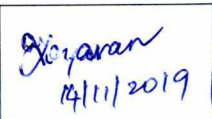
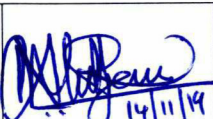
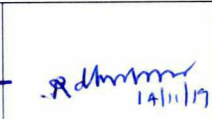
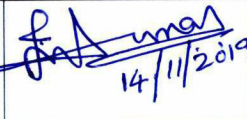
7. INSPECTION AND CERTIFICATION:

All the finished components shall be visually and dimensionally inspected as per sampling plan. All the test results shall be documented and maintained. Products to be inspected at works & test certificates (in English) shall be submitted with the following details counter signed by BHEL/BHEL Authorized Inspection agency as indicated in the PO. Manufacturers Test certificate (MTC) shall contain the following:

- 1) Purchase Order No. (BHEL), TDC No, Specification and Grade.
- 2) Name of raw material bar supplier.
- 3) Forming process
- 4) Dimensional reports for each product.
- 5) Chemistry including incidental elements on the raw material and final product checked in NABL lab/ suppliers own lab.
- 6) HT details of materials temperature, soaking time, ROH/ROC medium etc.
- 7) All Mechanical test result report including hardness.
- 8) MPI, Micro examination and decarburization test report with the reference & acceptance standard.
- 9) TC of raw material, UT/MPI report done on raw material shall accompany the MTC.

8. AUDITS AT BHEL:

BHEL reserve the right to reject any item found to be not meeting the requirements during tests at supplier works or during subsequent processing at BHEL.

					
Abdur Rahman Sr. Engr/QA	M. Jeyaram DM/QA	N. Murugan AGM/Engg	R. Dharmar AGM/ QC	S Karunanidhy DGM/ MM	J.V.V. Aruna Kumar SDGM/QA
Prepared By		Reviewed by		Approved By	

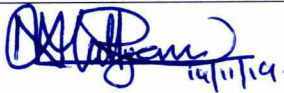
BHEL: TRICHY – 14

TEST SAMPLING PLAN FOR HSFG BOLTS, NUTS & WASHERS AS PER BHEL TDC: 5:215 Rev 00

Lot Size (In nos.)	SAMPLE SIZE										Remarks
	Visual (nos.)	Dimensional (nos.)	MPI (nos.)	Physical Tests							
				Total nos.	Hardness (nos.)	Hardness after Re-tempering (nos.)	Proof Load (nos.)	Wedge Load (nos.)	Min Tensile Strength (nos.)	Decarb (nos.)	
Upto 100	20	8	15	5	5	5	2	2	2	1	
101 to 300	32	13	15	5	5	5	2	2	2	1	
301 to 500	50	20	15	5	5	5	2	2	2	1	
501 to 1000	80	32	15	5	5	5	2	2	2	1	
1001 to 3000	125	50	25	8	8	8	2	4	2	1	Upto 1500 nos. 15 nos. for MPI
3001 to 10000	200	80	50	13	13	13	2	6	2	1	Upto 5000 nos. 25 nos. for MPI
10001 to 35000	315	125	75	20	20	20	4	10	4	2	Upto 15000 nos. 50 nos. for MPI
Above 35000	500	200	100	32	32	32	6	15	6	3	Upto 50000 nos. 75 nos. for MPI
Inspection by BHEL/BHEL AIA	W	W	W		W	W	W	W	W	W	

Remarks:

- Acceptance Number is zero. If the sample is having deviations in Visual, Dimensional and MPI then the entire lot shall be 100% inspected. In case of deviations in Physical tests a second sample of twice the sample size of initial sample shall be taken. The lot will get rejected if the second sample fails.
- Preservation & Packing: The bolts shall be supplied in the dull black heat treated condition with a residual coating of light oil. Finished products shall be packed in a bituminous coated Polythene lined Hessian cloth/bag. Each bag shall contain only the same size of bolts/nuts/washers respectively and the same shall be indicated in the tags.
- Colour coding: To be done only on bolt head as per BHEL drawing no. 3-35-700-06802 (Latest revision on the date of Purchase order).
- Inspection by BHEL / BHEL AIA shown as "W" shall be witnessed for the sample size indicated against the lot size.

 14/11/2019	 14/11/2019	 14/11/19	 14/11/19	 14/11/19	 14/11/2019
Abdur Rahman Sr. Engr/QA	M. Jeyaram DM/QA	N Murugan AGM/Engg	R. Dharmar AGM/ QC	S Karunanidhy DGM/ MM	J.V.V. Aruna Kumar SDGM/QA
Prepared By		Reviewed By			Approved By

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC : 6 : 388 / Rev: 02 Effective Date: 16/05/2018 Page: 1 of 3
Product: High Strength Friction Grip Fasteners For Structural (Property class Bolt 8.8, 10.9/Nut 8, 10)		
CUST: 1725 & 1726		PROJECT: MAITREE (2x660 MW)

Revision record:

Rev 00: Dt:- 29/07/2017 - Fresh Issue

Rev 01: Dt:- 08/05/2018 – Cl.1 and Cl.7 modified to include seaworthy rust preventive coating.

Rev 02: Dt:- 16/05/2018 – Cl.1 and Cl.7 modified to include plant lab document reference.

1. SCOPE:

This technical delivery condition covers the requirements for the High strength structural steel bolts, Nuts and Washers applicable for boiler structures. The product shall conform to the mandatory requirements, test methods and procedures as called for in the applicable standards. The requirements stated herein are in addition to material specification requirements.

Size, Specification and Quantity: As per the BHEL Purchase order (PO) / BHEL Drawing. The bolts, nuts and washers shall be supplied in the dull black heat-treated condition *with one coat of seaworthy rust preventive coating as per PR:CHEM:09-06 (latest revision).*

For Bolts: EN: 14399-3 (Latest) Property class: 8.8 or 10.9 & EN ISO 898 -1 for Mechanical properties.

For Nuts: EN: 14399-3 (Latest) Property Class: 8 or 10, Regular nut Style 1, Coarse thread & EN ISO 898 -2 for Mechanical properties

For Washers: EN: 14399-5 (Latest)

2. RAW MATERIAL:

- Chemical composition:** Shall be checked on receipt of raw material at supplier works for every heat/cast. In case of disputes, product analysis applies.

Bolts: Carbon steel with additives (eg B, Mn or Cr)– As per Table 2 of ISO 898 -1 (Latest)

Nuts: Carbon steel as per Table 3 of ISO 898 -2 (Latest)

Washers: Steel as per EN: 14399-5 (Latest)

3. DIMENSIONS AND TOLERANCES:

- Threads on the bolts shall be checked with a properly calibrated ring gauge with a tolerance class 6g. Threads on the nuts shall be checked with a properly calibrated plug gauge with tolerance class 6H (in an NABL accredited LAB).
- Dimensions of the Bolts shall be as per Figure 1 and Table 2 of EN: 14399-3
- Dimensions of the Nuts shall be as per Figure 3 and Table 4 of EN: 14399-3
- Dimensions of the Washers shall be as per Figure 1 and Table 2 of EN: 14399-5
- The tolerances of the bolts and nuts shall be checked by appropriate gauges or measuring equipment of the required accuracy as specified in table 2 and Table 3 of EN 14399-1.

4. Post Forming Heat Treatment (HT):

- Bolt: After forming shall be quenched and tempered as per Table-2 of EN ISO 898-1 (Latest)
- Nut: Shall be quenched and tempered as per Table-3 of EN ISO 898-2 (Latest)
- Washer: Shall be hardened and tempered. Carburized washers are not permitted.

5. MECHANICAL&NDE:(on Heat Treated finished product)

Sample Size for Mechanical test: & NDE: As per Sampling Plan (refer to Clause 9 below)

BOLT :
Mechanical:

- The mechanical and physical properties shall be according to Tables 3 to 7 of EN: 14399-3 for the respective property class
- Bolts shall be tested for the series FF1 and MP2 for full loadability, using the test methods described in Clause 9 EN ISO 898 -1.
- Bolts shall be subject to the following tests:
 - Hardness test
 - Strength under wedge load test (if wedge load test is satisfactory, axial tensile test is not required)
 - Minimum Tensile Strength
 - Proof load test
 - Decarburization test

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC : 6 : 388 / Rev: 02 Effective Date: <i>16/05/2018</i> Page: 2 of 3
Product: High Strength Friction Grip Fasteners For Structural (Property class Bolt 8.8, 10.9/Nut 8, 10)		
CUST: 1725 & 1726	PROJECT: MAITREE (2x660 MW)	

- Hardness after Re-Tempering (test not mandatory, to be applied in case of dispute only)

NDE:

- Surface Quality shall meet the requirements of ISO 6157-1

NUT :

Mechanical:

- The mechanical and physical properties shall be according to Tables 4 and 6 of EN: 14399-3 and to be tested using methods described in Clause 9 EN ISO 898 -2.
- Nuts shall be subject to the following tests:
 - Hardness test
 - Proof Load test

NDE:

- Surface Quality shall meet the requirements of ISO 6157-2

WASHERS :

- Hardness range 300HV to 370HV.

6. MARKING, PRESERVATION AND PACKING:

- The following to be hot stamped or embossed on the top surface of the bolt and nut:
 - Bolt – Manufacturer's Identification mark with marking symbol HR8.8/HR10.9 as per clause 10.3 of EN ISO 898 -1.
 - Nut – Manufacturer's Identification Symbol and HR8/ HR10 as per clause 10.3 of EN ISO 898 -2
 - Washers Manufacturer's Identification mark and letter H as per clause 4 of EN: 14399-3
- The following details shall be clearly indicated in the tags tied to the bundle:
 - 1) Customer Name
 - 2) Manufacturer's Name
 - 3) Vendor Code
 - 4) Purchase Order No and Supplier internal W.O No
 - 5) Quantum and Weight
 - 6) BHEL Material Code
 - 7) Item Description with diameter, length
- Shall be packed in bituminous-coated Polythene lined Hessian Cloth/Bag. Each bag shall contain only the same size of bolts/nuts/washers respectively and the same shall be indicated in the tags. The weight of each bag shall be limited to 25 Kg (approximately) for ease of handling.

7. INSPECTION AND CERTIFICATION:

All the finished components shall be visually and dimensionally inspected as per sampling plan. All the test results shall be documented and maintained. Products to be inspected at works & test certificates (in English) shall be submitted with the following details counter signed by BHEL/BHEL Authorized Inspection agency as indicated in the PO. Manufacturers Test certificate (MTC) shall contain the following:

- 1) Purchase Order No.(BHEL), TDC No, Specification and Grade with year of code.
- 2) Name of raw material bar supplier.
- 3) Forming process
- 4) Dimensional reports for each product.
- 5) Chemistry including incidental elements.
- 6) HT details of materials temperature, soaking time, cooling medium etc.
- 7) All Mechanical test result report including hardness.
- 8) MPI, Micro examination and decarburization test report with the reference & acceptance standard.
- 9) TC of raw material shall accompany the MTC.
- 10) *Certification of seaworthy rust preventive coating inline with PR:CHEM:09-06 (latest revision).*

8. AUDITS BY BHEL:

BHEL reserves the right to reject any item found to be not meeting the requirements during tests at supplier works or during subsequent processing at BHEL.



BHEL – Tiruchirappalli - 620014, India.
Department

Quality Assurance
TECHNICAL DELIVERY CONDITIONS

DOC No: TDC : 6 : 388 / Rev: 02
Effective Date: 16/05/2018
Page: 3 of 3

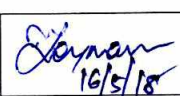
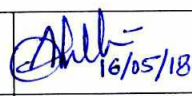
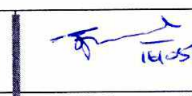
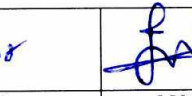
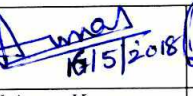
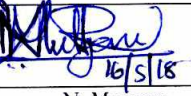
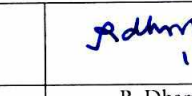
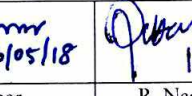
Product: High Strength Friction Grip Fasteners For Structurals (Property class Bolt 8.8, 10.9/Nut 8, 10)

CUST: 1725 & 1726

PROJECT: MAITREE (2x660 MW)

9. SAMPLING PLAN:

S.No.	Lot Size (Nos.)	Sample Size (as per ISO2859- 1)	Acceptance Number/ Rejection Number, (Ac/Re) @AQL=1%	SAMPLE SIZE									Remarks
				Visual (Nos.)	Dimensional (Nos.)	NDE (Nos)	Physical Tests						
							Hardness	Hardness after Re- tempering	Proof Load (nos.) \$	Wedge Load (nos.) \$	Min Tensile Strength (nos.) \$	Decarburization (nos.) \$	
1	Upto 280	15	0/1	15	15	15	15	15	5	5	5	5	For tests marked with ‘S’, Ac/Re=0/1
2	281-500	20	0/1	20	20	20	20	20	5	5	5	5	
3	501- 1200	32	1/2	32	32	32	32	32	5	5	5	5	
4	1201- 3200	50	1/2	50	50	50	50	50	5	5	5	5	
5	3201- 10000	80	2/3	80	80	80	80	80	10	10	10	10	
6	10001 to 35000	125	3/4	125	125	125	125	125	10	10	10	10	
7	35001 to 150000	200	5/6	200	200	200	200	200	10	10	10	10	
8	150001 to 500000	315	7/8	315	315	315	315	315	10	10	10	10	
9	>500000	500	10/11	500	500	500	500	500	10	10	10	10	
	Inspection by BHEL/BHEL AIA			W	W	W	W	W	W	W	W	W	
Note: Inspection by BHEL / BHEL AIA shown as “W” shall be witnessed for the sample size indicated against the lot size.													

 16/5/18	 16/05/18	 16/5/18	 16/5/2018	 16/5/18	 16/05/18	 16/5/2018	 16/5/18
M Jeyaram Dy. Mgr/QA	Abdur Rahman Sr. Engr/QA	G. Panneer Selvam DGM/QA	J V V Aruna Kumar DGM/QA	N. Murugan SDGM/PE(FB)	R. Dharmar AGM/QC	R. Narayanan SDGM/MM	Amit Roy AGM/QA & BE
Prepared By			Reviewed By			Approved By	

BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPPALLI-620 014

SUPPORTING STRUCTURES/PE(FB)



Title Sheet

Specification for

HEXAGON FIT BOLT, NUT ASSEMBLIES AND WASHERS

Specification Number: SSFIT-001

Revision No. 03

03	30.07.2026	Clause 8.0 - Raw material requirements (Critical) added	HK/VSrk/JEYARAM
02	28.02.2026	Clause 1.0, 5.0 & 6.0 revised; Clause 7.0 added	HK/KRG/VSrk
01	20.09.2025	Ref. standard for clause 5.0 is revised to BS EN 14399-9	HK/KRG/VSrk
Rev. No.	Revision Date	Revision Statement	Checked & Approved

	Name	Signature	Date
Prepared	HARIKRISHNA.T		04-06-2015
Checked	D.VISWANATHAN		05-06-2015
Approved	N.MURUGAN		06-06-2015

HEXAGON FIT BOLT, NUT ASSEMBLIES AND WASHERS

1.0 SCOPE

Covers the requirements of Hexagon fit bolt, Nut and Washers

Type / Category	Consists of
Bolt Assembly	1 Bolt + 1 Nut + 2 Plain washers
Bolt Assembly with DTI	1 Bolt + 1 Nut + 1 DTI + 1 Bolt face washers

The Bolt Assembly / Bolt Assembly with DTI shall be obtained from a single vendor source.

2.0 REFERRED STANDARD FOR HEXAGON FIT BOLT (CURRENT VERSION IS APPLICABLE)

BS EN 14399-8: Latest Rev. High-strength structural bolting assemblies for preloading – Part 8: System HV – Hexagon fit bolt and nut assemblies

2.1 DIMENSIONS OF FIT BOLTS

Dimensions see Figure 1 and Table 1, clamp length see Figure 2 and Table 2

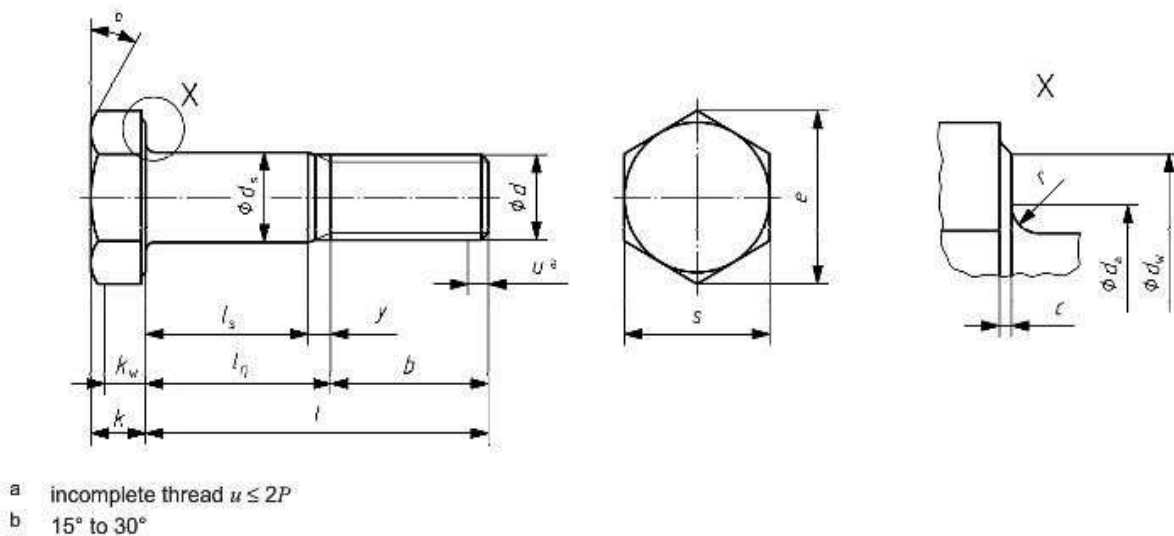


Figure 1 — Dimensions of fit bolts

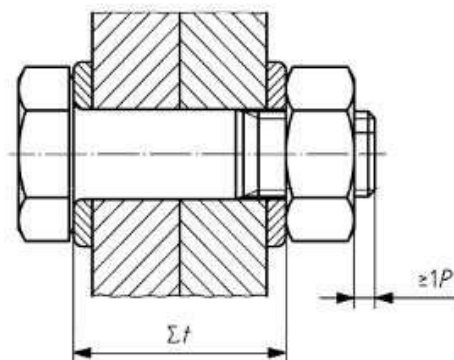


Figure 2 — Clamp length Σt

Table 1 --- Dimensions of fit bolts ^a

Dimensions in millimetres									
Thread <i>d</i>		M12	M16	M20	M22	M24	M27	M30	M36
<i>p_b</i>		1,75	2	2,5	2,5	3	3	3,5	4
<i>b</i>	(ref.)	23	28	33	34	39	41	44	52
<i>c</i>	min.	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4
	max.	0,6	0,6	0,8	0,8	0,8	0,8	0,8	0,8
<i>d_a</i>	max.	15,2	19,2	24	26	28	32	35	41
<i>d_s</i>	nom.	13	17	21	23	25	28	31	37
	min. ^c	12,74	16,74	20,71	22,71	24,71	27,71	30,67	36,67
	max. ^c	12,85	16,85	20,84	22,84	24,84	27,84	30,83	36,83
<i>d_w</i>	min.	20,1	24,9	29,5	33,3	38,0	42,8	46,6	55,9
	max.	d	d	d	d	d	d	d	d
<i>e</i>	min.	23,91	29,56	35,03	39,55	45,20	50,85	55,37	66,44
<i>k</i>	nom.	8	10	13	14	15	17	19	23
	min.	7,55	9,25	12,1	13,1	14,1	16,1	17,95	21,95
	max.	8,45	10,75	13,9	14,9	15,9	17,9	20,05	24,05
<i>k_w</i>	min.	5,28	6,47	8,47	9,17	9,87	11,27	12,56	15,36
<i>r</i>	min.	1,2	1,2	1,5	1,5	1,5	2	2	2
<i>s</i>	max.	22	27	32	36	41	46	50	60
	min.	21,16	26,16	31	35	40	45	49	58,8
<i>y</i>	max.	6,5	7,5	8,5	8,5	10,0	10,0	11,5	13,0

Table 1 (continued)

Dimensions in millimetres

Tread d			M12		M16		M20		M22		M24		M27		M30		M36	
l			l_s f and l_g e															
nom.	min.	max.	l_s min.	l_g max	l_s min.	l_g max.	l_s min.	l_g max.	l_s min.	l_g max.	l_s min.	l_g max.	l_s min.	l_g max.	l_s min.	l_g max.	l_s min.	l_g max.
50	48,75	51,25	20,5	27														
55	53,5	56,5	25,5	32														
60	58,5	61,5	30,5	37														
65	63,5	66,5	35,5	42	29,5	37												
70	68,5	71,5	40,5	47	34,5	42												
75	73,5	76,5	45,5	52	39,5	47	33,5	42										
80	78,5	81,5	50,5	57	44,5	52	38,5	47	37,5	46								
85	83,25	86,75	55,5	62	49,5	57	43,5	52	42,5	51								
90	88,25	91,75	60,5	67	54,5	62	48,5	57	47,5	56	41	51						
95	93,25	96,75	65,5	72	59,5	67	53,5	62	52,5	61	46	56	44	54			30	43
100	98,25	101,75			64,5	72	58,5	67	57,5	66	51	61	49	59			35	48
105	103,25	106,75			69,5	77	63,5	72	62,5	71	56	66	54	64	49,5	61	40	53
110	108,25	111,75			74,5	82	68,5	77	67,5	76	61	71	59	69	54,5	66		
115	113,25	116,75			79,5	87	73,5	82	72,5	81	66	76	64	74	59,5	71		
120	118,25	121,75			84,5	92	78,5	87	77,5	86	71	81	69	79	64,5	76		
125	123	127			89,5	97	83,5	92	82,5	91	76	86	74	84	69,5	81	60	73
130	128	132					88,5	97	87,5	96	81	91	79	89	74,5	86	65	78

NOTE The popular lengths are defined in terms of lengths l_s min and l_g max.

- ^a For hot-dip galvanized bolts, the dimensions apply before galvanizing.
- ^b P is the pitch of thread. ^c Corresponding to tolerance class
- b11. ^d $d_w \max = S_{\text{actual}}$ ^e $l_g \max. = l_{\text{nom.}} - b$ ^f $l_s \min. = l_g \max. - y_{\max}$

Table 2 – Clamp length $\sum t$ ^a

Dimension in millimeters

Tread d			M12		M16		M20		M22		M24		M27		M30		M36	
<i>l</i>			$\Sigma t_{\min b}$ and $\Sigma t_{\max c}$															
nom.	min.	max.	min.	max	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
50	48,75	51,25	31	36														
55	53,5	56,5	36	41														
60	58,5	61,5	41	46														
65	63,5	66,5	46	51	42	47												
70	68,5	71,5	51	56	47	52												
75	73,5	76,5	56	61	52	57	48	53										
80	78,5	81,5	61	66	57	62	53	58	52	57								
85	83,25	86,75	66	71	62	67	58	63	57	62								
90	88,25	91,75	71	76	67	72	63	68	62	67	59	64						
95	93,25	96,75	76	81	72	77	68	73	67	72	64	69	61	66			51	60
100	98,25	101,75			77	82	73	78	72	77	69	74	66	71			56	65
105	103,25	106,75			82	87	78	83	77	82	74	79	71	76	69	74	61	70
110	108,25	111,75			87	92	83	88	82	87	79	84	76	81	74	79		
115	113,25	116,75			92	97	88	93	87	92	84	89	81	86	79	84		
120	118,25	121,75			97	102	93	98	92	97	89	94	86	91	84	89		
125	123	127			102	107	98	103	97	102	94	99	91	96	89	94	83	88
130	128	132					103	108	102	107	99	104	96	101	94	99	88	93

NOTE The popular lengths are defined in terms of lengths $\sum t_{\min}$ and $\sum t_{\max}$.

^a For proper function of the proloaded bolted joint the following condition for the clamp length $\sum t$ shall be fulfilled:

$(l_{g \max} + 2P) < \sum t < (l_{\min} - P - m_{\max})$, where P is the pitch of thread and $m_{\max}$ is the maximum nut height according to Table 5.

The values of $\sum t_{\min}$ and $\sum t_{\max}$ specified in Table 3 are within this range.

The $\sum t_{\max}$ values are specified on the condition that the minimum bolt protrusion beyond the unloaded nut face shall be 1 P .

2.2 SPECIFICATION FOR BOLTS AND REFERENCE STANDARDS

Hexagon fit bolt shall be hot dip galvanized.

Table 3 --- Specifications for bolts and reference standards

Material		Steel
General requirements		EN 14399-1 ^a
Thread	Tolerance	6g ^b
	International Standards	ISO 261, ISO 965-2
Mechanical properties	Property class	10.9
	European Standard	EN ISO 898-1
Impact strength	Value	$K_{V,min} = 27 \text{ J at } -20^{\circ}\text{C}$
	Test specimen ^c	ISO 148-1
	Test	EN 10045-1
Tolerances	Product grade	C except: dimension c Tolerance for lengths $\geq 155 \text{ mm}$: $+17$ $-0,517$
	International Standard	EN ISO 4759-1
Surface finish^d	normal	as processed ^e
	hot dip galvanized	EN ISO 10684
	others	to be agreed ^f
Surface discontinuities		Limits for surface discontinuities are covered in EN 26157-1.
Acceptability		For acceptance procedure, see EN ISO 3269.
^a For the time being EN 14399-1 refers only to EN 14399-3 and EN 14399-4 as far as dimensions and mechanical characteristics of the components and functional characteristics of the assemblies are concerned. Such references shall also apply to EN 14399-8.		
^b The tolerance class specified applies without surface finish. Hot-dip galvanized bolts are intended for assembly with oversize tapped nuts.		
^c The preparation of the test specimens with V-notch in the fastener shall be as specified in EN ISO 898-1.		
^d Attention is drawn to the need to consider the risk of hydrogen embrittlement in the case of bolts of property class 10.9, when selecting an appropriate surface treatment process (e.g. cleaning and coating), see the relevant coating standards.		
^e "As processed" means the normal finish resulting from manufacture with a light coating of oil.		
^f Other coatings may be negotiated between the purchaser and the manufacturer provided they do not impair the mechanical properties or the functional characteristics. Coatings of cadmium or cadmium alloys are not permitted.		

2.3 MARKING OF HEXAGON FIT BOLTS

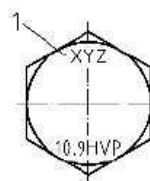
High-strength structural bolts according to this specification shall be marked with:

- Property class marking in accordance with EN ISO 898-1 and the letters HVP.

EXAMPLE 1 10.9 HVP

- b) The identification mark of the manufacturer of the assembly.
It is permissible for the marking to be either embossed or indented on the top surface of the head.

EXAMPLE 2 of bolt marking (see Figure 3):



Key

1 identification mark of the manufacturers of the assembly

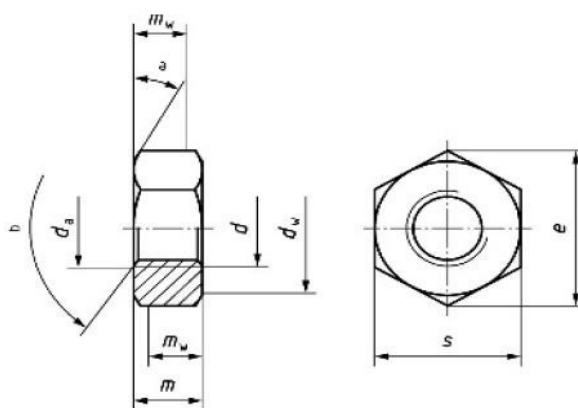
Figure 3 — Example for marking of a bolt

3.0 REFERRED STANDARD FOR NUT ASSEMBLIES (CURRENT VERSION IS APPLICABLE)

BS EN 14399-4: Latest Rev. High-strength structural bolting assemblies for preloading – Part 4: System HV – Hexagon bolt and nut assemblies.

3.1 DIMENSIONS OF NUTS

Dimensions see Figure 4 and Table 4.



Key

a 15° to 30°

b 110° to 130°

Figure 4 --- Dimensions of nuts

Table 4 --- Dimensions of nuts ^a

Dimensions in millimetres

Thread (<i>d</i>)		M12	M16	M20	M22	M24	M27	M30	M36
<i>P</i> ^a		1,75	2	2,5	2,5	3	3	3,5	4
<i>d</i> _a	max.	13,0	17,3	21,6	23,7	25,9	29,1	32,4	38,9
	min.	12	16	20	22	24	27	30	36
<i>d</i> _w	max.	^b	^b	^b	^b	^b	^b	^b	^b
	min.	20,1	24,9	29,5	33,3	38,0	42,8	46,6	55,9
<i>e</i>	min.	23,91	29,56	35,03	39,55	45,20	50,85	55,37	66,44
<i>m</i>	nom. = max.	10	13	16	18	20	22	24	29
	min.	9,64	12,30	14,90	16,90	18,70	20,70	22,70	27,70
<i>m</i> _w	min.	7,71	9,84	11,92	13,52	14,96	16,56	18,16	22,16
<i>s</i>	max.	22	27	32	36	41	46	50	60
	min.	21,16	26,16	31,00	35,00	40,00	45,00	49,00	58,80
^a <i>P</i> is the pitch of thread. ^b <i>d</i> _{w,max} = <i>s</i> _{actual} .									

3.2 SPECIFICATION FOR NUTS AND REFERENCE STANDARDS

Nut assemblies shall be hot dip galvanized.

Table 5 --- Specification for nuts and reference standards

Material		Steel		
General requirements		EN 14399-1 and EN 14399-2		
Thread	Coating of the bolt	Uncoated	Hot dip galvanized	Others
	Tolerance class of the nut	6H	6AZ	6H ^a
	International Standards	ISO 261, ISO 965-2	ISO 261, ISO 965-5	ISO 261, ISO 965-2, ISO 965-5
Mechanical properties	Property class	10		
	European Standard	EN ISO 898-2		
Tolerances	Product grade	B		
	European Standard	EN ISO 4759-1		
Finish — Coating	Uncoated	As processed ^b		
	Hot dip galvanized	EN ISO 10684		
	Others	to be agreed ^c		
Surface integrity		Limits for surface discontinuities as specified in EN ISO 6157-2.		
Acceptability		For acceptance procedure, see EN ISO 3269.		

^a For other coatings that need an increased fundamental deviation and according to the relevant standard, oversize tapped nuts with a thread tolerance class up to 6AZ may be used.

^b “As processed” means the normal finish resulting from manufacture with a light coating of oil.

^c Other coatings may be negotiated between the purchaser and the manufacturer provided they do not impair the mechanical properties or the functional characteristics. Coatings of cadmium or cadmium alloys are not permitted.

3.3 DECARBURIZATION OF THE NUT THREAD

The decarburization of the nut thread, when measured in analogy to external threads as given in EN ISO 898-1, shall not exceed $G = 0,015\text{mm}$.

3.4 MARKING OF NUTS

High-strength structural nuts according to this specification shall be marked with:

- a) Property class marking in accordance with EN 20898-2 and the letters HV.

EXAMPLE 1 10 HV

- b) The identification mark of the manufacturer of the assembly.

The marking shall be indented on either bearing face.

EXAMPLE 2 of nut marking (see Figure 5):

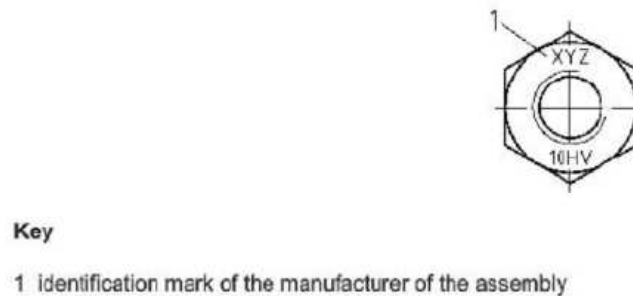


Figure 5 — Example for marking of a nut

4.0 DESIGNATION OF THE FIT BOLT / NUT ASSEMBLY

EXAMPLE 1 Designation of an assembly for high strength structural bolting, system HV, consisting of a hexagon fit bolt with large width across flats, with thread M16, nominal length $l = 80\text{ mm}$ and property class 10.9 and a hexagon nut with large width across flats, with thread M16 and property class 10:

Hexagon fit bolt/nut assembly EN 14399-8 --- M16 x 80 --- 10.9/10 --- HVP

If surface finishes other than “as processed” are required, the specified surface finish shall be added to the designation.

EXAMPLE 2 Designation of a hexagon fit bolt with large width across flats, with thread M16, nominal length $l = 80\text{ mm}$ and property class 10.9:

Hexagon fit bolt EN 14399-8 --- M16 x 80 --- 10.9 --- HVP

5 REFERRED STANDARD FOR PLAIN CHAMFERED WASHERS (CURRENT VERSION IS APPLICABLE)

BS EN 14399-6: Latest Rev High-strength structural bolting assemblies for preloading
– Part 6: Plain chamfered washers

5.1 DIMENSIONS OF PLAIN CHAMFERED WASHERS

Dimensions see Figure 6 and Table 6.

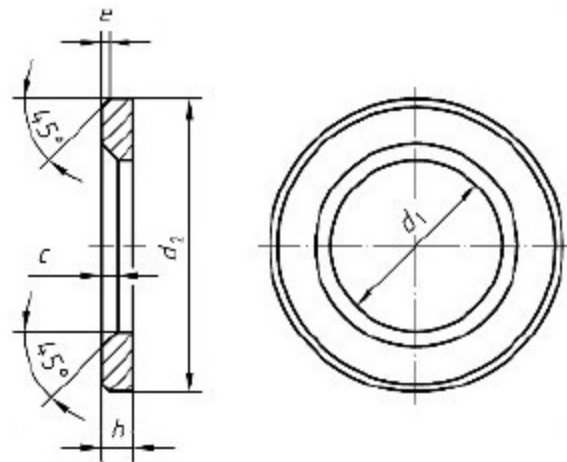


Figure 6 --- Dimensions

For coated washers the above dimensions apply prior to coating.

Table 6 --- Dimensions

Dimensions in millimetres

Nominal size d (nominal thread diameter of associated bolts)		12	(14) ^a	16	(18) ^a	20	22	24	27	30	36
d_1	min.	13	15	17	19	21	23	25	28	31	37
	max.	13,27	15,27	17,27	19,33	21,33	23,33	25,33	28,52	31,62	37,62
d_2	min.	23,48	27,48	29,48	33,38	36,38	38,38	43,38	49,00	54,80	64,80
	max.	24	28	30	34	37	39	44	50	56	66
h	nom.	3	3	4	4	4	4	4	5	5	6
	min.	2,7	2,7	3,7	3,7	3,7	3,7	3,7	4,4	4,4	5,4
	max.	3,3	3,3	4,3	4,3	4,3	4,3	4,3	5,6	5,6	6,6
e	nom. = min.	0,5	0,5	0,75	0,75	0,75	0,75	0,75	1	1	1,25
	max.	1,0	1,0	1,5	1,5	1,5	1,5	1,5	2,0	2,0	2,5
c	min.	1,6	1,6	1,6	2,0	2,0	2,0	2,0	2,5	2,5	2,5
	max.	1,9	1,9	1,9	2,5	2,5	2,5	2,5	3,0	3,0	3,0

^a Sizes in brackets are non-preferred sizes.

5.2 SPECIFICATION AND REFERENCE STANDARDS FOR PLAIN CHAMFERED WASHERS

Plain chamfered washers shall be hot dip galvanized.

Table 7 --- Specification and reference standards for plain chamfered washers

Material		Steel
General requirements		EN 14399-1 and EN 14399-2
Mechanical properties	Hardness range	300 HV to 370 HV
Tolerances	Product grade	A
	European Standard	EN ISO 4759-3
Finish — Coating ^a	Uncoated	as processed ^b
	Hot dip galvanized	EN ISO 10664
	Others	to be agreed ^c
Workmanship		Parts shall be uniform and free of irregularities or detrimental defects. No protruding burrs shall appear on the washer.
Acceptability		For acceptance procedure, see EN ISO 3269.

^a Attention is drawn to the need to consider the risk of hydrogen embrittlement when selecting an appropriate surface treatment process (e.g. cleaning and coating), see the relevant coating standards.

^b "As processed" means the normal finish resulting from heat treatment with a light coating of oil.

^c Other coatings may be negotiated between the purchaser and the manufacturer provided they do not impair the mechanical properties or the functional characteristics. Coatings of cadmium or cadmium alloys are not permitted.

5.3 DESIGNATION

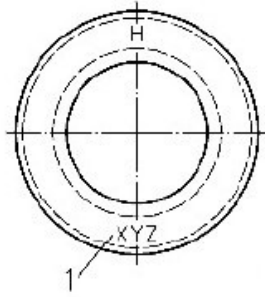
EXAMPLE A hardened and tempered chamfered plain washer for high-strength structural bolting for preloading, of nominal size $d = 16$ mm, with hot dip galvanized coating(tZn), is designated as follows:

Washer EN 14399-6 --- 16 --- tZn

5.4 MARKING

Hardened and tempered chamfered washers shall be marked with at least the manufacturer's trade (identification) mark and the letter H. The manufacturer may decide to mark washers with HR or HV (instead of H marking) when they are supplied as component of bolting assemblies of system HR or HV respectively.

The marking shall be indented on the non-chamfered side.



Key

- 1 identification mark of the manufacturer of the assembly

Figure 7 --- Example of marking

6.0 REFERRED STANDARD FOR BOLT FACE WASHERS FOR BOLT AND NUT ASSEMBLIES (CURRENT VERSION IS APPLICABLE)

BS EN 14399-9: Latest Rev High-strength structural bolting assemblies for preloading - System HR or HV.

Direct tension indicators for bolt and nut assemblies

6.1 DIMENSIONS OF BOLT FACE WASHERS (HB)

Dimensions see Figure 6 and Table 6.

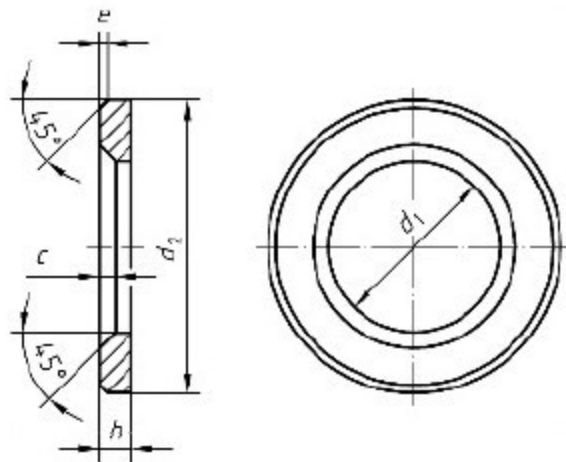


Figure 6 --- Dimensions of bolt face washers (HB)

For coated washers the above dimensions apply prior to coating.

Table 7 — Dimensions of bolt face washers (HB)

Dimensions in millimetres

Nominal size <i>d</i> (nominal thread diameter of associated bolt)	Internal diameter		External diameter		Thickness		Inside chamfer		Outside chamfer	
	<i>d</i> ₁ min.	<i>d</i> ₁ max.	<i>d</i> ₂ min.	<i>d</i> ₂ max.	<i>h</i> min.	<i>h</i> max.	<i>c</i> min.	<i>c</i> max.	<i>e</i> min.	<i>e</i> max.
M12	13	13,27	23,48	24	2,7	3,3	1,6	1,9	0,50	1,0
M16	17	17,27	29,48	30	3,7	4,3	1,6	1,9	0,75	1,50
M20	21	21,33	36,38	37	3,7	4,3	2,0	2,5	0,75	1,50
M22	23	23,33	38,38	39	3,7	4,3	2,0	2,5	0,75	1,50
M24	25	25,33	43,38	44	3,7	4,3	2,0	2,5	0,75	1,50
M27	28	28,52	49	50	4,4	5,6	2,5	3,0	1,0	2,0
M30	31	31,62	54,80	56	4,4	5,6	2,5	3,0	1,0	2,0
M36	37	37,62	64,80	66	5,4	6,6	2,5	3,0	1,25	2,50

6.2 SPECIFICATION AND REFERENCE STANDARDS FOR WASHERS

Bolt face washers shall be Sherardized / Zinc flake coating

Table 8 — Specifications and reference standards for nut face washers (HN) and bolt face washers (HB)

Material		Steel
General requirements		EN 14399-1 and EN 14399-2
Heat treatment		hardened and tempered
Hardness ^a	Rockwell hardness	38 HRC to 45 HRC
	European Standard	EN ISO 6508-1
	Vickers hardness	372 HV30 to 448 HV30
	European Standard	EN ISO 6507-1
Tolerances	Product grade	C ^b
	Standard	EN ISO 4759-3
Finish — Coating ^c	Uncoated	as processed ^d
	Sherardized	EN ISO 17668
	Others	to be agreed ^e
Associated bolts and nuts		EN 14399-3, EN 14399-4, EN 14399-7 or EN 14399-8
Associated washers		EN 14399-5 or EN 14399-6
Acceptability		For acceptance procedure, see EN ISO 3269:2000.
^a In case of dispute, the Vickers hardness test shall be the referee test method. ^b Except as otherwise specified in Tables 6 and 7. ^c These washers shall not be electroplated or subjected to any process that could result in hydrogen embrittlement. ^d "As processed" means the normal finish resulting from manufacture with a light oil coating. ^e Other coatings may be negotiated between the purchaser and the manufacturer providing they do not impair the mechanical properties or functional characteristics. Coatings of cadmium or cadmium alloys are not permitted.		

6.3 DESIGNATION

Example 1: A bolt face washer (HB) for high-strength structural bolting assemblies, of nominal size $d = 20$ mm, processed, is designated as follows:

Washer HB EN 14399-9 — M20

6.4 MARKING

Bolt face washers (HB) shall be marked with the identification mark of the manufacturer of the bolting assembly and the letters HB. The marking shall be indented into one face.

6.5 COATING

Type / Category	Consists of	Coating
Bolt Assembly	1 Bolt + 1 Nut	Hot Dip Galvanization
	2 Plain washers	
Bolt Assembly with DTI	1 Bolt + 1 Nut	Hot Dip Galvanization
	1 DTI + 1 Bolt face washers	Sherardized / Zin Flake Coating

For Hot Dip Galvanization:

- 1) Cleaning and pickling shall be alkaline or mechanical process as per clause 5.2 of ISO 10684. Avoid acid cleaning.
- 2) Galvanizing temperature shall be as per clause 5.5 of ISO 10684.
- 3) Nuts tapped oversize to tolerance class 6AZ after coating as per clause 6.2.2 of ISO 10684. Nuts tapped oversize shall be marked with the letter Z immediately after the property class
- 4) Nuts (tapped to 6AZ tolerance) must be supplied with factory applied lubricant. Based on the lot size, additional lubricant should be supplied to site along with bolt assembly.
- 5) Zinc coating thickness shall be minimum of 50 μm and maximum of 60 μm .

For Sherardized coating ISO 17668 and for Zin flake coating ISO 10683 to be followed.

7.0 FUNCTIONAL CHARACTERISTICS OF THE BOLT/NUT/WASHERS ASSEMBLY

The Bolt Assembly / Bolt Assembly with DTI shall be obtained from a single vendor source.

The nut of the bolting assembly shall be suitably lubricated in the as delivered condition, to ensure that seizure will not take place during tightening of the assembly and that the required preload is obtained.

The manufacturer of the bolting assemblies shall state the suitable methods for tightening in accordance with EN 1090-2 in relation the declared k-class. The necessary information for at least one relevant tightening method as mentioned in the below Table shall be stated on the label or packaging.

Information related to tightening methods for the required preload, $F_{p,C} = 0.7f_{ub}A_s$

Tightening method according to EN 1090-2	Minimum information to be supplied	k-class
Torque method	$k_m = \dots\dots\dots$ 1 st step: Torque = Nm 2 nd step: Torque =Nm	K2
Combined method	1 st step: Torque = Nm 2 nd step: Further rotation	K1 ^a
Direct tension indicator method	-	K0 ^b
^a K2 can also be used. ^b K1 or K2 could also be used, but declared as K0		

where

f_{ub} is the nominal ultimate tensile strength of the bolt material

A_s is the nominal stress area of the bolt

Eg: For M30 10.9 grade bolt

$$f_{ub} = 1000 \text{ MPa}; A_s = 561 \text{ mm}^2$$

Required preload $F_{p,C} = 393 \text{ kN}$

7.1 INDIVIDUAL VALUES OF THE k-factor (k_i), MEAN VALUE OF THE k-factor (k_m) AND COEFFICIENT OF THE k-factor (V_k)

7.1.1 Individual values of the k-factor (k_i) for k-class K1

For k-class K1, the k_i values shall be within the range of $0.1 \leq k_i \leq 0.16$

7.1.2 Mean value of the k-factor (k_m) and coefficient of the k-factor (V_k) for k-class K2

The mean value (k_m) of the k-factor shall be calculated as follows:

$$k_m = \frac{\sum_{i=1}^n k_i}{n}$$

with

$$k_i = \frac{M_{pi}}{F_{p,C} \times d}$$

where

M_{pi} is the individual value of the applied torque;

$F_{p,C}$ is the required preload;

d is the nominal bolt diameter

The coefficient of variation of the k-factor (V_k) shall be calculated as follows:

$$V_k = S_k / k_m$$

where

S_k is the standard deviation

$$S_k = \sqrt{\frac{\sum (k_i - k_m)^2}{n - 1}}$$

For k_m and V_k the following values apply:

$$0.1 \leq k_m \leq 0.23$$

$$V_k \leq 0.06$$

8.0 RAW MATERIAL REQUIREMENTS (CRITICAL)

8.1 Steel Grade & Chemical Composition

The following chemical composition requirements are mandatory and shall be evidenced by actual numerical values on the Material Test Certificate (MTC) issued by the steel producer for every heat of steel received. Pass/Fail statements are not acceptable.

Steel Grade & Alloy Selection: Input steel shall be an Alloy Structural Steel with sufficient Chromium (Cr) and Molybdenum (Mo) content to achieve the through-hardening requirements. While grades like 42CrMo4 (per EN 10083-3) or SAE 4140 are acceptable, the manufacturer must ensure at their end the specific alloy chemistry is capable of achieving approximately 90% martensite in the core of the threaded section in the "as-hardened" condition (before tempering).

Designation: The MTC shall explicitly state the standard grade designation. Where international equivalents (EN/SAE/AISI) are used in lieu of IS 5517:1993, prior approval from BHEL is required.

The limits for Sulphur (S), Phosphorus (P) and Boron (B) content shall be strictly maintained as per IS 1367-3 (latest). If Boron exceeds 0.001%, Aluminium (Al) shall be suitably added to achieve the desired metallurgical properties. In case of Steels with boron, the content of Boron must be clearly declared on the MTC.

Enhanced Alloying for Large Diameters: For bolt diameters M30 and above, the manufacturer shall ensure enhanced alloying (specifically Cr and Mo) to guarantee uniform through-hardening and prevent brittle "snapping" in the core.

Vacuum Degassing (VD): For steel processed via the VD route, the Hydrogen (H₂) content shall be measured and reported on the MTC.

Precedence: The Specific chemical limits and hardenability requirements stated in this clause shall take precedence over general limits provided in IS 5517 or any other international standards for raw material.

NOTE: Please get quality plan from vendors/suppliers.

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:5: 216 Rev: 00 Effective Date: 25/08/2026 Page: 1 of 8
Product: Hexagon Fit bolts, Nuts and Washers for Ceiling Girders (Property class Bolt 10.9/ Nut 10)		

Revision record:

Rev 00: Dt 25/08/26 – Fresh issue

1. SCOPE:

This technical delivery condition document covers the requirements for the High strength Hexagon Fit bolts, Nuts and Washers applicable for Ceiling Girders and shall be procured from the BHEL approved manufacturers only. The mandatory requirements, test methods and procedures from the applicable EN standards to confirm a product to its relevant latest EN standard shall be met with. TDC is in addition to specification.

Size, Specification and Qty: As per BHEL Purchase order (PO) /specification. The bolts, nuts and washers shall be supplied in Hot-Dip Galvanized (HDG) Fit Bolt Assemblies conforming to:

- EN 14399-1, EN 14399-2, EN 14399-8 (Fit Bolts)
- EN 14399-8(Nuts)
- EN 14399-6 (Washers)
- EN ISO 898-1 (Mechanical Properties)
- ISO 10684 (HDG Fasteners)
- BHEL specification SS-FIT-01

2. RAW MATERIAL & STEEL MAKING :

Bolts and Nuts: Rolled/Forged bar of IS5517. Washer: as per IS 1571 Part 2 (Latest)

Chemical composition: Shall be checked on receipt of raw material at supplier works for every heat

Bolts: Alloy steel quenched and tempered for Class 10.9 – As per Table 3 of EN 14399-8

Nuts: As per Table 5 of EN 14399-8.

Washers: As per Table 3 of EN 14399-6.

Sulphur, Phosphorous <0.06% in check analysis

DTI Washers/Nut face washers/Bolt face washers: As per EN 14399-9, if applicable as per PO.

Vacuum Degassing: mandatory for all Class 10.9 bolts of diameter M24 and above. The MTC shall confirm vacuum degassing was applied to that specific heat.

For steel processed via the VD routes the Hydrogen H₂ content' shall be measured and reported in the MTC. Hydrogen Content shall be <2 ppm (for larger diameters M 30 and above)

For Class 10.9 bolts, the free-ferrite decarburization depth on the incoming bar or rod shall not exceed 0.05 mm absolute

Steelmaking route:

The steelmaking route and supply chain model shall be declared on every Material Test Certificate (MTC).

The following requirements apply:

Accepted steelmaking routes: Electric Arc Furnace (EAF) + Ladle Refining Furnace (LRF)+
Continuous Casting (CC); or Basic Oxygen Furnace (BOF)+LRF+CC
Induction Furnace (IF) route is NOT permitted for Class 10.9.

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:5: 216 Rev: 00 Effective Date: 25/08/2026 Page: 2 of 8
Product: Hexagon Fit bolts, Nuts and Washers for Ceiling Girders (Property class Bolt 10.9/ Nut 10)		

Manufacturing process requirements

Heat treatment

- Oil quenching with agitation control
- Hardness monitoring per batch

Threading

- Thread rolling before heat treatment
- No laps, cracks, or thread defects

Hot-Dip Galvanizing as per ISO 10684 and clause 6.5 of specification SSFIT-01.

Strict process control for:

- Cleaning and pickling shall be alkaline or mechanical process, avoid acid cleaning.
- Pickling time – to avoid potential hydrogen embrittlement
- Galvanizing temperature shall be as per clause 5.5 of ISO 10684.
- Nuts tapped oversize to tolerance class 6AZ after coating as per clause 6.2.2 of ISO 10684. Nuts tapped oversize shall be marked with the letter Z immediately after the property class
- Nuts (tapped to 6AZ tolerance) must be supplied with factory applied lubricant. Based on the lot size, additional lubricant should be supplied to site along with bolt assembly.
- Zinc coating thickness shall be minimum of 50 µm and maximum of 60 µm.
- Bath temperature – to avoid potential LME
- Fluxing
- Mandatory de-embrittlement baking:
200°C ±10°C for minimum 4 hours
Within 1 hour of pickling/ galvanizing (log sheet/ reports to be submitted to substantiate the same

Hot-Dip Galvanizing procedure to be submitted by supplier and approved by BHEL

For Bolt face washers -Sherardized coating ISO 17668 and for Zin flake coating ISO 10683 to be followed.

3. DIMENSIONS AND TOLERANCES:

- **Process:** Cold/Hot Forging with Dies and tools clean of loose scale and sheet particles.
- Threads on the bolts shall be checked with a properly calibrated ring gauge with a tolerance class 6g. Threads on the nuts shall be checked with a properly calibrated plug gauge with tolerance class 6H in an NABL accredited LAB. Dimensions and tolerances as per specification SSFIT-01.

Note: The washers shall be flat with a maximum deviation not exceeding 0.25 mm from the straight edge laid along a line passing through the center of the hole. The hole of the washer shall be concentric with the outside dimensions within 0.50 mm. washers are required to be clipped to provide clearance, the clipped edge shall not be closer to the center of the washer than 0.9 of the bolt diameter.

4. Post Forming Heat Treatment (HT):

- **Bolt:** After forming shall be quenched (HT' at AC 3 temperature, with soaking time 30minutes per inch followed by quenching) and tempered (at 425°C min, 60 minutes per inch). There should be a sufficient hardenability to ensure a structure consisting of approximately 90 % martensitic in the core of the threaded sections for the fasteners in the as-hardened condition before tempering.
- **Nut:** Shall be hardened and then tempered (at a temperature of 425°C minimum).
- **Washer:** Shall be hardened and tempered. Carburized washers are not permitted.

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Product: Hexagon Fit bolts, Nuts and Washers for Ceiling Girders (Property class Bolt 10.9/ Nut 10)		

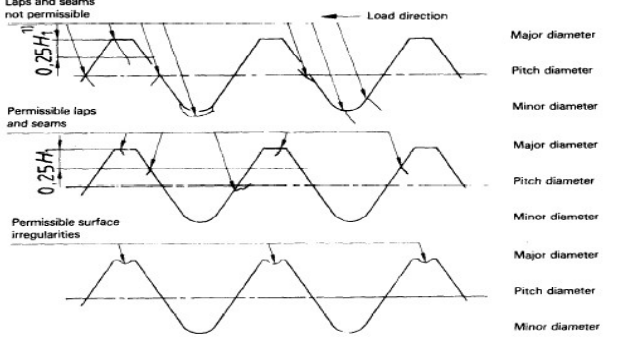
5. CHEMICAL & MECHANICAL & NDE: (on Heat Treated finished product)

Sample Size for Mechanical test: & NDE: As per Sampling Plan

BOLT :

Sl	Test	Test Method - As per Table 3 of ISO: 898 Part 1 (Latest)	Acceptance
1	Chemistry	Spectro / Wet Analysis Method – One sample for every heat Of raw material and One sample/HT batch on product	As per Cl 2.0 of this TDC
2	Hardness Test	Note: Surface hardness shall not be more than 30 Vickers above the measured core Hardness on the product when readings of both surface and core are carried out at HV 0.30.	10.9- Min 320 HV Max 380 HV 27 J min
	Impact Strength	Values are determined at a test temperature of –20 °C	
3	Minimum Tensile Strength, Yield,%Elongation on 5.65√A, % Reduction in Area after fracture	Axial tensile test must be performed and witnessed by BHEL along with graph from UTM. In case of samples not feasible as per ISO: 898-1, IS 1608 to be used for EL and RA testing.	10.9-1040N/mm ² , 9 min, 48% min
4	Proof Load Test	10.9 – Proof Load of M20 (203KN), M24 (293KN), M30 (466KN), M36 (678)KN	Length of the bolt after loading shall be the same as before loading within a tolerance of ± 12.5 µm allowed for measurement error.
5	Strength under Wedge load test	ISO: 898-1 (Latest)	10.9– 1040 N/mm ²
6	Decarburization Test at 200X min magnification	Determination of the following by MICROSCOPIC Method a) Minimum Height of non decarburized thread zone – E b) Maximum depth of complete decarburization – G	E = 2/3 H1 G = 0.015 mm
7	Hardness after Retempering	ISO: 898-1(Latest) test not mandatory, to be applied in case of dispute only	Reduction of hardness 20 HV max.
8	NDE for material soundness	before machining – For bar Diameter ≥ 30 mm: UT as per ASTM A388. For bar Diameter < 30 mm: MPI as per ASTM E 709 After machining – MPI as per ASTM E 709 or as per ISO 6157 Part 3 (Latest)	UT – ASME SEC-VIII. Div-II Part: 3.3.4 (Latest). MPI – Linear indications like cracks, folds & other injurious defects are not acceptable.
9	Micro Examination for Surface Integrity – Laps at threaded region.	Laps at thread region and defect if any can be determined by micro examination. Laps shall be checked before Hot dip galvanisation.	Max depth of laps in thread = 0.41 mm Laps of any depth or length are not permitted in the following places: - at the root of the thread - at the loaded flank of screw thread below the pitch diameter, even if they start beyond the pitch diameter.

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Product: Hexagon Fit bolts, Nuts and Washers for Ceiling Girders (Property class Bolt 10.9/ Nut 10)		

			The following laps are permissible : - laps in the crest of the threads of 0.25 H1 max.; - crest of the threads not entirely rolled out, maximum half a turn on one thread; - laps below the pitch diameter, if they run on the non-loaded flank towards the major diameter and not deeper than 0.25 H1 and not longer than half a turn on one thread.
10	Torque—Tension (k.-factor) test	As per EN 14399-2, EN 14399-8 and EN 1090-2, minimum tension to be achieved Each lot shall be tested. k factor to be furnished by the vendor, along with the tightening method	Refer CL:7 of EN 14399-8 For k-class K1, the k_i values shall be within the range of $0.1 \leq k_i \leq 0.16$ For k-class K2, $0.1 \leq k_m \leq 0.23$ $V_k \leq 0.06$
11	Additional Mandatory tests	Non-metallic inclusion rating as per ISO 4967 Hydrogen embrittlement as per ISO15330 Hydrogen content (for large dia bolts M 30 and above) Microstructure documentation.	Non-metallic inclusion - numerical ratings: Maximum 1 for type series A, B, C, D (thin)

NUT: (on Heat Treated finished product)

Sl	Test	Test Method	Acceptance Value
1.	Chemistry	Spectro / Wet Analysis Method – For every heat of raw material and, One sample/HT batch on product	As per Cl 2.0 of this TDC
2.	Hardness Test	Hardness of the test mandrel shall be minimum 45 HRC.	Min 272 HV Max 353 HV
3.	Proof Load Test	10HV M30 (595KN), M36 (866KN) shall be applied axially to the nut in a tensile testing machine for 15sec.	The nut shall resist the load without failure by stripping or rupture, and shall be removable by the fingers after the load is released.
4.	NDE for Surface Integrity	Before coating, as per ISO 6157-2 Cl 4.2 (Latest)	Linear indications like cracks, folds & Other injurious defects are not acceptable.

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:5: 216 Rev: 00 Effective Date: 25/08/2026 Page: 5 of 8
Product: Hexagon Fit bolts, Nuts and Washers for Ceiling Girders (Property class Bolt 10.9/ Nut 10)		

WASHER: The washers shall be free from cracks, burrs, pits and other defects. All sharp edges shall be removed.

Sl	Test	Test Method	Acceptance Value
1.	Chemistry	Spectro / Wet Analysis Method – For every heat of raw material and one sample/HT batch on product.	As per Cl 2.0 of this TDC
2.	Hardness Test for plain chamfered washer	EN 14399-6 (latest)	Min 300 HV Max 370 HV
3.	Hardness Test for DTI washer	EN 14399-9 (latest)	Max 380 HV
4.	Hardness Test for Nut face/Bolt face washer	EN 14399-9 (latest)	Min 372 HV Max 448 HV

6. MARKING, PRESERVATION AND PACKING:

The following to be hot stamped or embossed on the top surface of the bolt and nut:

Bolt- Manufacturer's Identification Symbol and, 10.9 HVP, Raw material Heat number (last 4 digits) and marking as indicated in specification is to be embossed/indented.

Nut- Manufacturer's Identification Symbol and, 10HV (as embossing is not allowed).

Washer- Marking as per specification Shall be identified by – the provision of 2 nibs and manufacturers identification symbol being placed as near to the outer edge as possible

The supplier shall maintain records of raw materials, manufacturing, heat treatment, testing and inspection, along with a Raw Material Heat Number Ledger. BHEL may verify these records by conducting audits during execution of the order

The following details shall be clearly indicated in the tags tied to the bundle:

1) Customer Name 2) Manufacturer's Name 3) Vendor Code 4) Purchase Order No and Supplier Internal W.O No 5) Quantity and Weight 6) BHEL Material Code 7) Item Description with diameter, length 8) Torque value, K factor, Raw material Heat no to be indicated on TAG with packing. Torque value and K factor to be witnessed by BHEL

Colour coding: To be done only on bolt head as per BHEL drawing as indicated in the Purchase order.

Bolts shall be packed in Polythene lined Hessian Cloth/Bag not exceeding 25kgs and shall be put inside wooden boxes with maximum weight of 3 MT for each box & there shall be no mixing of two or more sizes in single box.

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:5: 216 Rev: 00 Effective Date: 25/08/2026 Page: 6 of 8
Product: Hexagon Fit bolts, Nuts and Washers for Ceiling Girders (Property class Bolt 10.9/ Nut 10)		

7. INSPECTION AND CERTIFICATION:

All the finished components shall be visually and dimensionally inspected as per sampling plan. All the test results shall be documented and maintained. Products to be inspected at works & test certificates (in English) shall be submitted with the following details counter signed by BHEL/BHEL Authorized Inspection agency as indicated in the PO. Manufacturers Test certificate (MTC) shall contain the following:

- 1) Purchase Order No. (BHEL), TDC No, Specification and Grade.
- 2) Name of raw material bar supplier.
- 3) Bolt manufacturing process flow
- 4) Dimensional reports for each product (Annexure).
- 5) Chemistry including incidental elements on the raw material and final product checked in NABL lab/ suppliers own lab (ISO/IEC 17025:2017 accreditation).
- 6) HT details of materials temperature, soaking time, ROH/ROC medium, Time-Temperature charts for quenching and tempering etc.
- 7) All Mechanical test result report including tensile strength, yield, % Elongation, % RA, hardness & Impact strength.
- 8) MPI/ UT, Micro examination and decarburization test report with the reference & acceptance standard.
- 9) TC of raw material from a original steel producer, UT/MPI report done on raw material shall accompany the MTC.
- 10) Torque-tension test results with Torque value and K factor for the specific lot.
- 11) TC for rust preventive fluid as per PR: Chem:09-04, (Latest)
- 12) Non-metallic inclusion rating numerical rating as per IS 4163 /ISO 4967
- 13) Report for 90% martensite in the core of the threaded section before tempering.
- 14) Process Qualification Record (PQR) as per the BHEL approved procedure for HDG shall be submitted along with MTC
- 15) The detail reports for the tests conducted to be enclosed as Annexures with MTC.

8. AUDITS AT BHEL:

BHEL reserve the right to reject any item found to be not meeting the requirements during tests at supplier works or during subsequent processing at BHEL.

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:5: 216 Rev: 00 Effective Date: 25/08/2026 Page: 7 of 8
Product: Hexagon Fit bolts, Nuts and Washers for Ceiling Girders (Property class Bolt 10.9/ Nut 10)		

TEST SAMPLING PLAN FOR HEXAGON FIT BOLTS, NUTS & WASHERS FOR BHEL TDC: 5: 216

Lot Size (In nos.)	SAMPLE SIZE															Remarks
	Visual (nos.)	Dimensional (nos.)	MPI (nos.)	Physical Test												
				Total (nos.)	Hardness (nos.)	Hardness after Re-Tempering (nos.)	Proof of Load (nos.)	Wedge Load (nos.)	Min Tensile Strength (nos)	%EL	%RA	Minimum stress at 0.2 % non-proportional elongation	Impact test (nos)	Decarb (nos.)	Coating Thickness (nos.)	
Upto 100	20	8	15	5	5	5	2	2	2			2	1	2	2	
101 to 300	32	13	15	5	5	5	2	2	2			2	1	2	2	
301 to 500	50	20	15	5	5	5	2	2	2			2	1	2	2	
501 to1000	80	32	15	5	5	5	2	2	2			2	1	2	2	
1001 to 3000	125	50	25	8	8	8	2	4	2			2	1	4	4	Upto 1500 nos 15 nos. for MPI
3001 to 10000	200	80	50	13	13	13	2	6	2			2	1	6	6	Upto 5000 nos 25 nos. for MPI
10001 to 35000	315	125	75	20	20	20	4	8	4			4	2	10	10	Upto 15000 nos 50 nos. for MPI
35000 to 70000	500	200	100	32	32	32	6	12	5			6	3	15	15	Upto 50000 nos 75 nos. for MPI
Inspection by BHEL/BHEL AIA	W	W	W	W	W	W	W	W	W			W	W	W	W	

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC534 Rev: 00 Effective Date: 25/08/2026 Page: 8 of 8
Product: Hexagon Fit bolts, Nuts and Washers for Ceiling Girders (Property class Bolt 10.9/ Nut 10)		

Remarks:

1. Acceptance Number is zero. If the sample is having deviations in Visual, Dimensional and MPI then the entire lot shall be 100% inspected. In case of deviations in Physical tests a second sample of twice the sample size of initial sample shall be taken. The lot will get rejected if the second sample fails.
2. Inspection by BHEL/BHEL AIA shown as "W" shall be witnessed for the sample size indicated against the lot size
3. Any quantity offered above 70000 nos, will be considered as a new lot and sampling plan shall be reapplied for them.
4. In physical test minimum one number per heat of raw material used to be covered.

					
Dr. T Sriharsha SM/QA	M. Jeyaram SM /QA	B Sriram Manager/MM	V Saravanakumar DGM/Engg	S Krishna Kumar AGM/QC	S Lakshmi AGM/QA&QC
Prepared	Reviewed				Approved

		BHEL: IVP Goindwai Quality Assurance	STANDARD QUALITY PLAN				QP No	SQP:FITBOLT:001		
			Item: FIT BOLT Fasteners (Bolts, Nuts and Washers)				Rev	7		
							Date	27.08.2026		
							Page	1 of 3		
SN	Component & Operation	Characteristics	Type of Check	Quantum of check	Reference Document	Acceptance Norm	Format of Record	Agency		Remarks
								M	B	
1.0	Raw material									
1.1	Raw material	Chemical, Mechanical etc	TC verification	100%	BHEL Specification, TDC, TCC, Drawing & PO		TC & Report	V	V	Format as per BHEL TCC
2.0	In Process									
2.1	Raw Material Testing	Chemical & NDE	Report Review	100%	DO		R	P	V	NDE in Raw Material: MPI for diameter (D) <30 mm and UT for diameter (D) ≥ 30 mm For Chemical: Refer Note 2
2.2	Manufacturing & Heat Treatment process	Dimensions, Temperature, Time, Medium, HT Chart	Report Review	100%	DO		R	P	V	Refer Note 3, 4 & 5
2.3	Micro examination (Before HDG)	Laps at threaded region	Report Review	refer remarks	DO		R	P	V	Minimum 1 sample per shift
2.4	Hot Dip Galvanising (HDG)	Method of cleaning and Zinc Bath temprature	Procedure & Report Review	100%	DO		R	P	V	HDG procedure to be submitted by supplier
2.5	Hydrogen Embrittlement test	Hydrogen Embrittlement	Report Review	Minimum 2 Tests per lot	DO		R	P	V	As per EN ISO 15330 (latest). BHEL can randomly witness.
3.0	Final Inspection (*)									
3.1	Visual & Dimension (*)	Visual, Dimension, thread & Marking (identification & colour coding)	Measurement/ Thread gauge	Sampling plan (*)	DO		R	P	W	
3.2	Mechanical testing (*, #)	Hardness	Testing	DO	DO	DO	R	P	W	
		Strength under wedge load test till fracture								
		Minimum Tensile strength								
		%EL, %RA								
		Minimum stress at 0.2 % non-proportional elongation								Refer Note 6
		Proof load test								
		Impact Test								
		Decarburization test								

Prepared By
Sanju Kohli
Sr. Manager (QM)

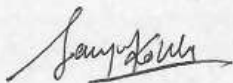


Approved By
Shelley Kohli
SDGM (QM and BE)



		BHEL: IVP Goindwal Quality Assurance		STANDARD QUALITY PLAN Item: FIT BOLT Fasteners (Bolts, Nuts and Washers)			QP No	SQP:FITBOLT:001		
							Rev	7		
							Date	27.08.2026		
							Page	2 of 3		
SN	Component & Operation	Characteristics	Type of Check	Quantum of check	Reference Document	Acceptance Norm	Format of Record	Agency		Remarks
3.3	Torque value (*)	Torque to tighten the Bolt assembly	Testing	DO	Minimum tension to be achieved as per IS 4000 table 3		R	P	W	Refer Note no 7
3.4	Chemical (*)	Chemical composition	Testing	DO	BHEL Specification, TDC, TCC, Drawing & PO		R	P	W	Spectro analysis– One sample for every heat of raw material
3.5	NDE (*)	Surface quality	Testing (visual & MPI)	DO	DO		R	P	W	
3.6	Coating	Hot Dip Galvanizing	Testing	DO	As per ISO-10684		R	P	W	Thickness to be checked
		Zinc Flake			As per ISO-10683		R	P	W	
		Sherardized			As per EN ISO 17668		R	P	W	
3.7	Packing	Packing and Marking	Verification		BHEL Specification, TCC, Drawing & PO		R	P	V	Refer Note 8
Legends: M-Manufacturer/Sub contractor, B-BHEL/Authorised inspection agency, V-Verification, W-Witness, P-Perform, R-Report, C-Customer, CHP- Customer Hold point, TC- Test Certificates										
(*) BHEL/BHEL TPIA will witness final inspection in supplier works or NABL approved Lab (#) For nut: only hardness test and Proof load test. For washers: hardness test only Note: 1. This QP shall be read along with relevant PO, TDC, applicable standards and drawings. Requirements shall be compiled. 2. NABL report per Heat of used Raw material conforming its chemical properties wrt to mill TCs. 3. Calibration certificates of all instruments and machines used during testing to be provided along with calibration certificate of furnace and thermocouple (For quenching, Tempering furnaces). 4. Internal inspection report from supplier for grade 8.8 and above, regarding sufficient hardenability to ensure a structure consisting of approximately 90 % martensite in the core of the threaded sections for the fasteners in the "as-hardened" condition before tempering as per point f of table 2 of ISO 898-1 5. Heat Treatment process to be qualified & witness by BHEL as per BHEL format (for one size of Bolt during manufacturing of First Lot) 6. Machined Bolt sample shall be prepared as per ISO 898-1 (latest). Graph from UTM mandatory. In case of samples not feasible as per ISO 898-1, IS 1608 to be used for EL and RA testing. 7. Torque values, K factor to be witnessed as per BHEL specification 8. A standardized tag format shall be attached to every gunny bag as per tender terms and conditions										

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Sr. Manager (QM)



Approved By
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SDGM (QM and BE)



	BHEL: IVP Goindwal	STANDARD QUALITY PLAN				SQP-FITBOLT:001	
		Item: FIT BOLT Fasteners (Bolts, Nuts and Washers)				QP No	Rev
						Date	27.08.2026
						Page	3 of 3

SAMPLE SIZE																Remarks
Lot Size (In nos.)	Visual (nos.)	Dimensional (nos.)	MPI (nos.)	Physical Test												
				Total (nos.)	Hardness (nos.)	Hardness after Re- Tempering (nos.)	Proof Load (nos.)	Wedge Load (nos.)	Min Tensile Strength (nos)	%EL	%RA	Minimum stress at 0.2 % non- proportional elongation	Impact test (nos)	Decarb (nos.)	Coating Thickness (nos.)	
Upto 100	20	8	15	5	5	5	2	2	2				2	1	2	2
101 to 300	32	13	15	5	5	5	2	2	2				2	1	2	2
301 to 500	50	20	15	5	5	5	2	2	2				2	1	2	2
501 to 1000	80	32	15	5	5	5	2	2	2				2	1	2	2
1001 to 3000	125	50	25	8	8	8	2	4	4				2	1	4	4
3001 to 10000	200	80	50	13	13	13	2	6	6				2	1	6	6
10001 to 35000	315	125	75	20	20	20	4	8	8				4	2	10	10
35000 to 70000	500	200	100	32	32	32	6	12	12				6	3	15	15
Inspection by BHEL/ BHEL AIA	W	W	W	W	W	W	W	W	W				W	W	W	W

Remarks:

1. Acceptance Number is zero. If the sample is having deviation in Visual, Dimensional and MPI, then the entire lot shall be 100% inspected. In case of deviations in Chemical and Physical tests, a second sample of twice the sample size of initial sample shall be taken. The lot will get rejected if the second sample fails.
2. Inspection by BHEL/BHEL AIA shown as "W" shall be witnessed for the sample size indicated against the lot size
3. Any quantity offered above 70000 nos, will be considered as a new lot and sampling plan shall be reapplied for them.
4. In physical test minimum one number per heat of raw material used to be covered.

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Sr. Manager (QM)

Approved by
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HEAT TREATMENT PROCESS CHECKLIST

Quenching & Tempering - Quality Control

Bolt Class:	
Material Spec:	
Batch/Lot Number:	
Quantity (pcs):	
Date of Treatment:	
Furnace ID & Type:	
Operator Name:	
Supervisor:	

Phase	Parameter	Requirement	Acceptance Criteria	Verified/Values Recorded	Remarks
PRE-TREATMENT INSPECTION	Visual inspection of bolts	Clean, no defects	No cracks, corrosion, or deformation	☐	
	Chemical composition verification	Cert. of Conformance	Valid CoC from supplier	☐	
	Dimensional check (length, dia)	Within tolerance	Per ISO 898-1	☐	
	Surface cleanliness	Degreased	Free of oil, grease, rust	☐	
	Initial hardness check (sample)	As received	Per batch specification	☐	
FURNACE PREPARATION	Furnace calibration	Calibration certificate	Proper validity	☐	
	Furnace temperature uniformity	Calibration certificate & Temperature recording of Thermocouples	Recorded Temperature variation between all thermocouple readings of all zones during start of soaking cycle to match with manufacturer procedure/practice#	☐	
	Thermocouples check	Functional & verified	All thermocouples working	☐	
	Interior cleanliness	Clean, no scale/debris	No contaminants	☐	
	Furnace atmosphere check	Neutral/slight oxidizing	Vendor to Confirm	☐	

LOADING & AUSTENITIZING	Ramp-up rate to austenitizing	Controlled heating	Recorded values to match with manufacturer procedure/practice#	☐	
	Austenitizing temperature	Hold within tolerance		☐	
	Temperature tolerance band	Deviation to be as minimum as possible		☐	
	Soak/dwell time	Full austenite transformation		☐	
	Temperature stability check	Stable $\pm 5^{\circ}\text{C}$ for 5 min before quench	Ready for quench	☐	
	Sample extraction (for Hardness)	Full austenite transformation (2Nos samples)	Monitor hardness trend ($\pm 2\text{HRC}$)	☐	
QUENCHING PROCESS	Quenching medium type	Oil (mineral/synthetic) as per manufacturer procedure/practice	Spec of medium to be noted	☐	
	Quenching bath temperature	Control flash point safety	Vendor to confirm	☐	
	Quenching bath volume check	Min. 3x load volume for Adequate heat capacity	Vendor to confirm	☐	
	Oil circulation system	Running during quench	Uniform cooling	☐	
	Transfer time from furnace to quench bath	Time to be as minimum as possible	Recorded value to match with manufacturer procedure/practice#		
	Quenching agitation	Moderate agitation	Avoid cracking/distortion	☐	
	Quench time in oil	Full cooling to below 40°C	Recorded value to match with requirement	☐	

	Post-quench cooling to room temp	30-40 min before tempering	Medium to be noted and should match manufacturer procedure/practice#	☐	
	Quench bath condition check	Oil clarity & no contamination	Oil change interval monitored	☐	
	Microstructure and hardness check	min. 90% martensite (2Nos samples each for both Hardness & Microstructure check)	i) Hardness levels to be uniform through the surface and core ($\pm 2\text{HRC}$) ii) Presence of min. 90% martensite during microscopic examination	☐	
TEMPERING PROCESS	Preheat temperature*	Reduce thermal shock	Recorded values to match with manufacturer procedure/practice#	☐	
	Preheat duration*	Uniform preheating		☐	
	Transfer to tempering furnace*	Transfer Time to be <5 min after preheat to Minimize surface oxidation	Recorded value to match with requirement	☐	
	Tempering furnace temperature	As per standard	Recorded value to match standard	☐	
	Tempering soak time	Full tempering	Recorded value to match with manufacturer procedure/practice#	☐	
	Temperature tolerance band	Strict control on temperature variation	Recorded value to match with manufacturer procedure/practice#	☐	
	Furnace atmosphere during tempering	Air/neutral to eliminate decarburization	Vendor to confirm	☐	

	Cooling from tempering temp	Controlled cooling to room temp naturally	Recorded cooling rate to match with manufacturers procedure/practice)#	☐	
	Final inspection after tempering & Microstructure Check	Presence of min. 90% tempered martensite (2Nos samples for Microstructure check)	i) Visual check for color/finish (Expected straw/light blue) ii) Presence of min. 90% tempered martensite during microscopic examination	☐	
POST-TREATMENT TESTING	Hardness measurement (HV/HRC)	As per standard	As per sampling plan in QP	☐	
	Hardness test location	As per IS 1367-P3	Consistent sampling	☐	
	Dimensional check post-treatment	Within tolerance	As per standard	☐	
	Surface inspection	No decarburization/cracks	Accept/Reject	☐	
	Tensile test (batch sample)	As per standard	As per ISO 898-1 min values	☐	
	Yield strength test	As per standard	As per ISO 898-1	☐	
	Ductility check (elongation %)	As per standard	Tensile test result	☐	

*(if applicable as per manufacturer's procedure)

ref: Documented procedure of Manufacturer

Heat Treatment Operator:	
Quality Inspector:	
Supervisor/Manager:	
Date:	
Batch Approved: ☐ YES ☐ NO	

Additional Technical Conditions of Contract

[Applicable for procurement of Fit Bolts, Nuts and Washers]

Ref. No.: BHEL:TCC:FitBolts:Rev00

Date: 07.08.2026

1.0 SCOPE OF WORK

1.1 This document covers design, manufacture, testing, inspection, packing, supply and delivery of Hot-Dip Galvanized (HDG) Fit Bolt Assemblies conforming to:

- a) EN 14399-1, EN 14399-2, EN 14399-8 (Fit Bolts)
- b) EN 14399-6 (Washers)
- c) EN ISO 898-1 (Mechanical Properties)
- d) ISO 10684 (HDG Fasteners)

1.2 Scope Includes:

- a) Fit bolts (precision shank)
- b) Nuts
- c) Hardened washers

2.0 MANUFACTURING TESTING FACILITY REQUIREMENTS (MANDATORY)

2.1 The following facilities shall be IN-HOUSE (OWN FACILITY ONLY). Sub-Contracting of these processes is strictly prohibited:

- a) Production Facilities: -
 - i. Cold / Hot Forging Facility
 - ii. CNC machining for Fit bolts
 - iii. Thread rolling machines
 - iv. Controlled heat treatment furnace / Facility
- b) Testing Facility: All equipment must have valid NABL calibration certification: -
 - i. Universal Testing Machine (UTM)
 - ii. Spectrometer
 - iii. Hardness tester (Rockwell & Vickers)
 - iv. Metallurgical Microscope
 - v. Torque testing facility
 - vi. Coating Thickness gauge

If testing facility is not available in house, testing shall be witnessed at NABL approved lab only.

2.2 Hot dip galvanization preferably in-house. If HDG is outsourced, a valid MoU/Agreement with the HDG sub-supplier shall be submitted.

3.0 RAW MATERIAL REQUIREMENTS (CRITICAL)

3.1 Source of Steel- Input steel for all fit bolt assemblies shall be sourced exclusively from original steel producers having valid BIS licence for IS 5517 or from their authorised dealers, stockist, channel partners with current validity. The fastener manufacturer itself cannot self-certify input steel.

3.2 Steelmaking Route

The steelmaking route and supply chain model shall be declared on every Material Test Certificate. The following requirements apply:

- a) Accepted steelmaking routes: Electric Arc Furnace (EAF) + Ladle Refining Furnace (LRF)+ Continuous Casting (CC); or Basic Oxygen Furnace (BOF) + LRF + CC
- b) Induction Furnace (IF) route is NOT permitted for Class 10.9.
- c) Vacuum Degassing: **mandatory** for all Class 10.9 bolts of diameter M24 and above. The MTC shall confirm vacuum degassing was applied to that specific heat

3.3 Material Test Certificate: Format & Content

The Material Test Certificate submitted with each consignment shall meet the following requirements:

Additional Technical Conditions of Contract

[Applicable for procurement of Fit Bolts, Nuts and Washers]

Ref. No.: BHEL:TCC:FitBolts:Rev00

Date: 07.08.2026

- a) Certificate type: MTC issued by the steel producer's Authorised inspector who is independent of the production department. The fastener manufacturer shall not re-issue, reproduce, re- certify the steel MTC under any circumstances.
- b) The testing laboratory whose results are reported on the MTC shall hold current NABL accreditation under ISO/IEC 17025:2017 or at least have all equipment calibrated NABL traceability.
- c) The following parameters shall be reported with actual numerical values on every MTC: chemical composition (C, Mn, Si, Cr, Mo, Ni, P, S, B, Al, V, Cu as applicable); non-metallic inclusion rating per IS 4163 / ISO 4967 - numerical ratings for series A, B, C, D (thin and thick) are mandatory; decarburization depth - total decarburization and free-ferrite depth in mm; Hydrogen Content ≤ 2 ppm (for larger diameters); mechanical properties (UTS, YS, elongation, reduction of area) where applicable.
- d) The heat number on the MTC shall exactly match the heat number on the physical material tag attached to the consignment and on the despatch note. Any mismatch shall be treated as a non-conformance and the consignment shall be quarantined pending clarification.
- e) For Class 10.9 bolts, the free-ferrite decarburization depth on the incoming bar or rod shall not exceed 0.05 mm absolute.
- f) Ultrasonic Testing (UT) of bar stock: for all alloy steel bar of diameter 30 mm and above used for HSFG/FIT bolt manufacture, 100% ultrasonic testing shall be mandatory. UT shall be conducted per IS 3664:1981 or equivalent international standard with acceptance criteria per EN 10308:2002. The UT test result — 'Done OK' or equivalent with defect classification — shall be reported on the MTC or on a separate UT certificate cross-referenced to the MTC heat number. Bar lots for which UT has not been conducted or reported by steel producer shall not be used for BHEL supply of Class 10.9 bolts of M30 diameter and above.

4.0 MANUFACTURING PROCESS REQUIREMENTS

4.1 Forging

- a) Closed-die forging with induction heating (preferred)
- b) Controlled temperature to prevent grain growth

4.2 Heat Treatment

- a) In House heat treatment
- b) Oil quenching with agitation control
- c) Hardness monitoring per batch

4.3 Threading

- a) Thread rolling before heat treatment (preferred)
- b) No laps, cracks, or thread defects

4.4 Fit Bolt Machining

- a) Shank tolerance: as per EN 14399
- b) Precision machining and inspection (air gauge preferred)

4.5 Hot-Dip Galvanizing (Critical for 10.9)

- a) As per ISO 10684
- b) Strict process control for:
 - i. Pickling time – to avoid potential hydrogen embrittlement
 - ii. Bath temperature – to avoid potential LME
 - iii. Fluxing
 - iv. Mandatory de-embrittlement baking:
 - 200°C $\pm$ 10°C for minimum 4 hours

Additional Technical Conditions of Contract

[Applicable for procurement of Fit Bolts, Nuts and Washers]

Ref. No.: BHEL:TCC:FitBolts:Rev00

Date: 07.08.2026

- Within 1 hour of pickling/ galvanizing (log sheet/ reports to be submitted to substantiate the same)

5.0 TRACEABILITY

- 5.1 Bolt- Manufacturer's Identification Symbol, Raw material Heat number (last 4 digits) and marking as indicated in specification is to be embossed/indented.
- 5.2 Nut- Marking as per specification to be indented only (as embossing is not allowed).
- 5.3 Washer- Marking as per specification
- 5.4 The supplier shall maintain records of raw materials, manufacturing, heat treatment, testing and inspection, along with a Raw Material Heat Number Ledger. BHEL may verify these records by conducting audits during execution of the order

6.0 MISCELLANEOUS REQUIREMENTS

- 6.1 Mandatory Technical Personnel Requirement- Manufacturer shall have one qualified full time QC Engineer on company rolls.

7.0 DOCUMENTATION & QUALITY RECORDS

- 7.1 Certification: Each dispatched lot must be accompanied by a comprehensive Quality Dossier containing:
 - a) Steel MTC: Mill Test Certificate from a original steel producer.
 - b) Heat Treatment Records: Time-Temperature charts for quenching and tempering.
 - c) Galvanizing Records: Including certificate of post-coating de-embrittlement (baking).
 - d) Mechanical & chemical properties of fasteners, including impact strength
 - e) SUT/k-factor Report: Torque-tension test results for the specific lot.
 - f) NDT Reports: Surface/ Ultrasonic test reports as per the Quality Plan.
 - g) Hydrogen Embrittlement test report/certificate
 - h) All other test results/documents as per QP (if not covered above).



Bharat Heavy Electricals Ltd.,
Tiruchirappalli -14

Doc. No: PR: CHEM: 09 - 04

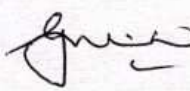
Rev: 03

Date: 01.04.2009

Page 1 of 3

PLANT LABORATORY

TECHNICAL SPECIFICATION FOR TEMPORARY RUST PREVENTIVE FLUID FOR BHEL USE TO IS 1153 (MODIFIED)

REV	DATE	PREPARED BY	REVIEWED AND APPROVED BY
03	01-04-2009	 L. Gragori DM/Plant Lab	 Dr. G. Ravichandran SDGM/Plant Lab

Controlled Copy No:	Issued to:



**Bharat Heavy Electricals Ltd.,
Tiruchirappalli -14**

Doc. No: PR: CHEM: 09 – 04

Rev: 03

Date: 01.04.2009

Page 2 of 3

Record of Revisions

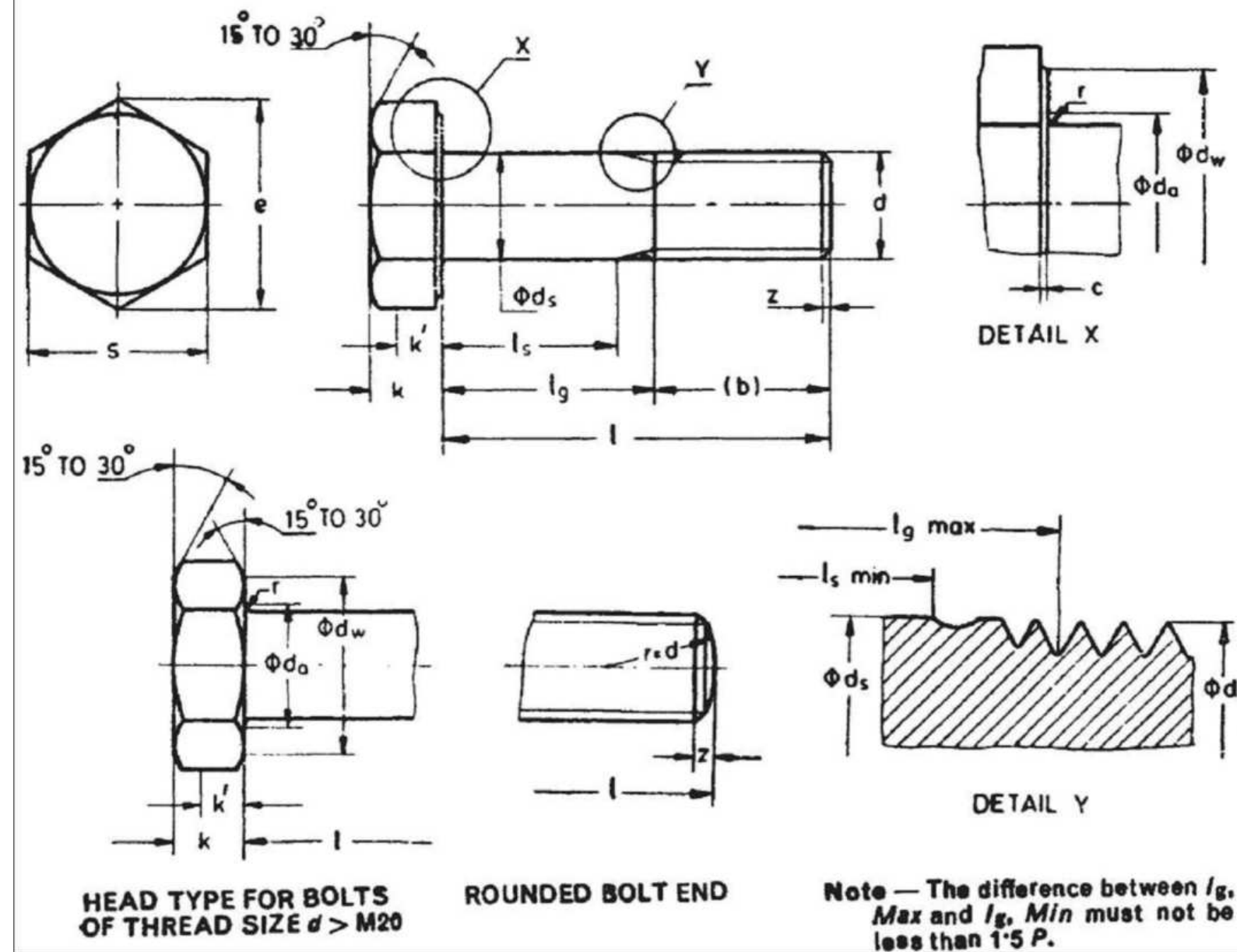
Rev. No	Date	Details of Revision	Remarks
00	05.11.1992	NEW	----
01	04.04.1995	Sl.No. 1,3 & 5 modified	Quality improvement
02	20.05.2003	Sl.No. 8 Temperature Resistance Newly added	Based on Valves Requirement
03	01.04.2009	Editorial corrections made & new requirements added in Sl.No. 6, 12 & 16. Other Sl. No. Changed accordingly.	SSTP's additional requirements as given in TDC/CHEM/06 added.



REQUIREMENTS FOR TEMPORARY RUST PREVENTIVE FLUID

1	Specific Gravity at ambient temperature	0.85 - 0.95
2	Flash Point °C (min)	40
3	Drying time : Surface Dry (Hours, max)	½
	Tack free (Hours, max)	4
4	Dry film thickness (Microns) per coat-min	20
5	Ford cup Viscosity (No.4) seconds at ambient temperature	25 ± 5
6	Odour	No objectionable Odour
7	Film type Transparent/Translucent	Transparent
8	Application Method	Brush/Spray
9	% Non- Volatiles by mass	55 ± 5
10	Temperature Resistance of RPF film at 50 °C (for 6 hrs)	To pass test.
11	Corrosion Protection under conditions of condensation for 300 hours.	No sign of corrosion.
12	Liebermann –Storch test for the detection of natural resin & its derivatives	No development of pink colour – indicating absence of natural resin.
13	Salt spray test for 72 hours	No sign of corrosion.
14	Outdoor durability	The coating shall not crack or turn opaque when exposed to out door, unsheltered condition for 1 year.
15	Scratch Hardness test (Under load of 1000 g as per IS 101 (Latest)	To pass test
16	Compatibility with Alkyd /Lacquer based paints.	Compatible.
17	Keeping Property – Months (Shelf life) min.	12
18	General conformance to I.S Specification	IS 1153 (Latest)
19	Packing standard/markings	Supply in 200/20/10 Lt. Barrels as per PO indicating the following. Rust Preventive fluid for BHEL use only. Supplier's Name: Batch No: Date Quantity: Shelf Life: BHEL Specn.PR:CHEM:09-04 (latest)
20	Test certificate	The supplier shall furnish test certificate for the above requirements Sl.No.1 to 16 in duplicate.

DRAWING NO:
3-35-700-06802

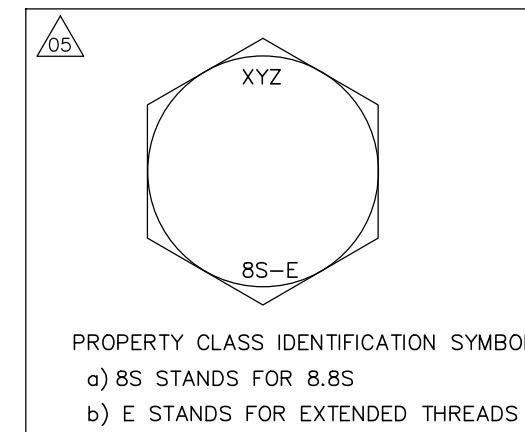


HSGF BOLT FIGURE AS GIVEN IN IS-3757 STANDARD

Sl.No	Bolt Variant	l (mm)	b (mm)	l _g (mm)	Bolt head color
1	M24X70-Extended	70	65	5	Red
2	M24X90-Extended	90	70	20	Green
3	M24X130-Extended	130	80	50	Orange
4	M24X170-Extended	170	80	90	Blue
5	M24X200-Extended	200	80	120	Yellow

NOTES:

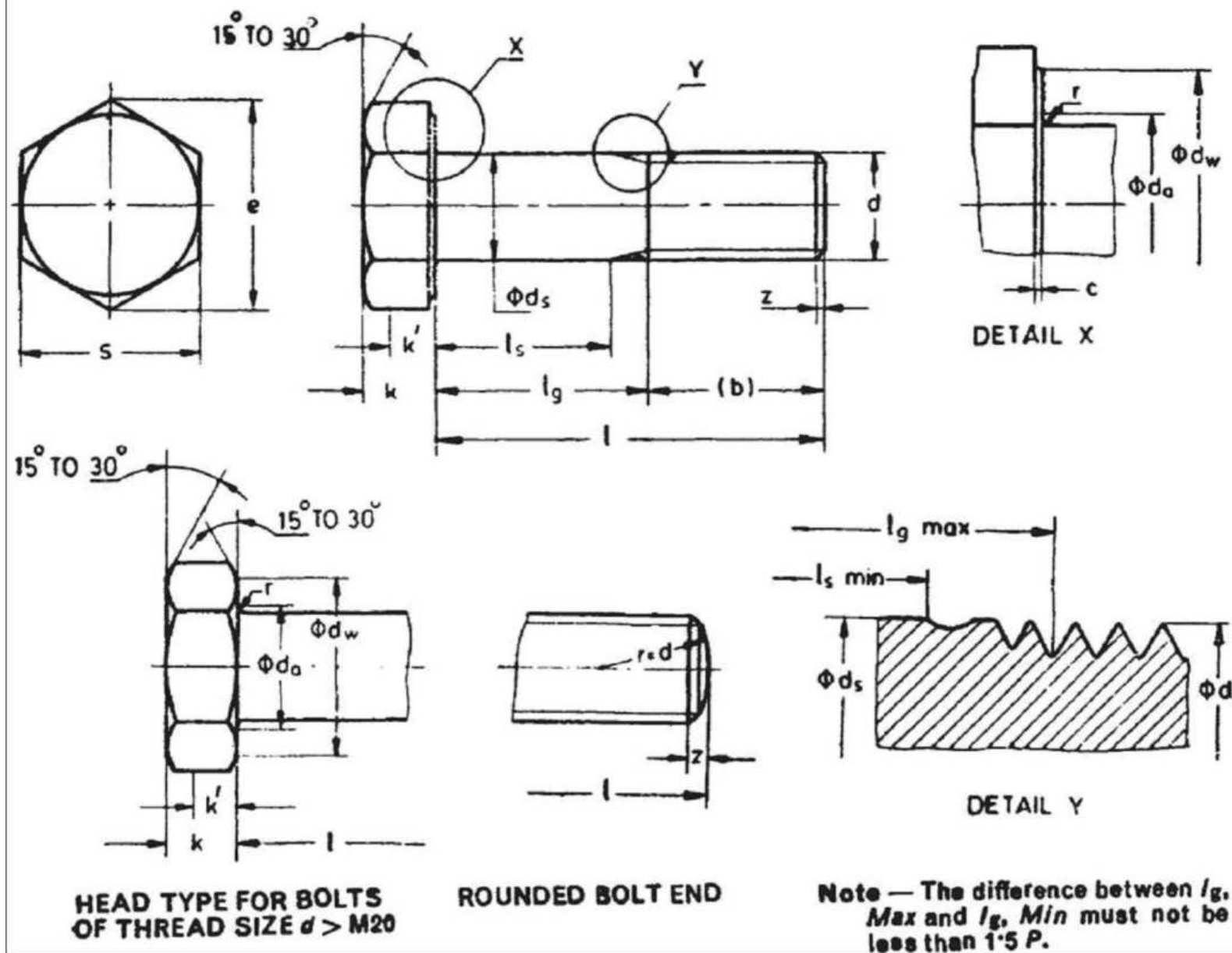
1. THE THREADED PORTION AND SHANK LENGTH ARE TO BE FOLLOWED AS PER TABLE
2. OTHER DIMENSIONS ARE AS PER IS-3757 STANDARD
3. BOLTS PROPERTY CLASS 8.8.



REV	DATE	ALTERED : PRAVEEN	REV	DATE	ALTERED : K.S.PANDIAN
06	28.10.2023	CHD & APPD: GANESAN	03	25-04-2019	CHD & APPD: MUTHU.S
		M24X200 - EXTENDED ADDED.			SKETCH RESIZED
REV	DATE	ALTERED : R.GOVINDASAMY	REV	DATE	ALTERED : SHAILESH
05	21.10.2022	CHD & APPD: S.MUTHU	02	16.08.2018	CHD & APPD: MPN/MUTHU.S
05		PROPERTY CLASS IDENTIFICATION SYMBOL ADDED.			NOTES NO.03 ADDED.
REV	DATE	ALTERED : K.PRAKASH	REV	DATE	ALTERED : MUTHU
04	01.11.2019	CHD & APPD: YUVARAJ.S	01	21.07.2018	CHD & APPD: SARAVANA
		TABLE UPDATED WITH COLOR REQUIREMENT ON BOLT HEAD			DIMENSIONS UPDATED IN FIGURE

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TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT				DRN	NAME SHAILESH	SIGNATURE	DATE 08.06.18
 Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI - 620014 355-055				CHD	MPN/MUTHU		08.06.18
				APPD	SHANMUGAM		08.06.18
DEPT ST	ALL DIMENSIONS ARE IN MM	PROJECTION	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG		
CODE 122							
TITLE M24X70,90,130 170-EXTENDED THREAD-HSGF BOLTS					DRAWING NO : 3-35-700-06802		REV 06

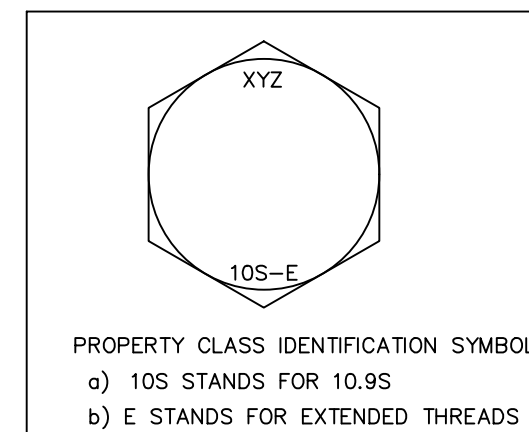


HSFG BOLT FIGURE AS GIVEN IN IS-3757 STANDARD

Sl.No	Bolt Variant	l (mm)	b (mm)	lg (mm)	Bolt head color
1	M30X90-Extended	90	70	20	GREEN
2	M30X130-Extended	130	80	50	ORANGE
3	M30X170-Extended	170	90	80	BLUE
4	M30X200-Extended	200	80	120	YELLOW
5	M30X230-Extended	230	80	150	RED

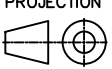
NOTES:

1. THE THREADED PORTION AND SHANK LENGTH ARE TO BE FOLLOWED AS PER TABLE
2. OTHER DIMENSIONS ARE AS PER IS-3757 STANDARD
3. BOLTS PROPERTY CLASS 10.9.

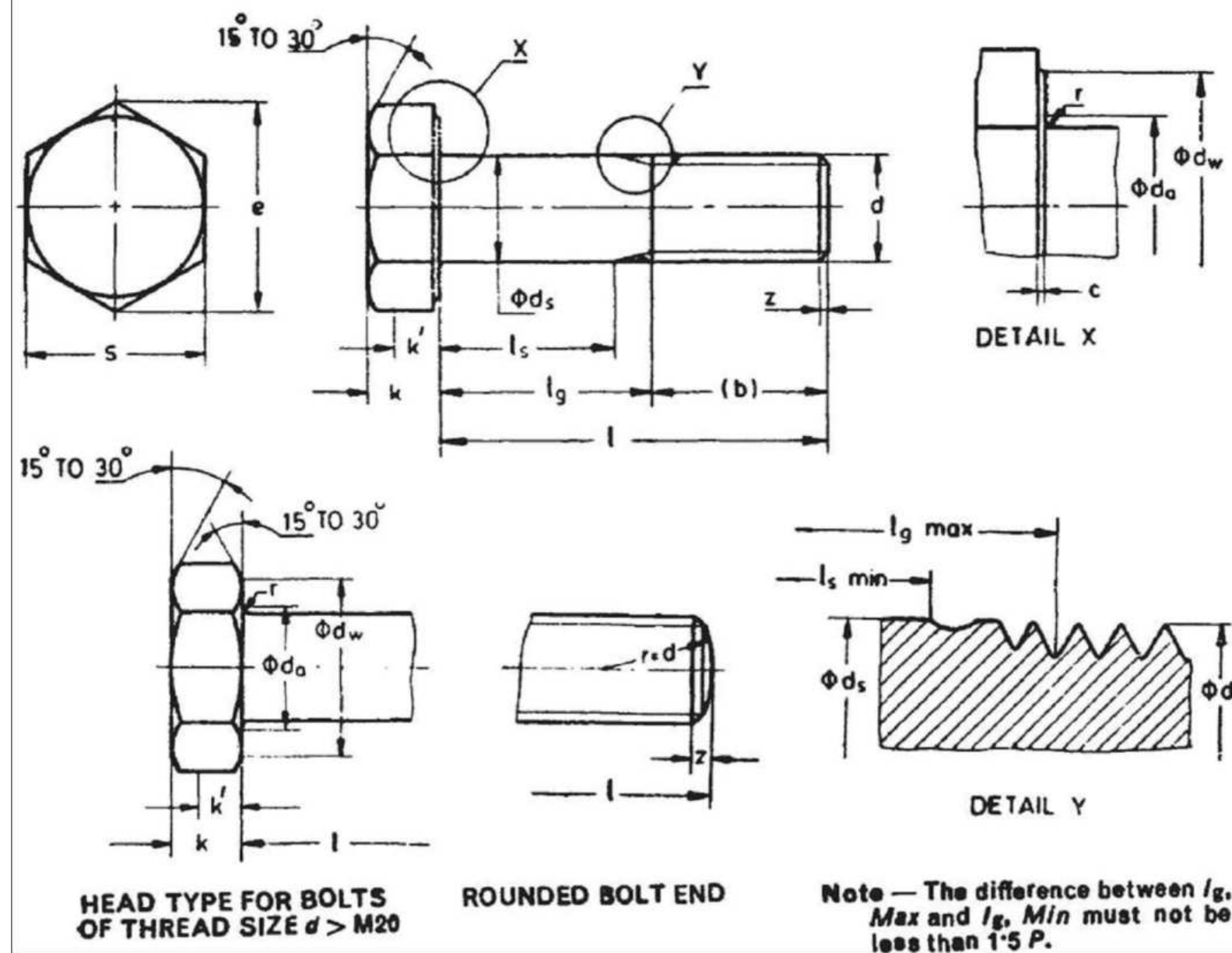


REV	DATE	ALTERED : SUBATHRA DEVI P
01	27.05.2026	CHD & APPD: ASHWIN
		M30 X 230 VARIANT ADDED

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TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT			
 355-055	Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI - 620014		
	DRN	NAME S.SETHUPATHI	SIGNATURE DATE 30.04.2022
	CHD	KRG/MPN/VRS/AGN/YUVA	30.04.2022
DEPT ST	ALL DIMENSIONS ARE IN MM	PROJECTION 	SCALE
CODE 122		WEIGHT (Kg)	REF TO ASSY / OLD DWG
TITLE M30X90,130,170&200-EXTENDED THREAD-HSFG BOLTS			DRAWING NO : 3-35-700-09999
			REV 01

3-35-700-09998

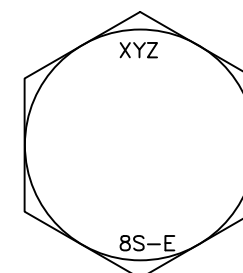


HSFG BOLT FIGURE AS GIVEN IN IS-3757 STANDARD

Sl.No	Bolt Variant	l (mm)	b (mm)	lg (mm)	Bolt head color
1	M20X60-Extended	60	55	5	MAGENTA
2	M20X90-Extended	90	70	20	GREEN
3	M20X130-Extended	130	70	60	ORANGE
4	M20X160-Extended	160	70	90	INDIGO

NOTES:

1. THE THREADED PORTION AND SHANK LENGTH ARE TO BE FOLLOWED AS PER TABLE
2. OTHER DIMENSIONS ARE AS PER IS-3757 STANDARD
3. BOLTS PROPERTY CLASS 8.8.



PROPERTY CLASS IDENTIFICATION SYMBOL

- a) 8S STANDS FOR 8.8S
b) E STANDS FOR EXTENDED THREADS

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TYPE OF PRODUCT
OR NAME OF
CUSTOMER/PROJECT



Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI – 620014

355-055

DRN	NAME S.SETHUPATHI	SIGNATURE	DATE 30.04.2022
CHD	KRG/MPN/VRS/AGN/YUVA		30.04.2022
APPD	K.RAJMOHAN		30.04.2022

DEPT _____

ST

ALL
DIMENSIONS
ARE IN MM



SCALE

WEIGHT (Kg)

	REF TO ASSY / OLD DWG
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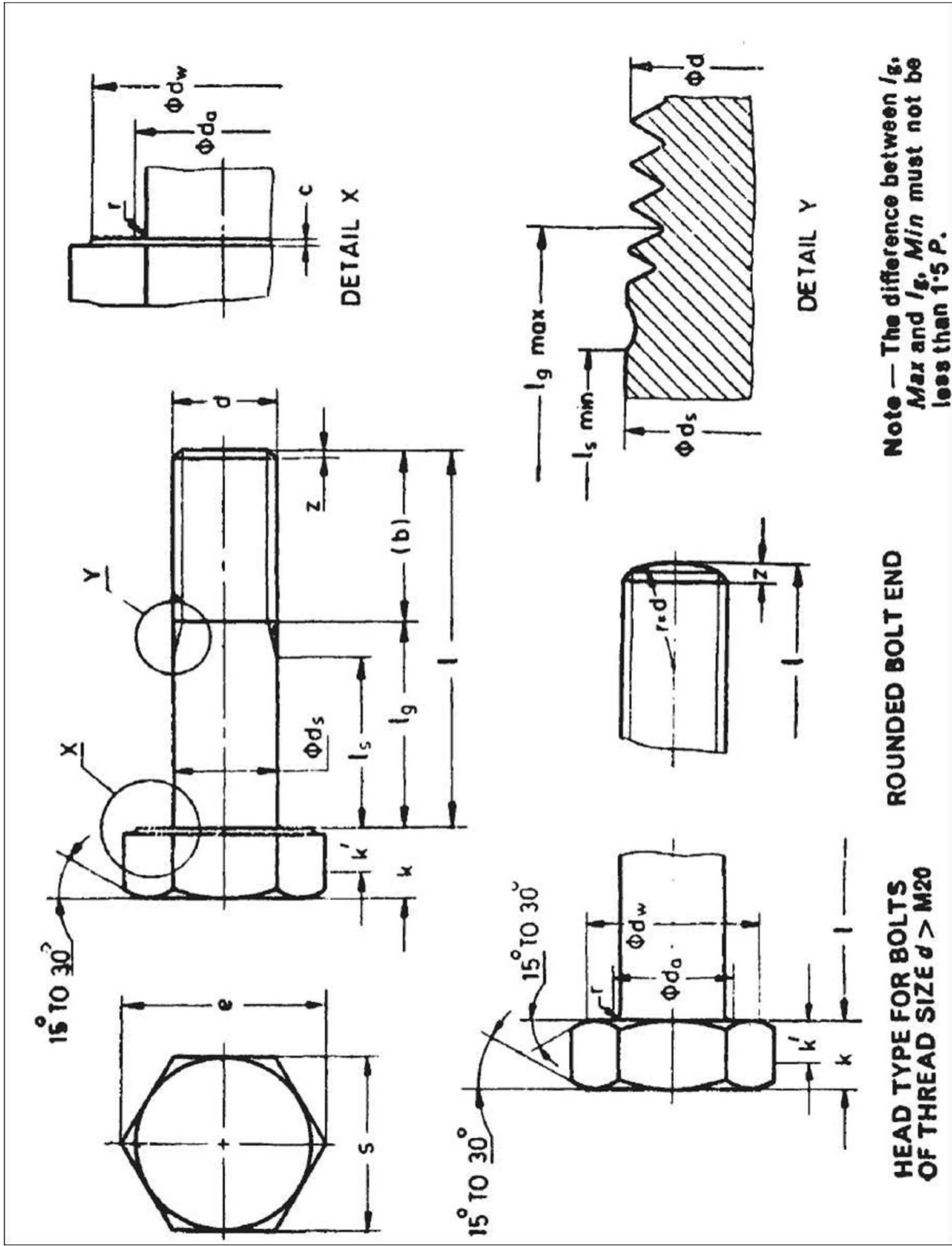
TITLE
M20X60,90,130&160-EXTENDED
THREAD-HSFG BOLTS

DRAWING NO :	REV
3-35-700-09998	00

REV

DRAWING NO:

0-86-700-A0323

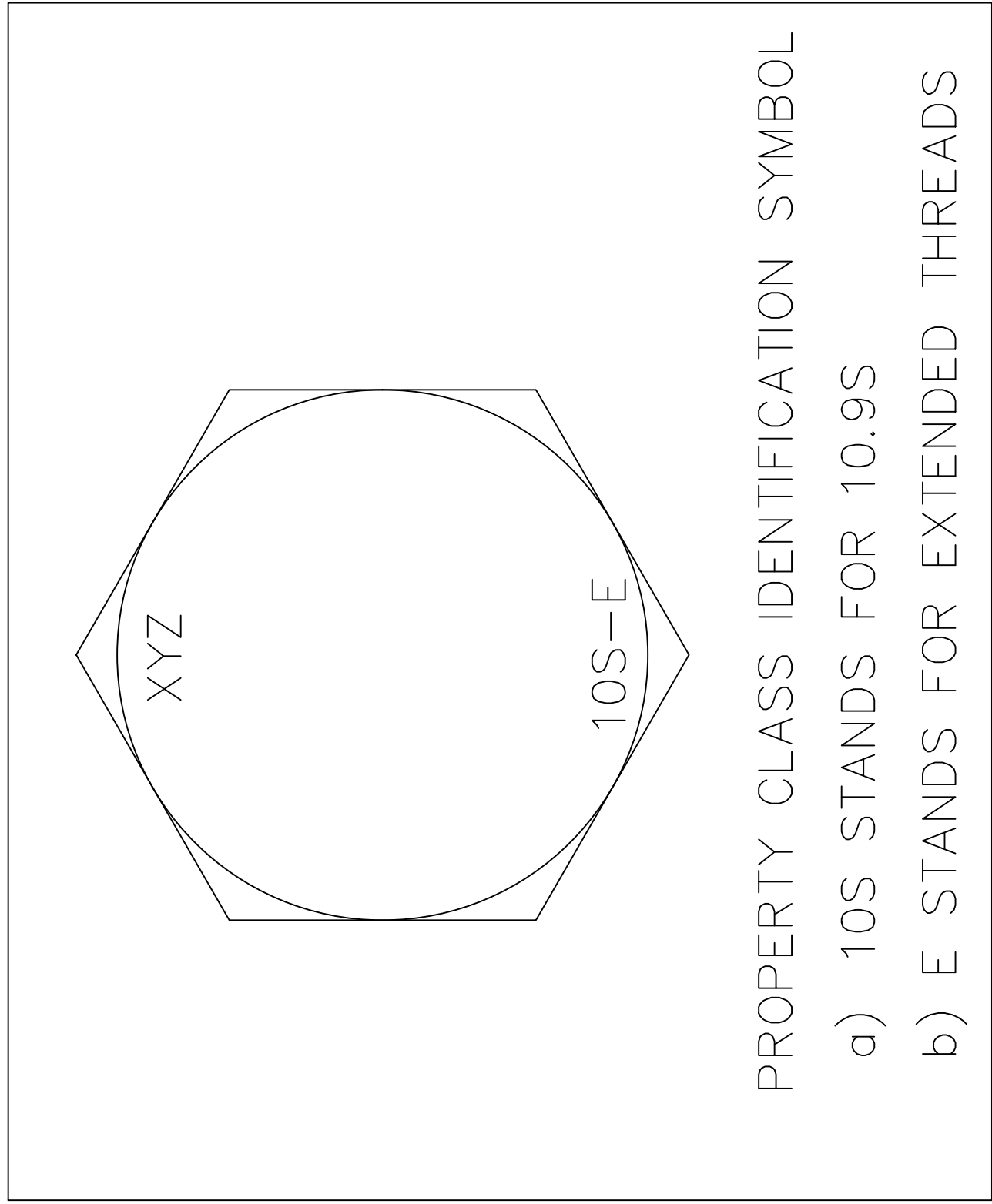


HSFG BOLT FIGURE AS GIVEN IN IS-3757 STANDARD

Sl.No.	Bolt Variant	l(mm)	b(mm)	lg(mm)	Bolt head colour
1	M36X100-Extended	100	85	15	GREEN
2	M36X120-Extended	120	85	35	ORANGE
3	M36X140-Extended	140	95	45	BLUE
4	M36X160-Extended	160	95	65	YELLOW
5	M36X190-Extended	190	105	85	RED

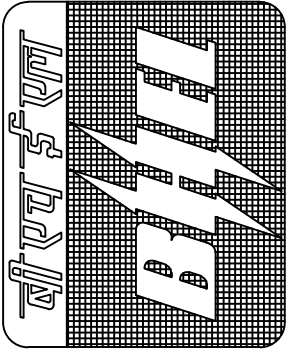
NOTES:

- THE THREADED PORTION AND SHANK LENGTH ARE TO BE FOLLOWED AS PER TABLE
- OTHER DIMENSIONS ARE AS PER IS-3757 STANDARD
- BOLTS PROPERTY CLASS 10.9.



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TYPE OF PRODUCT
OR NAME OF
CUSTOMER/PROJECT



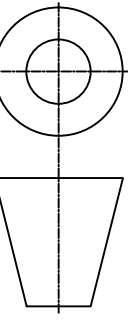
355-055

DEPT
CODE

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497

ALL
DIMENSIONS
ARE IN MM

PROJECTION



SCALE

WEIGHT (Kg)

DRN
CHD
APPD

NAME
JKJ
JKJ/PC/KD/NK/AKT/RK
TMSR

SIGNATURE
DATE
14.02.2024
14.02.2024
14.02.2024

TITLE
M36X100,120,140,160&190-EXTENDED
THREAD-HSFG BOLTS

DRAWING NO :
0-86-700-A0323

REV
00

CORPORATE DRG ID:TP-DG-0-86-700-A0323/00

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:5:215 Rev: 03 Effective Date: 08/08/2026 Page: 1 of 8
Product: Extended Thread High Strength Friction Grip Fasteners For Structural (Property class Bolt 8.8,10.9/ Nut 8 &10)		

Revision record:

Rev 00: Dt 14/11/2019 – Fresh issue

Rev01 : Dt 12/08/2022 –In clause 1.0,5.0,6.0, class 10.9 for bolts & 10 for nuts included, Drawing no's removed in Clause 1.0,3.0 &6.0. Weight of bags included in Cl 6.0

Rev02 : Dt 08/08/2024 – Clause 6.0 Packing condition & RPF specification modified.

Rev03 : Dt 08/08/2026- Clause 1.0 TDC 5 211 removed, Clause 2.0 Steel making &MTC requirements newly added, Clause 5 ,Table sl no 2,3& 8 modified,10-11 added.
Clause 6.0& 7.0 modified.

1. SCOPE:

This technical delivery condition document covers the requirements for the High strength structural steel bolts, Nuts and Washers applicable for boiler structures and shall be procured from the BHEL approved manufacturers only. The mandatory requirements, test methods and procedures from the applicable IS standards to confirm a product to its relevant latest IS standard shall be met with. TDC is in addition to specification. **TDC: 5:211 (Dt 28.10.2014) is obsolete and this TDC supersedes for normal HSFG bolts requirements**

Size, Specification and Qty: As per BHEL Purchase order (PO) / BHEL Drawing. The bolts, nuts and washers shall be supplied in the dull black heat treated condition with rust preventive fluid (RPF) as per Clause 6.0.

For Bolts: As per BHEL drawing as indicated in the Purchase order.

and IS: 3757 (Latest) Property class: 8.8,10.9. Product Grade C of IS Specification IS: 1367 Part 2 (Latest).

For Nuts: IS: 6623 (Latest) Property class: 8 & 10, Product Grade B

For Washers: IS: 6649 (Latest) Material: 45C8, Type-A: Plain hole Circular Washers. Grade: Ordinary

2. RAW MATERIAL & STEEL MAKING :

Bolts and Nuts: Rolled/Forged bar ~~of IS5517~~. Washer: as per IS 1571 Part 2 (Latest)

Chemical composition: Shall be checked on receipt of raw material at supplier works for every heat

Bolts: Alloy steel, Plain Carbon Steel, Carbon steel with additives (e.g. Br, Mn or Cr) **quenched and tempered for Class 8.8** – As per Table 2 of IS: 1367 Part 3)

Alloy steel quenched and tempered for Class 10.9 – As per Table 2 of IS: 1367 Part 3)

Nuts: As per Table 4 of IS 1367 Part 6 (Latest)

Washers: As per IS 1570 Part 2 and Sulphur, Phosphorous <0.06% in check analysis

The chemical composition requirements are mandatory and shall be evidenced by actual numerical values on the Material Test Certificate (MTC) issued by the steel producer for every heat of steel received. pass/ Fail statements are not acceptable. For the materials of the property classes: 8.8,10.9, there shall be a sufficient hardenability to ensure a structure consisting of approximately 90 % martensite in the core of the threaded sections for the fasteners in the “as-hardened” condition before tempering.

The alloy steel shall have sufficient Chromium (Cr) and Molybdenum (MO) content to achieve the through-hardenability requirements. While grades like 42CrM04 (per EN 10083-3) or SAE 4140 are acceptable, the manufacturer must ensure at their end that the specific alloy chemistry is capable of achieving approximately 90% martensite in the core of the threaded section in the "as-hardened" condition (before tempering).

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:5:215 Rev: 03 Effective Date: 08/08/2026 Page: 2 of 8
Product: Extended Thread High Strength Friction Grip Fasteners For Structural (Property class Bolt 8.8,10.9/ Nut 8 &10)		

The MTC shall explicitly state the standard grade designation. Where international equivalents (EN/SAE/AISI) are used in lieu of IS 5517 (Latest) prior approval from BHEL is required. The limits for Sulphur (S), Phosphorus (P) and Boron (B) content be strictly maintain as per IS 1367-3 (latest). If Boron exceeds 0.001%. Aluminium (Al) shall be suitably added to achieve the desired metallurgical properties. In case of Steels with Boron, the content of Boron must be clearly declared in the MTC.

Enhanced Alloying for Large Diameters: For bolt diameters M30 and above, the manufacturer shall ensure enhanced alloying (specifically Cr and Mo) to guarantee through-hardening and prevent brittle “snapping” in the core.

Vacuum Degassing: mandatory for all Class 10.9 bolts of diameter M24 and above. The MTC shall confirm vacuum degassing was applied to that specific heat.

For steel processed via the VD routes the Hydrogen H₂ content' shall be measured and reported in the MTC. Hydrogen Content shall be ≤ 2 ppm (for larger diameters M 30 and above)

For Class 10.9 bolts, the free-ferrite decarburization depth on the incoming bar or rod shall not exceed 0.05 mm absolute

The Specific chemical limits and hardenability requirements stated in this clause shall take precedence over general limits provided in IS 5517 or any other international standards for raw material.

Steelmaking route:

The steelmaking route and supply chain model shall be declared on every Material Test Certificate (MTC).

The following requirements apply:

Accepted steelmaking routes: Electric Arc Furnace (EAF) + Ladle Refining Furnace (LRF)+ Continuous Casting (CC); or Basic Oxygen Furnace (BOF)+LRF+CC
Induction Furnace (IF) route is NOT permitted for Class 10.9.

Manufacturing process requirements

Heat treatment

- Oil quenching with agitation control
- Hardness monitoring per batch

Threading

- Thread rolling before heat treatment
- No laps, cracks, or thread defects

3. DIMENSIONS AND TOLERANCES:

- **Process:** Cold/Hot Forging with Dies and tools clean of loose scale and sheet particles.
- Threads on the bolts shall be checked with a properly calibrated ring gauge with a tolerance class 6g. Threads on the nuts shall be checked with a properly calibrated plug gauge with tolerance class 6H in an NABL accredited LAB.
- Dimensions of the Bolts shall be as per BHEL drawing as indicated in the Purchase order.
- Dimensions of the Nuts shall be as per the table given in IS: 6623 (Latest)
- Dimensions of the Washers shall be as per the table given in IS 6649 (Latest)

Note: The washers shall be flat with a maximum deviation not exceeding 0.25 mm from the straight edge laid along a line passing through the center of the hole. The hole of the washer shall be concentric with the outside dimensions within 0.50 mm. washers are required to be clipped to provide clearance, the clipped edge shall not be closer to the center of the washer than 0.9 of the bolt diameter.

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:5:215 Rev: 03 Effective Date: 08/08/2026 Page: 3 of 8
Product: Extended Thread High Strength Friction Grip Fasteners For Structurals (Property class Bolt 8.8,10.9/ Nut 8 &10)		

4. Post Forming Heat Treatment (HT):

- **Bolt:** After forming shall be quenched (HT at AC 3 temperature, with soaking time 30minutes per inch followed by quenching) and tempered (at 425°C min, 60 minutes per inch). There should be a sufficient hardenability to ensure a structure consisting of approximately 90 % martensitic in the core of the threaded sections for the fasteners in the as-hardened condition before tempering.
- **Nut:** Shall be hardened and then tempered (at a temperature of 425°C minimum).
- **Washer:** Shall be hardened and tempered. Carburized washers are not permitted.

5. CHEMICAL & MECHANICAL & NDE: (on Heat Treated finished product)

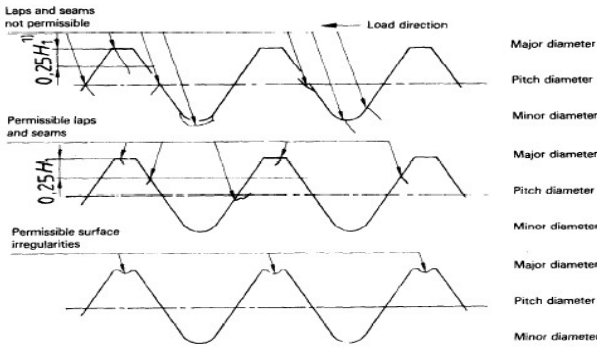
Sample Size for Mechanical test: & NDE: As per Sampling Plan

BOLT :

Sl	Test	Test Method - As per Table 3 of IS: 1367 Part 3 (Latest)	Acceptance
1	Chemistry	Spectro / Wet Analysis Method – One sample for every heat Of raw material and One sample/HT batch on product	As per Cl 2.0 of this TDC
2	Hardness Test	Note: Surface hardness shall not be more than 30 Vickers above the measured core Hardness on the product when readings of both surface and core are carried out at HV 0.30.	8.8 – Min 255 HV Max 335 HV 10.9- Min 320 HV Max 380 HV
	Impact Strength	Values are determined at a test temperature of –20 °C	27 J min
3	Minimum Tensile Strength, Yield,%Elongation on 5.65√A, % Reduction in Area after fracture	Axial tensile test must be performed and witnessed by BHEL along with graph from UTM. In case of samples not feasible as per IS 1367 P3, IS 1608 to be used for EL and RA testing.	8.8 – 830N/mm ² , 12 min, 52% min 10.9-1040N/mm ² , 9 min, 48% min
4	Proof Load Test	8.8 – Proof Load of M20 (147KN), M24 (212KN), M30 (337KN), M36 (490KN) 10.9 – Proof Load of M20 (203KN), M24 (293KN), M30 (466KN), M36 (678)KN	Length of the bolt after loading shall be the same as before loading within a tolerance of ± 12.5 µm allowed for measurement error.
5	Strength under Wedge load test	IS: 1367 Part 3 (Latest)	8.8 – 830N/mm ² 10.9– 1040 N/mm ²
6	Decarburization Test at 200X min magnification	Determination of the following by MICROSCOPIC Method a) Minimum Height of non decarburized thread zone – E b) Maximum depth of complete decarburization – G	E = 2/3 H1 G = 0.015 mm
7	Hardness after Retempering	IS: 1367 Part 3 (Latest) test not mandatory, to be applied in case of dispute only	Reduction of hardness 20 HV max.
8	NDE for Surface Integrity	before machining – For bar Diameter ≥ 30 mm: UT as per ASTM A388. For bar Diameter < 30 mm: MPI as per ASTM E 709 After machining – MPI as per ASTM E 709 or as per ISO 6157 Part 3 (Latest)	UT – ASME SEC-VIII. Div-II Part: 3.3.4 (Latest). MPI – Linear indications like cracks, folds & other injurious defects are not acceptable.



Product: Extended Thread High Strength Friction Grip Fasteners For Structural (Property class Bolt 8.8,10.9/ Nut 8 &10)

9	Micro Examination for Surface Integrity – Laps at threaded region.	If any defectives found in visual and NDE examinations, the extent of defect can be determined by micro examination. 	Max depth of laps in thread = 0.41 mm Laps of any depth or length are not permitted in the following places: • at the root of the thread • at the loaded flank of screw thread below the pitch diameter, even if they start beyond the pitch diameter. The following laps are permissible : • laps in the crest of the threads of 0.25 H1 max.; • crest of the threads not entirely rolled out, maximum half a turn on one thread; • laps below the pitch diameter, if they run on the non-loaded flank towards the major diameter and not deeper than 0.25 H1 and not longer than half a turn on one thread.
10	Torque—Tension (k.-factor) test	As per IS 4000 minimum tension to be achieved Each lot shall be tested.	
11	Additional Mandatory tests (document review)	Non-metallic inclusion rating as per IS 4163/ ISO 4967 Hydrogen content (for large dia bolts M 30 and above) Microstructure documentation.	

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:5:215 Rev: 03 Effective Date: 08/08/2026 Page: 5 of 8
Product: Extended Thread High Strength Friction Grip Fasteners For Structural (Property class Bolt 8.8,10.9/ Nut 8 &10)		

NUT: (on Heat Treated finished product)

Sl	Test	Test Method	Acceptance Value
1.	Chemistry	Spectro / Wet Analysis Method – For every heat of raw material and, One sample/HT batch on product	As per Cl 2.0 of this TDC
2.	Hardness Test	Hardness of the test mandrel shall be minimum 45 HRC.	Min 272 HV Max 372 HV
3.	Proof Load Test	Proof Load of 8S – Proof Load of M20 (263.4KN), M24 (379.5KN), M30 (603.1KN), M36 (878.3KN) 10S -M20 (305KN), M24 (439.5KN), M30 (698.4KN), M36 (1017.2KN) shall be applied axially to the nut in a tensile testing machine for 15sec.	The nut shall resist the load without failure by stripping or rupture, and shall be removable by the fingers after the load is released.
4.	NDE for Surface Integrity	Before coating, as per IS 1367 Part 10 Cl 4.2 (Latest)	Linear indications like cracks, folds & Other injurious defects are not acceptable.

WASHER: As per IS 5369. The washers shall be free from cracks, burrs, pits and other defects. All sharp edges shall be removed.

Sl	Test	Test Method	Acceptance Value
1.	Chemistry	Spectro / Wet Analysis Method – For every heat Of raw material and One sample/HT batch batch on product.	As per Cl 2.0 of this TDC
2.	Hardness Test	IS 1586 (latest)	Min 35 HRC Max 45 HRC

6. MARKING, PRESERVATION AND PACKING:

The following to be hot stamped or embossed on the top surface of the bolt and nut:

Bolt- Manufacturer's Identification Symbol and 8.8S,10.9S, **Raw material Heat number (last 4 digits) and marking as indicated in specification is to be embossed/indented.**

Nut- Manufacturer's Identification Symbol and 8S,10S (as embossing is not allowed).

Washer- Marking as per specification Shall be identified by – the provision of 2 nibs and manufacturers identification symbol being placed as near to the outer edge as possible

The supplier shall maintain records of raw materials, manufacturing, heat treatment, testing and inspection, along with a Raw Material Heat Number Ledger. BHEL may verify these records by conducting audits during execution of the order

The following details shall be clearly indicated in the tags tied to the bundle:

1) Customer Name 2) Manufacturer's Name 3) Vendor Code 4) Purchase Order No and Supplier Internal W.O No 5) Quantity and Weight 6) BHEL Material Code 7) Item Description with diameter, length 8) **Torque value, K factor, Raw material Heat no to be indicated on TAG with gunny bag. Torque value and K factor to be witnessed by BHEL**

Colour coding: To be done only on bolt head as per BHEL drawing as indicated in the Purchase order.

The bolts shall be supplied in the dull black heat treated condition with rust preventive fluid (RPF) as per BHEL specification PR: Chem:09-04 confirming to IS 1153(Latest).

Bolts shall be packed in Polythene lined Hessian Cloth/Bag not exceeding 25kgs and shall be put inside wooden boxes with maximum weight of 3 MT for each box & there shall be no mixing of two or more sizes in single box.

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:5:215 Rev: 03 Effective Date: 08/08/2026 Page: 6 of 8
Product: Extended Thread High Strength Friction Grip Fasteners For Structurals (Property class Bolt 8.8,10.9/ Nut 8 &10)		

7. INSPECTION AND CERTIFICATION:

All the finished components shall be visually and dimensionally inspected as per sampling plan. All the test results shall be documented and maintained. Products to be inspected at works & test certificates (in English) shall be submitted with the following details counter signed by BHEL/BHEL Authorized Inspection agency as indicated in the PO. Manufacturers Test certificate (MTC) shall contain the following:

- 1) Purchase Order No. (BHEL), TDC No, Specification and Grade.
- 2) Name of raw material bar supplier.
- 3) Bolt manufacturing process flow
- 4) Dimensional reports for each product (Annexure).
- 5) Chemistry including incidental elements on the raw material and final product checked in NABL lab/ suppliers own lab (ISO/IEC 17025:2017 accreditation).
- 6) HT details of materials temperature, soaking time, ROH/ROC medium, Time-Temperature charts for quenching and tempering etc.
- 7) All Mechanical test result report including tensile strength, yield, % Elongation, % RA, hardness & Impact strength.
- 8) MPI/ UT, Micro examination and decarburization test report with the reference & acceptance standard.
- 9) TC of raw material from a original steel producer, UT/MPI report done on raw material shall accompany the MTC.
- 10) Torque-tension test results with Torque value and K factor for the specific lot.
- 11) TC for rust preventive fluid as per PR: Chem:09-04, (Latest)
- 12) Non-metallic inclusion rating per IS 4163 /ISO 4967 - numerical ratings for series A, B, C, D (thin and thick) are mandatory
- 13) Report for 90% martensite in the core of the threaded section before tempering.
- 14) The detail reports for the tests conducted to be enclosed as Annexures with MTC.

8. AUDITS AT BHEL:

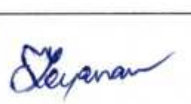
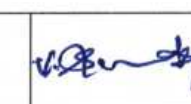
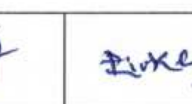
BHEL reserve the right to reject any item found to be not meeting the requirements during tests at supplier works or during subsequent processing at BHEL.

TEST SAMPLING PLAN FOR HSFG BOLTS, NUTS & WASHERS FOR BHEL TDC: 5:215

Lot Size (In nos.)	SAMPLE SIZE															Remarks
	Visu al (nos .)	Dimen sional (nos.)	MPI (nos.)	Physical Test												
				Total (nos.)	Hardn ess (nos.)	Hardnes s after Re- Temperi ng (nos.)	Pro of Loa d (nos .)	Wed ge Load (nos.)	Min Tensil e Streng th (nos)	%E L	%R A	Minimum stress at 0.2 % non- proportion al elongation	Impa ct test (nos)	Dec arb (no s.)	Coatin g Thickn ess (nos.)	
Upto 100	20	8	15	5	5	5	2	2	2			2	1	2	2	
101 to 300	32	13	15	5	5	5	2	2	2			2	1	2	2	
301 to 500	50	20	15	5	5	5	2	2	2			2	1	2	2	
501 to1000	80	32	15	5	5	5	2	2	2			2	1	2	2	
1001 to 3000	125	50	25	8	8	8	2	4	2			2	1	4	4	Upto 1500 nos 15 nos. for MPI
3001 to 10000	200	80	50	13	13	13	2	6	2			2	1	6	6	Upto 5000 nos 25 nos. for MPI
10001 to 35000	315	125	75	20	20	20	4	8	4			4	2	10	10	Upto 15000 nos 50 nos. for MPI
35000 to 70000	500	200	100	32	32	32	6	12	5			6	3	15	15	Upto 50000 nos 75 nos. for MPI
Inspection by BHEL/ BHEL AIA	W	W	W	W	W	W	W	W	W			W	W	W	W	

Remarks:

1. Acceptance Number is zero. If the sample is having deviations in Visual, Dimensional and MPI then the entire lot shall be 100% inspected. In case of deviations in Physical tests a second sample of twice the sample size of initial sample shall be taken. The lot will get rejected if the second sample fails.
2. Inspection by BHEL/BHEL AIA shown as "W" shall be witnessed for the sample size indicated against the lot size
3. Any quantity offered above 70000 nos, will be considered as a new lot and sampling plan shall be reapplied for them.
4. In physical test minimum one number per heat of raw material used to be covered.

					
Dr. T Sriharsha SM/QA	M. Jeyaram SM /QA	B Sriram Manager/MM	V Saravanakumar DGM/Engg	Ravi Tirkey SM/QC	Dr. V Deepesh DGM/QA
Prepared	Reviewed				Approved

Additional Technical Conditions of Contract

[Applicable for procurement of HSFG Bolts, Nuts and Washers]

Ref. No.: BHEL:TCC:HSFG:Rev00

Date: 20.08.2026

1.0 SCOPE

- 1.1 This document covers design, manufacture, testing, inspection, packing, supply and delivery of HSFG Assemblies i.e. Bolts, Nuts & Washers.

2.0 MANUFACTURING TESTING FACILITY REQUIREMENTS (MANDATORY)

- 2.1 The following facilities shall be IN-HOUSE (OWN FACILITY ONLY). Sub-Contracting of these processes is strictly prohibited:

- a) Production Facilities: -
 - i. Cold / Hot Forging Facility
 - ii. Thread rolling machines
 - iii. Controlled heat treatment furnace / Facility
- b) Testing Facility: All equipment must have valid NABL calibration certification: -
 - i. Universal Testing Machine (UTM)
 - ii. Spectrometer
 - iii. Hardness tester (Rockwell & Vickers)
 - iv. Metallurgical Microscope
 - v. Torque testing facility

If testing facility is not available in house, testing shall be witnessed at NABL approved lab only.

3.0 RAW MATERIAL REQUIREMENTS (CRITICAL)

- 3.1 Source of Steel- Input steel for all bolt assemblies shall be sourced exclusively from original steel producers having valid BIS license for IS 5517 or alternately from their authorized dealers, stockiest, channel partners with current validity. Sourcing of Steel from traders or intermediaries is not allowed. The fastener manufacturer itself cannot self-certify input steel.

3.2 Material Test Certificate: Format & Content

The Material Test Certificate submitted with each consignment shall meet the following requirements:

- a) Certificate type: MTC issued by the steel producer's Authorised inspector who independent of the production department. The fastener manufacturer shall not re-issue, reproduce, re- certify the steel MTC under any circumstances.
- b) The testing laboratory whose results are reported on the MTC shall hold current NABL accreditation under ISO/IEC 17025:2017 or at least have all equipment calibrated NABL traceability.
- c) The following parameters shall be reported with actual numerical values on every MTC: chemical composition (C, Mn, Si, Cr, Mo, Ni, P, S, B, Al, V, Cu as applicable); non-metallic inclusion rating per IS 4163 / ISO 4967 - numerical ratings for series A, B, C, D (thin and thick) are mandatory; decarburization depth - total decarburization and free-ferrite depth in mm; Hydrogen Content ≤ 2 ppm (for larger diameters); mechanical properties (UTS, YS, elongation, reduction of area) where applicable.
- d) The heat number on the MTC shall exactly match the heat number on the physical material tag attached to the consignment and on the despatch note. Any mismatch shall be treated as a non-conformance and the consignment shall be quarantined pending clarification.
- e) For Class 10.9 bolts, the free-ferrite decarburization depth on the incoming bar or rod shall not exceed 0.05 mm absolute.
- f) Ultrasonic Testing (UT) of bar stock: for all alloy steel bar of diameter 30 mm and above used for HSFG bolt manufacture, 100% ultrasonic testing shall be mandatory. UT shall be conducted per IS 3664:1981 or equivalent international standard with acceptance criteria

Additional Technical Conditions of Contract

[Applicable for procurement of HSFG Bolts, Nuts and Washers]

Ref. No.: BHEL:TCC:HSFG:Rev00

Date: 20.08.2026

per EN 10308:2002. The UT test result — 'Done OK' or equivalent with defect classification — shall be reported on the MTC or on a separate UT certificate cross-referenced to the MTC heat number. Bar lots for which UT has not been conducted or reported by steel producer shall not be used for BHEL supply of Class 10.9 bolts of M30 diameter and above.

4.0 MANUFACTURING PROCESS REQUIREMENTS

4.1 Forging

- a) Closed-die forging with induction heating (preferred)
- b) Controlled temperature to prevent grain growth

4.2 Heat Treatment

- a) In House heat treatment
- b) Oil quenching with agitation control
- c) Hardness monitoring per batch

4.3 Threading

- a) Thread rolling before heat treatment (preferred)
- b) No laps, cracks, or thread defects

5.0 MISCELLANEOUS REQUIREMENTS

- 5.1 Mandatory Technical Personnel Requirement- Manufacturer shall have one qualified full time QC Engineer on company rolls.

		BHEL: IVP Goindwal Quality Assurance	STANDARD QUALITY PLAN Item: HSFG Fasteners (Bolts, Nuts and Washers)				QP No	SQP:HSFG:001		
							Rev	6		
							Date	21.08.2026		
							Page	1 of 3		
SN	Component & Operation	Characteristics	Type of Check	Quantum of check	Reference Document	Acceptance Norm	Format of Record	Agency		Remarks
								M	B	
1.0	Raw material									
1.1	Raw material	Chemical & Mechanical	TC verification	100%	BHEL TCC,TDC, Drawing & PO		TC & Report	V	V	Format as per BHEL TCC
2.0	In Process									
2.1	Raw Material Testing	Chemical & NDE	Report Review	100%	DO		R	P	V	NDE in Raw Material: MPI for diameter (D) <30 mm and UT for diameter (D) ≥ 30 mm For Chemical: Refer Note 2
2.2	Manufacturing & Heat Treatment process	Dimensions, Temperature, Time, Medium, HT Chart	Report Review	100%	DO		R	P	V	Refer Note 3, 4 & 5
3.0	Final Inspection (*)									
3.1	Visual & Dimension (*)	Visual, Dimension, thread & Marking (identification & colour coding)	Measurement/ Thread gauge	Sampling plan (*)	DO		R	P	W	
3.2	Mechanical testing (*, #)	Hardness	Testing	DO	DO	DO	R	P	W	
		Strength under wedge load test till fracture								
		Minimum Tensile strength								
		%EL, %RA								
		Minimum stress at 0.2 % non-proportional elongation								Refer Note 6
		Proof load test								
		Impact Test								
		Decarburization test								

Prepared By
Sanju Kohli
Sr. Manager (QM)

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Approved By
Shelley Kohli
SDGM (QM and BE)

		BHEL: IVP Goindwal Quality Assurance		STANDARD QUALITY PLAN Item: HSFG Fasteners (Bolts, Nuts and Washers)			QP No	SQP:HSFG:001		
							Rev	6		
							Date	21.08.2026		
							Page	2 of 3		
SN	Component & Operation	Characteristics	Type of Check	Quantum of check	Reference Document	Acceptance Norm	Format of Record	Agency		Remarks
3.3	Torque value (*)	Torque to tighten the Bolt assembly	Testing	DO		Minimum tension to be achieved as per IS 4000 table 3	R	P	W	Refer Note no 7
3.4	Chemical (*)	Chemical composition	Testing	DO	BHEL TDC, Drawing & PO		R	P	W	Spectro analysis– One sample for every heat of raw material
3.5	NDE (*)	Surface quality	Testing (visual & MPI)	DO		DO	R	P	W	
3.6	Packing	Packing and Marking	Verification			DO	R	P	V	Refer Note 8
Legends: M-Manufacturer/Sub contractor, B-BHEL/Authorised inspection agency, V-Verification, W-Witness, P-Perform, R-Report, C-Customer, CHP- Customer Hold point, TC- Test Certificates										
(*) BHEL/BHEL TPIA will witness final inspection in supplier works or NABL approved Lab (#) For nut: only hardness test and Proof load test. For washers: hardness test only Note: 1. This QP shall be read along with relevant PO, TDC, applicable standards and drawings. Requirements shall be compiled. 2. NABL report per Heat of used Raw material conforming its chemical properties wrt to mill TCs 3. Calibration certificates of all instruments and machines used during testing to be provided along with calibration certificate of furnace and thermocouple (For quenching, Tempering furnaces). 4. Internal inspection report from supplier for grade 8.8 and above, regarding sufficient hardenability to ensure a structure consisting of approximately 90 % martensite in the core of the threaded sections for the fasteners in the “as-hardened” condition before tempering as per point f of table 2 of IS 1367-3 5. Heat Treatment process to be qualified & witness by BHEL as per BHEL format (for one size of Bolt during manufacturing of First Lot) 6. Machined Bolt sample shall be prepared as per IS 1367-3 (latest). Graph from UTM mandatory. In case of samples not feasible as per IS 1367 P3, IS 1608(Latest Rev.) to be used for EL and RA testing. 7. Torque values, K factor to be witnessed as per BHEL procedure (latest) 8. A standardized tag format shall be attached to every gunny bag as per tender terms and conditions.										

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Sr. Manager (QM)

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Shelley Kohli
SDGM (QM and BE)

	BHEL: IVP Goindwal	STANDARD QUALITY PLAN	QP No	SQP:HSFG:001
		Item: HSFG Fasteners (Bolts, Nuts and Washers)	Rev	6
			Date	21.08.2026
			Page	3 of 3

Lot Size (In nos.)	SAMPLE SIZE															Remarks
	Visual (nos.)	Dimensional (nos.)	MPI (nos.)	Physical Test												
				Total (nos.)	Hardness (nos.)	Hardness after Re- Tempering (nos.)	Proof Load (nos.)	Wedge Load (nos.)	Min Tensile Strength (nos)	%EL	%RA	Minimum stress at 0.2 % non- proportional elongation	Impact test (nos)	Decarb (nos.)	Torque/K factor (nos)	
Upto 100	20	8	15	5	5	5	2	2	2			2	1	2		
101 to 300	32	13	15	5	5	5	2	2	2			2	1	2		
301 to 500	50	20	15	5	5	5	2	2	2			2	1	2		
501 to 1000	80	32	15	5	5	5	2	2	2			2	1	2		
1001 to 3000	125	50	25	8	8	8	2	4	2			2	1	4	Upto 1500 nos 15 nos. for MPI	
3001 to 10000	200	80	50	13	13	13	2	6	2			2	1	6	Upto 5000 nos 25 nos. for MPI	
10001 to 35000	315	125	75	20	20	20	4	8	4			4	2	10	Upto 15000 nos 50 nos. for MPI	
35000 to 70000	500	200	100	32	32	32	6	12	5			6	3	15	Upto 50000 nos 75 nos. for MPI	
Inspection by BHEL/ BHEL AIA	W	W	W	W	W	W	W	W	W			W	W	W		

Remarks:

- Acceptance Number is zero. If the sample is having deviation in Visual, Dimensional and MPI, then the entire lot shall be 100% inspected. In case of deviations in Chemical and Physical tests, a second sample of twice the sample size of initial sample shall be taken. The lot will get rejected if the second sample fails.
- Inspection by BHEL/BHEL AIA shown as "W" shall be witnessed for the sample size indicated against the lot size
- Any quantity offered above 70000 nos, will be considered as a new lot and sampling plan shall be reapplied for them.
- In physical test minimum one number per heat of raw material used to be covered.

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Approved by
Shelley Kohli
SDGM (QM and BE)

HEAT TREATMENT PROCESS CHECKLIST

Quenching & Tempering - Quality Control

Bolt Class:	
Material Spec:	
Batch/Lot Number:	
Quantity (pcs):	
Date of Treatment:	
Furnace ID & Type:	
Operator Name:	
Supervisor:	

Phase	Parameter	Requirement	Acceptance Criteria	Verified/Values Recorded	Remarks
PRE-TREATMENT INSPECTION	Visual inspection of bolts	Clean, no defects	No cracks, corrosion, or deformation	☐	
	Chemical composition verification	Cert. of Conformance	Valid CoC from supplier	☐	
	Dimensional check (length, dia)	Within tolerance	Per ISO 898-1	☐	
	Surface cleanliness	Degreased	Free of oil, grease, rust	☐	
	Initial hardness check (sample)	As received	Per batch specification	☐	
FURNACE PREPARATION	Furnace calibration	Calibration certificate	Proper validity	☐	
	Furnace temperature uniformity	Calibration certificate & Temperature recording of Thermocouples	Recorded Temperature variation between all thermocouple readings of all zones during start of soaking cycle to match with manufacturer procedure/practice#	☐	
	Thermocouples check	Functional & verified	All thermocouples working	☐	
	Interior cleanliness	Clean, no scale/debris	No contaminants	☐	
	Furnace atmosphere check	Neutral/slight oxidizing	Vendor to Confirm	☐	

LOADING & AUSTENITIZING	Ramp-up rate to austenitizing	Controlled heating	Recorded values to match with manufacturer procedure/practice#	☐	
	Austenitizing temperature	Hold within tolerance		☐	
	Temperature tolerance band	Deviation to be as minimum as possible		☐	
	Soak/dwell time	Full austenite transformation		☐	
	Temperature stability check	Stable $\pm 5^{\circ}\text{C}$ for 5 min before quench	Ready for quench	☐	
	Sample extraction (for Hardness)	Full austenite transformation (2Nos samples)	Monitor hardness trend ($\pm 2\text{HRC}$)	☐	
QUENCHING PROCESS	Quenching medium type	Oil (mineral/synthetic) as per manufacturer procedure/practice	Spec of medium to be noted	☐	
	Quenching bath temperature	Control flash point safety	Vendor to confirm	☐	
	Quenching bath volume check	Min. 3x load volume for Adequate heat capacity	Vendor to confirm	☐	
	Oil circulation system	Running during quench	Uniform cooling	☐	
	Transfer time from furnace to quench bath	Time to be as minimum as possible	Recorded value to match with manufacturer procedure/practice#		
	Quenching agitation	Moderate agitation	Avoid cracking/distortion	☐	
	Quench time in oil	Full cooling to below 40°C	Recorded value to match with requirement	☐	

	Post-quench cooling to room temp	30-40 min before tempering	Medium to be noted and should match manufacturer procedure/practice#	☐	
	Quench bath condition check	Oil clarity & no contamination	Oil change interval monitored	☐	
	Microstructure and hardness check	min. 90% martensite (2Nos samples each for both Hardness & Microstructure check)	i) Hardness levels to be uniform through the surface and core ($\pm 2\text{HRC}$) ii) Presence of min. 90% martensite during microscopic examination	☐	
TEMPERING PROCESS	Preheat temperature*	Reduce thermal shock	Recorded values to match with manufacturer procedure/practice#	☐	
	Preheat duration*	Uniform preheating		☐	
	Transfer to tempering furnace*	Transfer Time to be <5 min after preheat to Minimize surface oxidation	Recorded value to match with requirement	☐	
	Tempering furnace temperature	As per standard	Recorded value to match standard	☐	
	Tempering soak time	Full tempering	Recorded value to match with manufacturer procedure/practice#	☐	
	Temperature tolerance band	Strict control on temperature variation	Recorded value to match with manufacturer procedure/practice#	☐	
	Furnace atmosphere during tempering	Air/neutral to eliminate decarburization	Vendor to confirm	☐	

	Cooling from tempering temp	Controlled cooling to room temp naturally	Recorded cooling rate to match with manufacturers procedure/practice)#	☐	
	Final inspection after tempering & Microstructure Check	Presence of min. 90% tempered martensite (2Nos samples for Microstructure check)	i) Visual check for color/finish (Expected straw/light blue) ii) Presence of min. 90% tempered martensite during microscopic examination	☐	
POST-TREATMENT TESTING	Hardness measurement (HV/HRC)	As per standard	As per sampling plan in QP	☐	
	Hardness test location	As per IS 1367-P3	Consistent sampling	☐	
	Dimensional check post-treatment	Within tolerance	As per standard	☐	
	Surface inspection	No decarburization/cracks	Accept/Reject	☐	
	Tensile test (batch sample)	As per standard	As per ISO 898-1 min values	☐	
	Yield strength test	As per standard	As per ISO 898-1	☐	
	Ductility check (elongation %)	As per standard	Tensile test result	☐	

*(if applicable as per manufacturer's procedure)

ref: Documented procedure of Manufacturer

Heat Treatment Operator:	
Quality Inspector:	
Supervisor/Manager:	
Date:	
Batch Approved: ☐ YES ☐ NO	

Information related to tightening methods for the required preload, $F_{p,C} = 0.7f_{ub}A_s$

Tightening method according to EN 1090-2	Minimum information to be supplied	k-class
Torque method	$k_m = \dots\dots\dots$ 1 st step: Torque = Nm 2 nd step: Torque =Nm	K2
Combined method	1 st step: Torque = Nm 2 nd step: Further rotation	K1 ^a
Direct tension indicator method	-	K0 ^b
^a K2 can also be used. ^b K1 or K2 could also be used, but declared as K0		

where

f_{ub} is the nominal ultimate tensile strength of the bolt material

A_s is the nominal stress area of the bolt

Eg: For M30 10.9 grade bolt

$$f_{ub} = 1000 \text{ MPa}; A_s = 561 \text{ mm}^2$$

Required preload $F_{p,C} = 393 \text{ kN}$

7.1 INDIVIDUAL VALUES OF THE k-factor (k_i), MEAN VALUE OF THE k-factor (k_m) AND COEFFICIENT OF THE k-factor (V_k)

7.1.1 Individual values of the k-factor (k_i) for k-class K1

For k-class K1, the k_i values shall be within the range of $0.1 \leq k_i \leq 0.16$

7.1.2 Mean value of the k-factor (k_m) and coefficient of the k-factor (V_k) for k-class K2

The mean value (k_m) of the k-factor shall be calculated as follows:

$$k_m = \frac{\sum_{i=1}^n k_i}{n}$$

with

$$k_i = \frac{M_{pi}}{F_{p,C} \times d}$$

where

M_{pi} is the individual value of the applied torque;

$F_{p,C}$ is the required preload;

d is the nominal bolt diameter

The coefficient of variation of the k-factor (V_k) shall be calculated as follows:

$$V_k = S_k / k_m$$

where

S_k is the standard deviation

$$\left(s_k = \sqrt{\frac{\sum (k_i - k_m)^2}{n - 1}} \right).$$

For k_m and V_k the following values apply:

$$0.1 \leq k_m \leq 0.23$$

$$V_k \leq 0.06$$



Bharat Heavy Electricals Ltd.,
Tiruchirappalli -14

Doc. No: PR: CHEM: 09 - 04

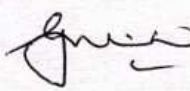
Rev: 03

Date: 01.04.2009

Page 1 of 3

PLANT LABORATORY

TECHNICAL SPECIFICATION FOR TEMPORARY RUST PREVENTIVE FLUID FOR BHEL USE TO IS 1153 (MODIFIED)

REV	DATE	PREPARED BY	REVIEWED AND APPROVED BY
03	01-04-2009	 L. Gragori DM/Plant Lab	 Dr. G. Ravichandran SDGM/Plant Lab

Controlled Copy No:	Issued to:



**Bharat Heavy Electricals Ltd.,
Tiruchirappalli -14**

Doc. No: PR: CHEM: 09 – 04

Rev: 03

Date: 01.04.2009

Page 2 of 3

Record of Revisions

Rev. No	Date	Details of Revision	Remarks
00	05.11.1992	NEW	----
01	04.04.1995	Sl.No. 1,3 & 5 modified	Quality improvement
02	20.05.2003	Sl.No. 8 Temperature Resistance Newly added	Based on Valves Requirement
03	01.04.2009	Editorial corrections made & new requirements added in Sl.No. 6, 12 & 16. Other Sl. No. Changed accordingly.	SSTP's additional requirements as given in TDC/CHEM/06 added.



REQUIREMENTS FOR TEMPORARY RUST PREVENTIVE FLUID

1	Specific Gravity at ambient temperature	0.85 - 0.95
2	Flash Point °C (min)	40
3	Drying time : Surface Dry (Hours, max)	½
	Tack free (Hours, max)	4
4	Dry film thickness (Microns) per coat-min	20
5	Ford cup Viscosity (No.4) seconds at ambient temperature	25 ± 5
6	Odour	No objectionable Odour
7	Film type Transparent/Translucent	Transparent
8	Application Method	Brush/Spray
9	% Non- Volatiles by mass	55 ± 5
10	Temperature Resistance of RPF film at 50 °C (for 6 hrs)	To pass test.
11	Corrosion Protection under conditions of condensation for 300 hours.	No sign of corrosion.
12	Liebermann –Storch test for the detection of natural resin & its derivatives	No development of pink colour – indicating absence of natural resin.
13	Salt spray test for 72 hours	No sign of corrosion.
14	Outdoor durability	The coating shall not crack or turn opaque when exposed to out door, unsheltered condition for 1 year.
15	Scratch Hardness test (Under load of 1000 g as per IS 101 (Latest)	To pass test
16	Compatibility with Alkyd /Lacquer based paints.	Compatible.
17	Keeping Property – Months (Shelf life) min.	12
18	General conformance to I.S Specification	IS 1153 (Latest)
19	Packing standard/markings	Supply in 200/20/10 Lt. Barrels as per PO indicating the following. Rust Preventive fluid for BHEL use only. Supplier's Name: Batch No: Date Quantity: Shelf Life: BHEL Specn.PR:CHEM:09-04 (latest)
20	Test certificate	The supplier shall furnish test certificate for the above requirements Sl.No.1 to 16 in duplicate.