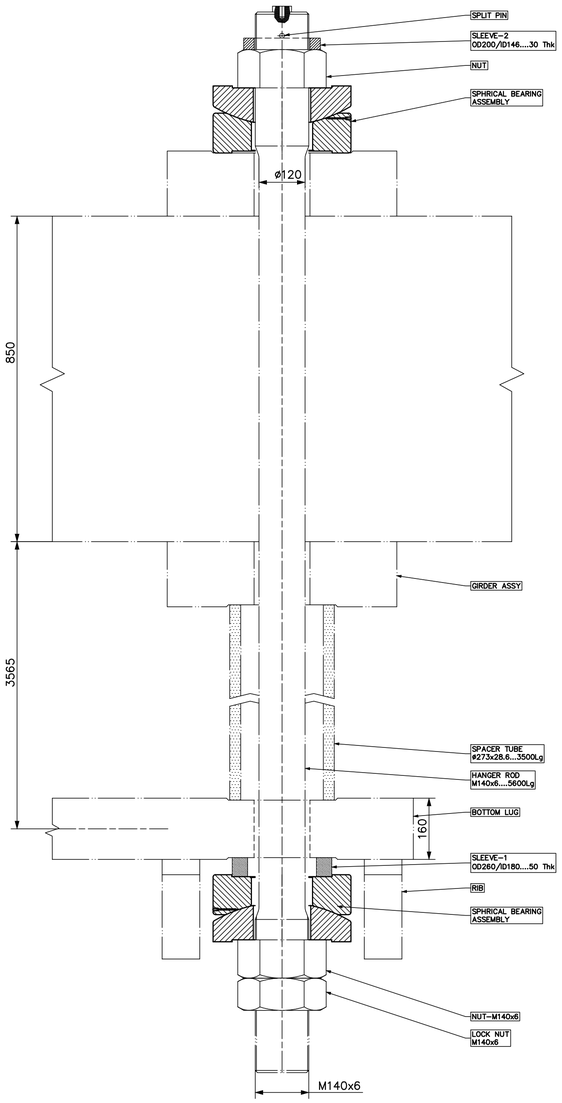
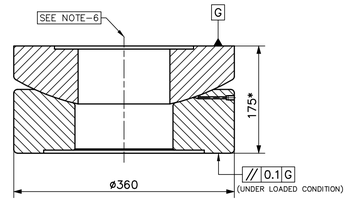
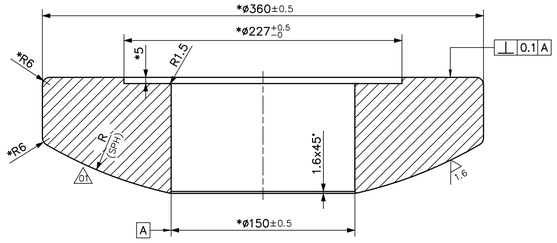
DRAWING NO: 1-93-171-05223

ALL DIMENSIONS ARE IN MILLIMETERS

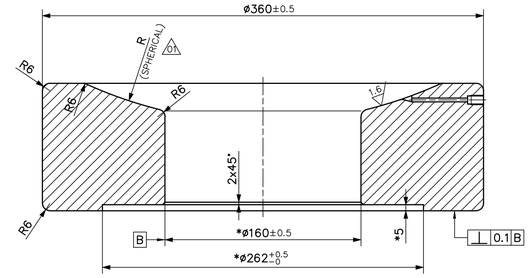




SPHERICAL BEARING ASSY



TOP SPHERICAL WASHER



BOTTOM SPHERICAL WASHER 02

NOTES: –

1. DESIGN VALIDATION, MATERIAL, MANUFACTURING & EXAMINATION SHALL BE AS PER APPLICABLE BHEL SPECIFICATION BHE: 3800: 700MWe: D157: 001/LATEST REVISION AND PC–M–965/REV–00.
2. MATERIAL DESIGN, FABRICATION EXAMINATION AND TESTING ETC., SHALL BE AS PER ASME SEC III SUB SECTION NF, CLASS–I SUPPORTS. FURTHER THEY SHALL MEET RELEVANT PROCEDURE APPROVED BY NPCIL.
3. 02 DETAIL DIMENSIONS & DESIGN SHALL BE PROVIDED BY THE SUPPLIER WITH AXIAL LOAD CAPACITY OF 422 TONNES FOR SPHERICAL WASHER ASSEMBLY.
4. THE COMPONENT SHALL BE SUPPLIED AS CLOSE TO THE FINISHED SHAPE AS POSSIBLE.
5. EASILY REMOVABLE RUST PREVENTIVE COATING SHALL BE APPLIED DURING SHIPPING TO ENSURE SEA–WORTHINESS AND FOR STORAGE IN TROPHICAL CONDITIONS.
6. AXIS OF BOTH TOP & BOTTOM PART OF SPHERICAL WASHER ASSEMBLY SET SHALL BE CONCENTRIC WITHIN 0.2
7. ALL SHARP EDGES SHALL BE ROUNDED OFF.
8. BRACKETED DIMENSIONS ARE FOR REFERENCE ONLY.
9. MATERIAL:
   i) SPHERICAL WASHER TOP : 817M40 (EN24)/EQUIVALENT OR SUPERIOR
   ii) SPHERICAL WASHER BOTTOM : 817M40 (EN24) / 34CrNiMo6/ EQUIVALENT (OR) SUPERIOR
10. APPROXIMATE WEIGHT:
    i) SPHERICAL WASHER TOP : 48 kg
    ii) SPHERICAL WASHER BOTTOM : 61 kg
11. 01 SPHERICAL WASHER SHALL BE SUPPLIED AS A SELF LUBRICATING TYPE STANDARD ITEM SUITABLE FOR FOLLOWING LOAD

CONDITIONS :	DESIGN/LEVEL–A	:	192 TONNES
	LEVEL–B	:	280 TONNES
	LEVEL–C	:	340 TONNES
	LEVEL–D	:	422 TONNES

12. SPHERICAL WASHER ASSEMBLY SHALL ENSURE SMOOTH ROTATION OF HANGER ROD TO ALLOW DISPLACEMENT OF SG BOTTOM IN BOTH HORIZONTAL DIRECTIONS. DISPLACEMENTS AT SG BOTTOM SUPPORT LUG UNDER VARIOUS OPERATION CONDITIONS ARE AS FOLLOWS:

CONDITION	DISPLACEMENT (mm)	
	EAST–WEST *	NORTH–SOUTH*
DESIGN/LEVEL–A	±10	±10
LEVEL–B	±15	±15
LEVEL–C	±20	±20
LEVEL–D	±20	±20

(*) – FOR DIRECTION, REFER DRG. No. 1–93–171–05208/LATEST REV.

Notes continued.....

16. TYPE TEST :

    SPHERICAL WASHER ASSEMBLY IS EXPECTED TO ALLOW MOVEMENT UNDER SPECIFIED LOADS AND DISPLACEMENTS FOR DESIGN/LEVEL–A (1000 CYCLES), LEVEL–B (50 CYCLES), LEVEL–C/D (10 CYCLES).

    SUITABLE TESTS SHALL BE CARRIED OUT TO DEMONSTRATE ABOVE FUNCTIONALITY ON SAMPLE SPHERICAL WASHER ASSEMBLY. APPROVED TEST SCHEME/PROCEDURE SHALL BE FOLLOWED.

    AFTER TESTING, THE MATING SURFACES SHALL BE SUBJECTED TO VISUAL AND SURFACE EXAMINATION TO ENSURE THERE IS NO APPRECIABLE DEGRADATION TO AFFECT THE FUNCTIONALITY.

    THE SPHERICAL WASHER ASSEMBLY SET SUBJECTED TO TYPE TESTING SHALL NOT BE PART OF THE SUPPLY.

17. SPHERICAL WASHER SHALL HAVE SUITABLE COMBINATION OF MATERIAL WITH REQUIRED SURFACE FINISH AND PROVISION OF SELF LUBRICATION VIZ., GRAPHITE IMPREGNATION ETC. ON ROCKING SURFACE. FINAL DETAILS/DESIGN BASED ON ABOVE POINTS SHALL BE SUBJECT TO APPROVAL BY NPCIL.
18. MATERIAL SHALL BE MELTED TO FINE GRAIN MELTING PRACTICE & VACUUM DEGASSED. HEAT TREATMENT SHALL BE AS PER NF2180.
19. ALL APPLICABLE MECHANICAL AND METALLURGICAL TEST INCLUDING IMPACT SHALL BE CARRIED OUT IN ACCORDANCE WITH RELEVANT MATERIAL SPECIFICATION. ADDITIONALLY, FOR ALL MATERIALS IMPACT TEST SHALL BE CARRIED OUT AS PER NF–2300 AT 0°C
20. NDE AS PER NF–2500 SHALL INCLUDE ATLEAST: VISUAL, SURFACE (MPT/LPT) AND UT. RODS & BARS SHALL BE UT EXAMINED AS PER NF–2584 & NPCIL APPROVED PROCEDURE.
21. AN ADDITIONAL PROVISION MAY BE GIVEN FOR SUITABLE EXTERNAL LUBRICATION BASED ON RECOMMENDATION OF SUPPLIER SUBJECT TO NPCIL APPROVAL. ANY REPAIR BY WELDING IS PROHIBITED.
22. 01 ATLEAST 80% BEARING CONTACT SHALL BE ENSURED IN EACH SPHERICAL WASHER ASSEMBLY SET IN FINAL ASSEMBLY.
23. * DIMENSIONS ARE APPROXIMATE.

13. ENVIRONMENTAL CONDITIONS:

    i) TEMPERATURE:
    SPHERICAL WASHER SHALL BE IN CONTACT WITH SLEEVE (ITEM–08, REF. 1–93–171–05208 FOR ASSEMBLY DETAILS) WHICH IS IN CONTACT WITH SG LUG (~ TEMPERATURE 200°C) AT AN AMBIENT TEMPERATURE OF 80° C DURING NORMAL OPERATION, AMBIENT TEMPERATURE DURING ACCIDENTAL CONDITION SHALL PEAK TO 175°C WITHIN ~30 SECONDS AND REDUCE TO 80°C WITHIN APPROX. 3 HOURS TIME.

    ii) RADIATION:
    IT SHALL BE DESIGNED TO WITHSTAND GAMMA AND NEUTRON RADIATION ACCUMULATED DOSE OF 20 MRADS OVER 40 YEARS WITHOUT DEGRADATION IN PERFORMANCE.

    iii) HUMIDITY : 100% (MAX)

    SPHERICAL WASHER SHALL DESIGNED FOR 40 YEARS LIFE WITHOUT MAINTENANCE AND FOR OPERATION WITHIN THE RATED LOAD, ENVIRONMENTAL CONDITIONS AND ASSEMBLY DETAILS SPECIFIED.

14. SIZE AND DETAILS OF SPHERICAL WASHERS SPECIFIED IN DRAWING ARE INDICATIVE. HOWEVER, DETAILS OF STANDARD SPHERICAL WASHER SHALL BE AS CLOSED AS POSSIBLE TO THE PROVIDED DIMENSIONS.
15. THE MATCHING COMPONENTS SHALL BE MODIFIED IF REQUIRED, BASED ON THE FINAL DIMENSIONS OF THIS COMPONENT SUBJECT TO NPCIL APPROVAL.

REFER DRG. NO. 1–93–171–05208
FOR VERTICAL SUPPORT ASSEMBLY PARTS

TOLERANCE IF NOT SPECIFIED SHALL BE AS BELOW (REFER IS:2102–m) (FOR MACHINING)

	LINEAR				ANGULAR	
0.5 TO 3	±0.1	400 TO 1000	±0.8	0 TO 10	± 1°
3 TO 6	±0.1	1000 TO 2000	±1.2	10 TO 50	±30'
6 TO 30	±0.2	2000 TO 4000	±2.0	50 TO 120	±20'
30 TO 120	±0.3	——	——	120 TO 400	±10'
120 TO 400	±0.5	——	——	OVER 400	± 5'

GENERAL TOLERANCES FOR FABRICATION	
FOR LINEAR	: ±1.5
FOR ANGLES	: ±1°
FOR MACHINING	: IS2102–m
FOR WELDING	: DIN EN ISO 13920 : 1996–11

REV	DATE	ALTERED : CHD&APPD :	REMARKS
02	280120		AXIAL LOAD CAPACITY CHANGED FROM 450 TO 422 TONNES IN NOTE–03 BASED ON CUSTOMER COMMENTS.
01	091119		DRAWING REVISED BASED ON CUSTOMER COMMENTS.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe Steam Generator
W.O.No.D157 TO D160–001–1–93–171–GHAVP–1&2

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI – 620014
05–227/D

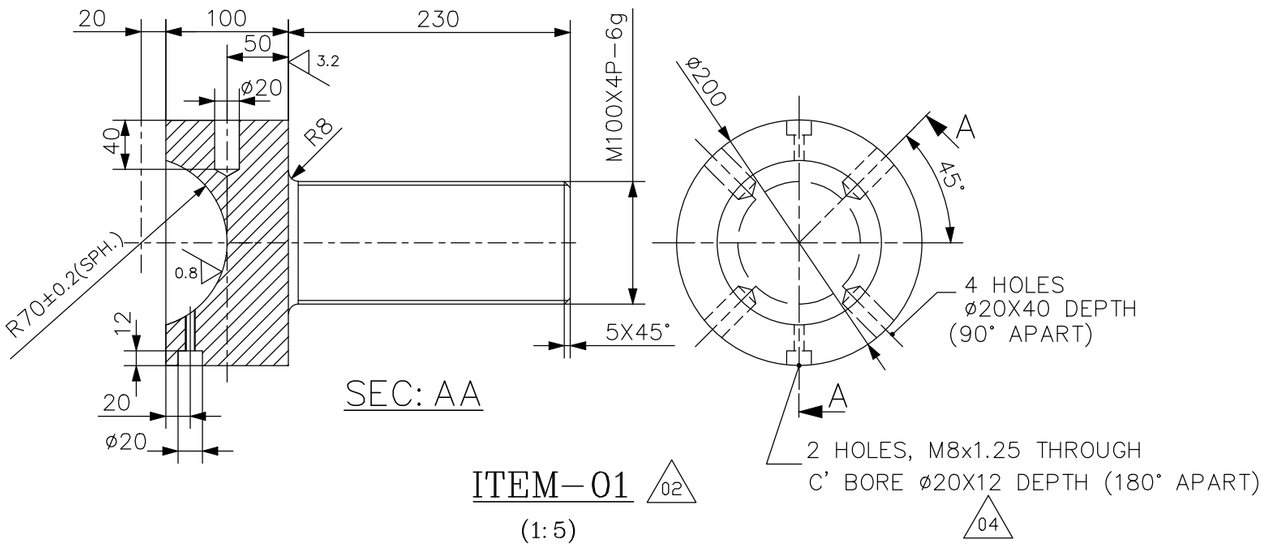
	NAME	SIGNATURE	DATE	NO. OF VAR
DRN	K.R.		100619	
CHD	MAK		100619	
APPD	MLN		100619	

DEPT.	GRADE OF UNTOL DIM	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	No OF ITEMS
NC	C/M/F			1–93–171–05208		
CODE 150						

TITLE: SPHERICAL BEARING ASSEMBLY
CARD CODE: U 01
DRAWING NO : 1–93–171–05223
REV: 02

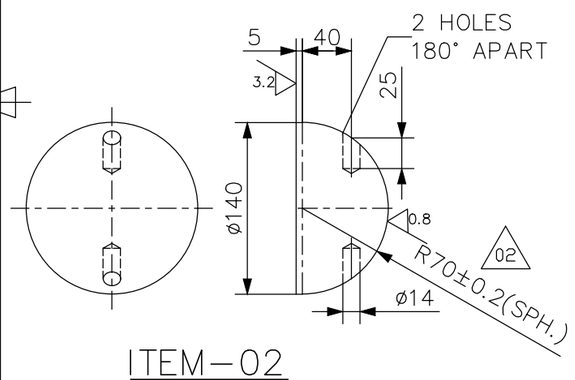
Size A1

DRAWING NO: 3-93-171-05470



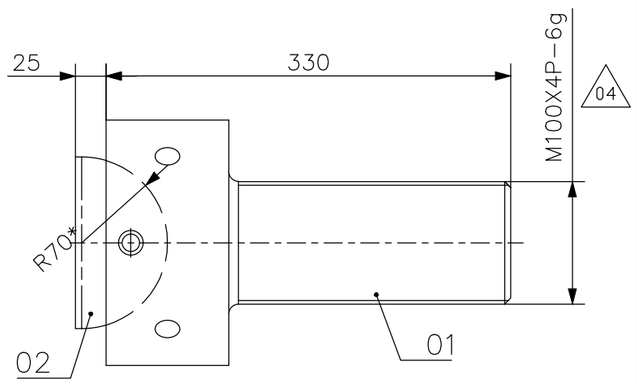
ITEM-01 02

(1:5)



ITEM-02

(1:5)



ASSEMBLY VIEW

(1:5)

04 NOTES:

3.2 / 3.2 / 0.8 ALL DIMENSIONS ARE IN MILLIMETERS

1. THE MATERIAL, FABRICATION AND EXAMINATION SHALL BE AS PER ASME SEC.III NF FOR CLASS-I COMPONENT SUPPORT & NPCIL APPROVED SPECIFICATION.
2. (01, 03) ALL RODS & BARS SHALL BE UT EXAMINED AS PER ASME SECTION-V, NF-2584 AND NPCIL APPROVED PROCEDURE.
3. SPHERICAL SURFACE OF HEMI SPHERICAL BALL SHALL BE LAPPED WITH SPHERICAL GROOVE IN BALL HOUSING FOR PROPER BEARING (70-80%) (BLUE MATCHING) HARDNESS OF HEMISPHERICAL BALL AND BALL HOUSING SHALL BE SUITABLY DIFFERENT WITH HARDNESS OF BALL HOUSING AT LEAST 4 HRC HIGHER THAN HEMISPHERICAL BALL.
4. ALL FINISH MACHINED SURFACES AND THREADED SURFACE SHALL BE PROTECTED SUITABLY TO AVOID ANY DAMAGE DURING HANDLING, HEAT TREATMENT OR OTHERWISE.
5. IMPACT TEST SHALL CARRIED OUT AS PER RELEVANT MATERIAL SPECIFICATION. ADDITIONALLY, FOR ALL MATERIALS IMPACT TEST BE CARRIED OUT AS PER NF-2300 AT 0°C.
6. ANY REPAIR BY WELDING IS PROHIBITED.
7. M.T. SHALL BE DONE ON BOLTING MATERIAL WITH NORMAL SIZE > 50mm.
8. ALL MACHINED SURFACES SHALL BE SUBJECTED TO P.T. AS PER SPECIFICATIONS.
9. THREADING SHALL BE AS PER IS: 4218 PART-1
10. THREADING SHALL BE DONE AFTER HT (IF ANY) OF SUB-ASSEMBLIES.
11. MATERIAL SHALL BE MELTED TO FINE GRAIN MELTING PRACTICE & VACUUM DEGASSED.
12. ALL UN MACHINED SURFACES SHALL BE PROTECTED WITH EPOXY BASED PRIMER, MACHINED SURFACES SHALL BE GREASED AND THREADED SURFACES SHALL BE PROVIDED WITH EASILY CLEANABLE PROTECTIVE COATING MATERIAL.
13. (02) *-DIMENSIONS ONLY FOR REFERENCE.

TOLERANCE IF NOT SPECIFIED SHALL BE AS BELOW (REFER IS: 2102-m)

LINEAR				ANGULAR	
0.5 TO 3	±0.1	400 TO 1000	±0.8	0 TO 10	± 1°
3 TO 6	±0.1	1000 TO 2000	±1.2	10 TO 50	± 30'
6 TO 30	±0.2	2000 TO 4000	±2.0	50 TO 120	± 20'
30 TO 120	±0.3	——	—	120 TO 400	± 10'
120 TO 400	±0.5	——	—	OVER 400	± 5'

ITEM NO.	DESCRIPTION	SPECN.
01	BALL HOUSING	SA193 Gr.B7
02	HEMI SPH. BALL	EN 24/34CrNiMo6

REV	DATE	ALTERED : / CHD&APPD :	REV	DATE	ALTERED : / CHD&APPD :
04	26.07.21	A.DL / NKK	03	07.02.20	A.DL / NKK
NPCIL COMMENTS HAVE BEEN INCORPORATED.			NOTE-2 MODIFIED AS PER NPCIL COMMENTS.		
02	29.01.20	A.DL / [illegible]	01	12.11.19	A.DL / NKK
ITEM No-01 VIEW CORRECTED, ITEM No-02 TOLERANCE AND SURFACE FINISH ADDED AND NOTE-13 ADDED AS PER CUSTOMER COMMENT.			NOTE-2 MODIFIED		

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: 700MWe-STEAM GENERATOR
W.O. D157 TO 160
(Customer Drg.: GHAVP-1&2/33111/4223/DD/REV: 01)

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014
05-229/D

	NAME	SIGNATURE	DATE	NO. OF VAR
DRN	A.DL	A.DL	02.05.19	
CHD	NKK	NKK	02.05.19	
APPD	MLN	M. Lakshmanan	02.05.19	

DEPT	GRADE OF UNTOL. DIM	SCALE	WEIGHT (Kg)	REF TO ASSY / OLD DWG	ITEM NO	No OF ITEMS
NC	C/M/F	1:5	41.0	2-93-171-05302		
CODE 150						

TITLE: HEMI SPHERICAL BALL HOUSING (SA-43)

CARD CODE: U 01

DRAWING NO : 3-93-171-05470 REV 04

Size A3

Advanced Technology Products
High Pressure Boiler Plant

Generic QAP for Hemi Spherical Ball Housing

CUSTOMER	Nuclear Power Corporation of India Limited (NPCIL)
PROJECT	Gorakhpur Haryana Anu Vidyut Pariyojana (GHAVP-1&2)
W.O.	D157 to D160-001-1-93-171

BHEL / Quality Assurance & Engineering			NPCIL
Prepared by:	Reviewed by:	Approved by:	
O R NITHIN 04/07/19	S LAKSHMI 4/7/19	M LAKSHMINARASIMHAN 4/7/19	
NITHIN K KRISHNAN 04/07/19	M ARUN KUMAR 04/07/19		

REVISIONS			
REVISION No.	DATE	DESCRIPTION	ORIGINATOR
00	01.07.2019	Initial Issue	Nithin K Krishnan

Supplier's LOGO	Supplier's Name and Address	Quality Plan for Hemi Spherical Ball Housing (QAP: GHAVP: HEMI SPHERICAL BALL HOUSING: 01/ Rev 00) Item: Hemi Spherical Ball Housing Material of Hemi Spherical Ball: 34CrNiMo6 (EN 10269:1.6582) Material of Ball Housing: SA193 GR. B7 Sub-system: Steam Generator	QP No.: To be filled by Supplier Rev. No.: To be filled by Supplier Date: To be filled by Supplier Page No: 1 of 4	Project: GHAVP 1& 2 W.O.: D157 to D160-001-1-93-171 P.O No.: To be filled

Sl. No	Component & Operations	Characteristics	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Agency			Remarks
									M	B	N	
1.	2.	3.	4.	5.	6.	7.	8.	D *	9. **			10.
1.0	**Raw Material:**											
1.1	**Verification of Documents**	Chemical	T.C. Verification	Sample/ heat	As per approved specification no. BHEL: 700MWe: Hemi Spherical Ball Housing: 001		TC	√	P	R	R	Refer note-1
1.2		Mechanical	T.C. Verification	Sample/ heat	As per approved specification no. BHEL: 700MWe: Hemi Spherical Ball Housing: 001		TC	√	P	R	R	Refer note-1
2.0	**Testing of raw material:**											
2.1	Ultrasonic testing of blanks	Material Integrity	NDE of metal	100%	As per BHEL: 700MWe: Hemi Spherical Ball Housing: 001& approved procedure: (UT Procedure to be submitted)		TC	√	P	R	R	Refer note-5 & 7
3.0	**Ball Housing:**											
3.1	Proof machining of ball housing	Machining	Measurement	100%	Approved Drawing (Drawing to be submitted)		---	--	P	R	--	Refer note-5

Prepared	**Reviewed & Approved**	**Reviewed & Approved**	**Reviewed & Approved**	**LEGEND:** * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **M:** SUPPLIER **B:** BHEL **N:** NPCIL/TPI **P:** PERFORM **R:** REVIEW **W:** WITNESS AND **H:** HOLD **TC:** TEST CERTIFICATE **RD:** RECORD **HD:** HISTORY DOCKET **IR:** INSPECTION REPORT
SUPPLIER'S NAME: To be filled		**BHEL**	**NPCIL**	

04/07/19
[Nithin-K-Krishnan]

04/07/19
[NITHIN.O.R]

Supplier's LOGO	Supplier's Name and Address	Quality Plan for Hemi Spherical Ball Housing (QAP: GHAVP: HEMI SPHERICAL BALL HOUSING: 01/ Rev 00)		Project: GHAVP 1& 2 W.O.: D157 to D160-001-1-93-171 P.O No.: To be filled
		Item: Hemi Spherical Ball Housing Material of Hemi Spherical Ball: 34CrNiMo6 (EN 10269:1.6582) Material of Ball Housing: SA193 GR. B7 Sub-system: Steam Generator	QP No.: To be filled by Supplier Rev. No.: To be filled by Supplier Date: To be filled by Supplier Page No:2 of 4	

3.2	Heat Treatment	Quenching and Tempering	Verification of HT record	100%	As per BHEL: 700MWe: Hemi Spherical Ball Housing: 001 & approved procedure: (HT Procedure/plan to be submitted)	TC	√	P	R	R	Refer note-4
3.3	LPE & MPE of Ball housing	Surface/Sub Surface defects.	NDE of metal	100%	As per BHEL: 700MWe: Hemi Spherical Ball Housing: 001 & approved procedure: (LPE & MPE Procedure to be submitted)	TC	√	P	R	R	Refer note-5, 6 & 7
3.4	Drilling of dia. 20 mm holes	Drilling	Measurement	100%	Approved Drawing (Drawing to be submitted)	---	--	P	R	--	Refer note-5
3.5	Machining of spherical face	Machining	Measurement	100%	Approved Drawing (Drawing to be submitted)	---	--	P	R	--	Refer note-5
3.6	Groove making for greasing	Machining	Measurement	100%	Approved Drawing (Drawing to be submitted)	---	--	P	R	--	Refer note-5
3.7	M8 x 1.25 Threading	Threading	Measurement	100%	Approved Drawing (Drawing to be submitted)	---	--	P	R	--	Refer note-5
3.8	M100 x 6 threading	Threading	Measurement	100%	Approved Drawing (Drawing to be submitted)	---	--	P	R	--	Refer note-5
3.9	LPE of Ball housing on Machined surfaces (Other than threaded area and holes)	Surface defects	NDE of metal	100%	As per BHEL: 700MWe: Hemi Spherical Ball Housing: 001 & approved procedure: (LPE Procedure to be submitted)	TC	√	P	W	W	Refer note-5, 6 & 7

				LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **M:** SUPPLIER **B:** BHEL **N:** NPCIL/TPI **P:** PERFORM **R:** REVIEW **W:** WITNESS AND **H:** HOLD **TC:** TEST CERTIFICATE **RD:** RECORD **HD:** HISTORY DOCKET **IR:** INSPECTION REPORT
Prepared	**Reviewed & Approved**	**Reviewed & Approved**	**Reviewed & Approved**	
SUPPLIER'S NAME: To be filled		**BHEL**	**NPCIL**	

04/07/19

04/07/19

Supplier's LOGO	Supplier's Name and Address	Quality Plan for Hemi Spherical Ball Housing (QAP: GHAVP: HEMI SPHERICAL BALL HOUSING: 01/ Rev 00)		Project: GHAVP 1& 2 W.O.: D157 to D160-001-1-93-171 P.O No.: To be filled
		Item: Hemi Spherical Ball Housing Material of Hemi Spherical Ball: 34CrNiMo6 (EN 10269:1.6582) Material of Ball Housing: SA193 GR. B7 Sub-system: Steam Generator	QP No.: To be filled by Supplier Rev. No.: To be filled by Supplier Date: To be filled by Supplier Page No:3 of 4	

3.10	Hardness check on the spherical surface of radius, R70	Hardness measurement	Hardness	100%	As per standard	TC	√	P	W	W	**Refer note-5 & 8**
3.11	Final Dimensional Check	Dimension , Gauge check of threads	Measurement, Gauge Check	100%	As per drawing (Drg: To be submitted)	TC	√	P	W	R	
4.0	**Hemi Spherical Ball:**										
4.1	Proof machining of Hemi spherical ball	Machining	Measurement	100%	Approved Drawing (Drawing to be submitted)	---	--	P	R	--	Refer note-5
4.2	Heat Treatment	Quenching and Tempering	Verification of HT record	100%	As per BHEL: 700MWe: Hemi Spherical Ball Housing: 001 & approved procedure: (HT Procedure/plan to be submitted)	TC	√	P	R	R	Refer note-4
4.3	LPE & MPE of Hemi spherical Ball	Surface/Sub Surface defects.	NDE of metal	100%	As per BHEL: 700MWe: Hemi Spherical Ball Housing: 001 & approved procedure: (LPE & MPE Procedure to be submitted)	TC	√	P	R	R	Refer note-5, 6 & 7
4.4	Machining of spherical face	Machining	Measurement	100%	Approved Drawing (Drawing to be submitted)	---	--	P	R	--	Refer note-5
4.5	Drilling of holes	Drilling	Measurement	100%	Approved Drawing (Drawing to be submitted)	--	--	P	R	--	Refer note-5

				LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **M:** SUPPLIER **B:** BHEL **N:** NPCIL/TPI **P:** PERFORM **R:** REVIEW **W:** WITNESS AND **H:** HOLD **TC:** TEST CERTIFICATE **RD:** RECORD **HD:** HISTORY DOCKET **IR:** INSPECTION REPORT
Prepared	**Reviewed & Approved**	**Reviewed & Approved**	**Reviewed & Approved**	
SUPPLIER'S NAME: To be filled		**BHEL**	**NPCIL**	

04/07/19

04/07/19

Supplier's LOGO	Supplier's Name and Address	Quality Plan for Hemi Spherical Ball Housing (QAP: GHAVP: HEMI SPHERICAL BALL HOUSING: 01/ Rev 00)		Project: GHAVP 1& 2 W.O.: D157 to D160-001-1-93-171 P.O No.: To be filled
		Item: Hemi Spherical Ball Housing Material of Hemi Spherical Ball: 34CrNiMo6 (EN 10269:1.6582) Material of Ball Housing: SA193 GR. B7 Sub-system: Steam Generator	QP No.: To be filled by Supplier Rev. No.: To be filled by Supplier Date: To be filled by Supplier Page No:4 of 4	

4.6	LPE of hemi spherical ball other than hole areas.	Material Integrity	NDE of metal	100%	As per BHEL: 700MWe: Hemi Spherical Ball Housing: 001& approved procedure: (LPE Procedure to be submitted)	TC	√	P	W	W	Refer note-5, 6 & 7
4.7	Hardness check on the hemispherical surface	Hardness measurement	Hardness	100%	As per standard & Specification BHE:700MWe:SPH BRNG:001	TC	√	P	W	W	**Refer note-5 & 8**
4.8	Final Dimensional Check	Dimension	Measurement	100%	As per drawing (Drg: To be submitted)	TC	√	P	W	R	
5.0	**Assembly of Hemi Spherical Ball Housing:**											
5.1	Lapping of Hemi Spherical ball and ball housing	Lapping	Visual check , Surface finish & Blue matching	100%	As per approved procedure (Lapping Procedure to be submitted)	TC	--	P	W	R	Refer note-5
6.0	**Packaging**	Rigidity	Verification and Visual	100%	As per approved procedure (Packing Procedure to be submitted)	---	--	P	R	R	---
7.0	**Documentation**	Compilation of documents	Verification	100%	As per Tender document	HD	--	P	H	R	---

Prepared	**Reviewed & Approved**	**Reviewed & Approved**	**Reviewed & Approved**
SUPPLIER'S NAME: To be filled		**BHEL**	**NPCIL**

LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
** **M:** SUPPLIER **B:** BHEL **N:** NPCIL/TPI
P: PERFORM **R:** REVIEW **W:** WITNESS AND **H:** HOLD
TC: TEST CERTIFICATE **RD:** RECORD **HD:** HISTORY DOCKET
IR: INSPECTION REPORT

04/07/19

04/07/19

Supplier's LOGO	Supplier's Name and Address	Quality Plan for Hemi Spherical Ball Housing (QAP: GHAVP: HEMI SPHERICAL BALL HOUSING: 01/ Rev 00)		Project: GHAVP 1& 2 W.O.: D157 to D160-001-1-93-171 P.O No.: To be filled
		Item: Hemi Spherical Ball Housing **Material of Hemi Spherical Ball: 34CrNiMo6 (EN 10269:1.6582)** **Material of Ball Housing: SA193 GR. B7** **Sub-system: Steam Generator**	**QP No.:** To be filled by Supplier **Rev. No.:** To be filled by Supplier **Date:** To be filled by Supplier **Page No**:5 of 4	

Note:

1. Co-related original material test certificate is acceptable. In the absence of co-related material test certificate, sample per lot (a lot means, all material having same heat mark / material specification requirements) for chemical and physical test shall be drawn and witnessed by BHEL. All material verification reports and test reports as per material specification shall be submitted to NPCIL for checking / verification and clearance.
2. Stamping of raw material and stamp transfer shall be done by BHEL.
3. MSTP (Material Sampling Plan), MPP (Manufacturing Process plan), Heat Treatment Plan, Ultrasonic Test Procedure, Liquid penetrant examination procedure, magnetic particle examination procedure, lapping procedure, packing procedures etc. shall be submitted by supplier and the same will be subjected to both BHEL & NPCIL approval.
4. Heat treatment shall be carried out in calibrated furnaces. Signed HT chart shall be submitted in case of heat treatment.
5. Calibrated instruments shall be used for inspection, examination and testing.
6. NPCIL approved chemicals for liquid penetrant examination shall be used.
7. Nondestructive examinations shall be done by qualified personnel.
8. Hardness of ball housing shall be at least 4 HRC higher than hemispherical ball (on the contact surface). If Hardness difference is not achieved, Suitable hardening method shall be followed by Supplier to achieve the above mentioned requirement. The method for achieving hardness requirement shall be mentioned in the offer (with a detailed flow chart) and subsequently in the quality Plan.

				LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **M:** SUPPLIER **B:** BHEL **N:** NPCIL/TPI **P:** PERFORM **R:** REVIEW **W:** WITNESS AND **H:** HOLD **TC:** TEST CERTIFICATE **RD:** RECORD **HD:** HISTORY DOCKET **IR:** INSPECTION REPORT
Prepared	**Reviewed & Approved**	**Reviewed & Approved**	**Reviewed & Approved**	
SUPPLIER'S NAME: To be filled		**BHEL**	**NPCIL**	

04/07/19

04/07/19

Advanced Technology Products
High Pressure Boiler Plant
Tiruchirappalli – 620 014

Specification for Hemi Spherical Ball Housing Assembly of Steam Generator's Top Guide Support

Specification No.: BHEL: 700MWe: Hemi Spherical Ball Housing Assy: 001

Contract	:	Nuclear Power Corporation of India Limited (NPCIL)
Project	:	Gorakhpur Haryana Anu Vidyut Pariyojna (GHAVP-1&2)
Work Order	:	D157 to D160-001-1-93-171

BHEL / ATP - Engineering			NPCIL
Prepared by:	Reviewed by:	Approved by:	
Nithin K. Krishnan	M Arun Kumar	R Ananthakrishnan	

REVISIONS			
REVISION No.	DATE	DESCRIPTION	ORIGINATOR
00	01.07.2019	Initial Issue	Nithin K. Krishnan
01	26.11.2019	Revised clause nos. 1.6, 2.0, 3.0, 4.1, 4.3, 4.4.2, 4.10, 4.11, 5.0, 6.2.5, Appendix-A	Nithin K. Krishnan
02	03.02.2020	Revised clause Nos. 3.0 and 4.1	Nithin K. Krishnan
03	02.02.2021	Clause 4.2.1 is added	Nithin K. Krishnan
04	20.07.2021	Cause nos. 4.2.2 & 6.2.6.4 are added. Cause nos. 4.1,4.5, 4.9 & 4.10 are revised.	Nithin K. Krishnan

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1.0 INSTRUCTIONS TO SUPPLIER

1.1 This specification covers the technical requirements for design, procurement of materials, manufacture/fabrication, inspection, guarantee, packing and supply of self-lubricating hemi spherical ball housing for 700MWe Steam Generator Support.

1.2 The requirements covered under this specification represents the minimum requirements and shall be fully met with.

1.3 This Engineering Specification is applicable for all the orders for hemi spherical ball housing to be placed under this enquiry.

1.4 No End User Certificate will be furnished by BHEL/NPCIL.

1.5 The Supplier shall complete and submit the Supplier Data Sheets and guarantees as per Section 8.0 of this specification with the equipment offered in full conformance with the specification. All omissions or exceptions to the requirements of this specification must be included in the EXCEPTIONS TO THE SPECIFICATION section of the Supplier data sheet(s). Without the complete data sheets and the EXCEPTIONS TO THE SPECIFICATION sheets, the proposal will not be evaluated.

1.6 The Supplier shall be governed by the following regulations, Codes, and standards, including their respective addenda, amendments, and errata. The design, fabrication, examination and testing shall be as per ASME Sec-III, Sub section-NF, Class-1 supports (Latest Edn.).

ASME Boiler & Pressure Vessel Code.

- Section II - Material Specification
- Section III Subsection NF - Components Support
- Section V - Non-Destructive Examination
- Section III Division 1 - Appendices

ISO Standards

- DIN EN 10269: Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties or equivalent manufacturing standard.

British Standard

- BS: 970 for Wrought Steel for Mechanical and allied engineering purpose or equivalent manufacturing standard.

1.7 Supplier will defend any suit or proceeding brought against, and will protect, indemnify, save and hold harmless BHEL from and against all liabilities, awards, judgments, losses, costs and expenses (including reasonable attorney's fees) which BHEL incurs or to which BHEL becomes subject, in each case to the extent (i) arising from a claim that any Product or related materials or parts thereof constitute an infringement of any intellectual property or other proprietary right of a third party; or (ii) arising from or relating to any claim that the receipt and use of Products or parts/spares/tools /technical literature /drawings and diagrams thereof or any information provided by Supplier constitute violation of any rights of third party provided under the respective intellectual property laws.

2.0 SCOPE OF EQUIPMENT TO BE SUPPLIED BY SUPPLIER

Each hemi spherical ball housing Set shall include, but is not limited to, the following components.

- Ball Housing
- Hemi Spherical Ball

Important Note:

The configuration of hemi spherical ball housing shall be machined as per BHEL drawing no.: 3-93-171-05470/ latest revision requirements. Details of greasing groove dimensions are suggestive in nature and to be confirmed by the supplier based on his design and experience. Supplier to confirm the overall dimensions and surface finish of hemi spherical ball housing indicated in the drawing. Workmanship and fabrication shall be of high quality and in accordance with best practices permitted to use in the Modern Nuclear Power Plant and shall conform to the requirement of ASME Sec-III, Sub Section-NF (Latest Edn.).

Assemblies shall be supplied as per the following.

a) Quantity of supply shall be as specified in Tender Specification
b) Supplier to include in their scope of supply, if any, complete one set of special tools required for installation and / or maintenance of the Hemi Spherical Ball Housing Assembly.
c) Engineering Drawings & Inspection Reports (The inspection report must be approved by the purchaser and the report shall accompany the hemi spherical ball housing assembly when they are shipped)

3.0 FUNCTIONAL REQUIREMENT OF HEMI SPHERICAL BALL HOUSING

3.1 During site erection, the Steam Generator is supported at the top with the help of Top Guide Supports. The Top Guide Supports will be assembled in such a way that 3-3.5 mm gap **(gap on one side only)** is maintained between the face of supporting lug of Steam Generator and the flat face of hemi spherical ball housing assembly of top guide supports (Refer Appendix-A for details).

3.2 The purpose of the specified hemi spherical ball housing assembly of top guide supports is to act as guide support in horizontal direction (N-S and E-W) and allow the angular movement of steam generator while safely transmitting the forces that arises due to dead weight, thermal expansion, earthquakes and pipe rupture events as specified in design data of section 5.0 from the supporting lug of steam generator to Top Guide Support Arrangement. The hemi spherical ball housing assembly shall be designed to allow movement under specified loads: **Design/Level-A (1000 cycles), Level-B (50 cycles), Level-C/D (10 cycles)** during its lifetime.

3.3 The hemi spherical ball housing assembly should be designed for 40 years of effective service life without maintenance and for operation with the rated loads provided in design data of section 5.

4.0 HEMI SPHERICAL BALL HOUSING CONSTRUCTIONAL REQUIREMENT

4.1 Material of hemi spherical ball bearing shall be 817M40 (EN 24) or 34CrNiMo6 (DIN EN 10269:1.6582) in forged round condition for the hemi spherical ball with additional mechanical and chemical test requirement (except impact test) as required under customer specification PC-M-965 Rev.00 and SA193 Gr. B7 for ball housing as per ASME Sec. II Part A (Latest Edn.). However, the supplier may select equivalent or superior material and material combination for meeting the functional requirement. The material shall be melted to the fine grain melting practice, vacuum degassed and shall be fully killed.

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4.2 Hemi spherical ball housing Chemical properties and Mechanical properties shall comply with 817M40 (EN 24) or 34CrNiMo6 (DIN EN 10269 :1.6582) for hemi spherical ball and SA193 Gr. B7 for ball housing or the equivalent or superior material grade standards.

4.2.1 Impact test shall be carried out as per applicable material specification. Additionally, impact test for all materials shall be carried out at 0°C as per ASME Sec. III Sub Sec.NF-2300.

4.2.2 Threading shall be carried out after PWHT, if applicable. Threading shall be as per IS 4218 Part 1.

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4.3 All material shall be subjected to Non-Destructive examination viz. Visual, Liquid penetrant/ Magnetic particle and 100% Ultrasonic examination as per ASME Sec. III Sub Sec.NF (Latest Edn.).

4.4.1 Magnetic Particle or Liquid penetrant examination shall be according to NF-2583.

4.4.2 Ultrasonic examination shall be according to NF-2584.

a) Ultrasonic Method: Examination shall be carried out by the straight beam, radial scan method.

b) Examination Procedure: Examination shall be performed at a nominal frequency of 2.25 MHz with a search unit not to exceed 650 mm2 area.

c) Calibration of Equipment: Calibration sensitivity shall be established by adjustment of the instruments so that the first back reflection is 75% to 90% of full screen height.

d) Acceptance Standards: Any discontinuity that causes an indication in

excess of 20% of the height of the first back reflection or any discontinuity which prevents the production of a first back reflection of 50% of the calibration amplitude is not acceptable.

4.5 Hardness of hemi spherical ball and ball housing shall be suitably different with hardness of ball housing at least 4 HRC higher than hemi spherical ball. The hardness value of the Hemi Spherical Ball shall be between 24-32 HRC after heat treatment. The hardness test shall be done according to the standard specified in the material specification to confirm the above hardness values.

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4.6 Heat Treatment of ball housing and hemi spherical ball, if required shall be carried out after proof machining keeping required minimum material on all dimensions.

4.7 Final machining shall be carried out after Heat Treatment to meet the final dimension.

4.8 Components shall be subjected to Visual and Liquid penetrant examinations as per approved procedure after machining.
Acceptance Standard for visual examination: No visible cracks or pores are acceptable.

4.9 Spherical surface of hemi spherical ball shall be lapped with spherical groove in ball housing ensuring proper bearing of 70-80% (Blue matching). Then, each assembly shall be identified with proper numbering as pair. Trial assembly demonstration shall be carried out and disassembled later.

04

4.10 Workmanship

Workmanship and fabrication shall be of high quality and in accordance with the best practices pertinent to use in a modern nuclear power plant and shall confirm to the requirements for class I component supports as per ASME Sec. III, sub section NF (Latest Edn.). Repair by welding is prohibited. All non-conformities shall be recorded and reported to determine their disposal.

04

4.11 Quality Control (QC) and Quality Assurance

All quality control and quality assurance procedures shall conform to ASME Section III, Division I, Sub section NCA-3800 and NCA-4000 (Latest Edn.).

Supplier shall submit a detailed Quality Assurance Plan (QAP) for approval of purchaser / NPCIL.

QAP should describe general practice and sequences of activities (such as non-destructive testing of material, fabrication, inspection, heat treatment, control, etc.) to be performed during manufacturing of items.

4.12 Spare & Special Tools

Supplier shall supply, if any, complete one set of special tools and spare parts required for installation and / or maintenance of the hemi spherical ball housing.

5.0 DESIGN LOAD DETAILS

Design Conditions			
Loading Conditions	**Units**	**Load in each pair of Ball Housing (T)**	
		Horz-1 Load (East-West)	**Horz-2 Load (North-South)**
Design	tons	2	5
Level- A	tons	11	9
Level B	tons	125	141
Level D	**tons**	**180**	**190**
Level D (Rupture)	tons	1	4
Load to be considered for design of Hemi Spherical Ball Housing Assembly	***tons***	***Level D Conditions (Max. Load condition)***	
Operating Conditions			
Temperature of surface in contact	°C	325	
Humidity	%	Max to 100%	
Environment	**Radiation:** It shall be designed to withstand Gamma and Neutron radiation accumulated dose of 20 MRads over 40 years without degradation in performance.		

6.0 DRAWINGS, DOCUMENTATION & REPORTS

6.1. To be submitted with Quotation

6.1.1 The Supplier to provide outline drawings of the hemi spherical ball housing conforming to the drawing provided. The drawings to contain material combination, overall dimensions, finish, lubrication/ coating type, mounting connections, clearances required for proper installation and state the weights of all major components.

6.1.2 List of special tools and equipment as required for assembling, complete dismantling, and maintenance of all equipment supplied.

6.1.3 QAP for Purchaser for review.

6.1.4 Clause to clause acceptance for the specification.

6.2 To be submitted after awarding Contract

6.2.1 Detailed engineering drawings of the hemi spherical ball housing unit including interface information, etc. All materials shall be readily identifiable on Supplier's drawings specifically in Bill of Material.

6.2.2 All the fabrication drawings to be submitted to purchaser for approval before commencement of fabrication of hemi spherical ball housing.

6.2.3 The quality plan to be submitted by supplier for purchaser's **approval prior to manufacture.**

6.2.4 Heat Treatment procedure to be submitted by supplier for purchaser's approval.

6.2.5 Non Destructives Examination (NDE) procedure for Liquid penetrant/ Magnetic particle and Ultrasonic Examination of forged round bar to be submitted by supplier in line with annexure for purchaser's **approval prior to manufacture.**

6.2.6 The following documents need to be submitted prior to dispatch clearance

6.2.6.1. As-built drawing for each hemi spherical ball housing

6.2.6.2. Material test certificates

6.2.6.3. Inspection reports as per quality plans as approved by purchaser or his authorized agency before shipment of the hemi spherical ball housing

04 6.2.6.4. Non conformities (NCR-Non Conformance Report) if any

7.0 IDENTIFICATION AND PACKAGING

Identification marking and packaging shall be done as specified below:

7.1 Each hemi spherical ball housing to be marked by electro etching or by any other suitable permanent marking method with following information as minimum.

a) Manufacturer's Name and Year of Manufacture
b) Material Specification
c) Part Number and / or Serial Number
d) Purchaser order / or Work Order number

7.2 All surfaces of the hemi spherical ball housing shall be cleaned and shall be free of oil, grease and other impurities before packing. All finish machined surfaces and threaded surfaces shall be protected suitably to avoid any damage during handling, heat treatment or otherwise. Packing must be suitable for tropical conditions and should protect the bearings and accessory parts against external damage during normal handling and shipping. It should be capable of withstanding storage period of about four years before its installation in the plant. Packaging shall be marked for identification, contents, destination, consignee and degree of handling care.

8.0 SUPPLIER DATA SHEET(s)

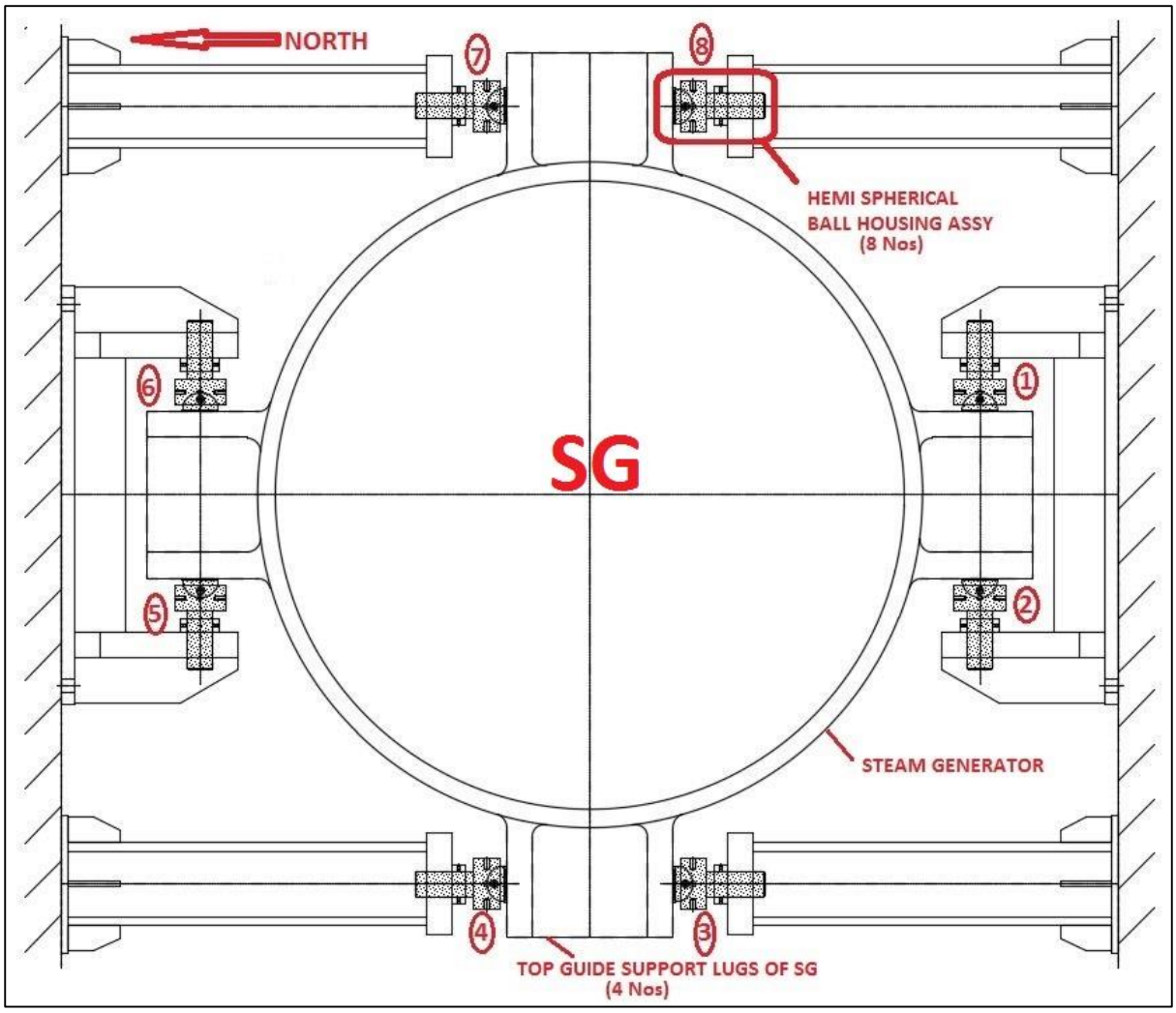
Design & Constructional Data			
Parameter	Units	Value	Remarks
Bearing Constructional Details			
Ball Housing Material			
Ball Housing Material Hardness	HRC		
Hemi Spherical Ball Material			
Hemi Spherical Ball Material Hardness	HRC		
Dimensional Details			
Bearing Area between Ball Housing and Hemi Spherical Ball (70-80% reqd)	%		

Note: Exceptions to the Specification

We have conformed to Sections 1.0 through 7.0 and Drg. no.: 3-93-171-05470/ Latest revision except as specifically noted as follows:

Enquiry Specification		Deviation	Accepted by BHEL
Clause No	Requirement		
			Yes/ No

Appendix A – Assembly of Hemi Spherical Ball Housing with Steam Generator



The assembly of Hemi Spherical Ball Housing with Steam Generator top guide support lugs is shown pictorially in the top sectional view of steam generator.

Bharat Heavy Electricals Limited

Advanced Technology Product
High Pressure Boiler Plant
Tiruchirappalli – 620 014

Generic QAP for Plain Thrust Spherical Bearing Assembly of Steam Generator's Vertical Support

QAP Ref. No.: BHEL: QAP: SPH BRNG: 001/ R00

Contract	:	Nuclear Power Corporation of India Limited (NPCIL)
Project	:	Gorakhpur Haryana Anu Vidyut Pariyojna (GHAVP-1&2)
Work Order	:	D157 to D160-001-1-93-171

BHEL / ATP - Engineering			NPCIL
Prepared by:	Reviewed by:	Approved by:	
O R Nithin 14/03/19	Amit Roy 14/3/19	A Sundararajan 18/3/19	
M Arunkumar 14/03/19	M Lakshminarasimhan 18/III/19		

REVISIONS			
REVISION No.	DATE	DESCRIPTION	ORIGINATOR
00	14-03-2019	Initial Issue	M.ARUN KUMAR

Supplier's LOGO	Supplier's Name and Address	Quality Plan for Plain Thrust Spherical Bearing Assembly		Project: GHAVP 1& 2 W.O.: D157 to D160-001-1-93-171 P.O No: To be filled
		Item: Spherical thrust washer Material: 34CrNiMo6 (EN 10269:1.6582) Sub-system: Steam Generator	QP No.: To be filled by Supplier Rev. No.: To be filled by Supplier Date: To be filled by Supplier Page No:1 of 3	

Sl. No	Component & Operations	Characteristics	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Agency			Remarks
									M	B	N	
1.	2.	3.	4.	5.	6.	7.	8.	D *	9. **			10.
1.0	**Raw Material (forged rod):**											
1.1	**Verification of Documents**	Chemical	T.C. Verification	Sample/ heat	As per approved specification no. BHE:700MWe:SPH BRNG:001		TC	√	P	W	R	Refer note-1
1.2		Mechanical	T.C. Verification	Sample/ heat	As per approved specification no. BHE:700MWe:SPH BRNG:001		TC	√	P	W	R	Refer note-1
2.0	**Testing of raw material**											
2.1	Ultrasonic testing of blanks	Material Integrity	NDE of metal	100%	As per BHE:700MWe:SPH BRNG:001 & approved procedure: (UT Procedure to be submitted)		RD	√	P	W	R	Refer note-5 & 7
3.0	**Bottom Washer :**											
3.1	Machining of bottom washer	Machining	Measurement	100%	Approved Drawing (Drawing to be submitted)		IR	--	P	R	--	Refer note-5
3.2	Drilling of central hole	Drilling	Measurement	100%	Approved Drawing (Drawing to be submitted)		IR	--	P	R	--	Refer note-5
3.3	Grinding of spherical face	Grinding	Measurement	100%	Approved Drawing (Drawing to be submitted)		IR	--	P	R	--	Refer note-5
3.4	Groove making for greasing	Machining	Measurement	100%	Approved Drawing (Drawing to be submitted)		IR	--	P	R	--	Refer note-5
3.5	Threading for grease nipple	Threading	Measurement	100%	Approved Drawing (Drawing to be submitted)		IR	--	P	R	--	Refer note-5

Prepared	**Reviewed & Approved**	**Reviewed & Approved**	**Reviewed & Approved**
SUPPLIER'S NAME: To be filled		**BHEL**	**NPCIL**

LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
** **M:** SUPPLIER **B:** BHEL, **N:** NPCIL/TPI
P: PERFORM R: REVIEW **W:** WITNESS AND H: HOLD
TC:TEST CERTIFICATE **RD:** RECORD **HD:** HISTORY DOCKET
IR: INSPECTION REPORT

14/03/19
(ENGG./ATP)

Supplier's LOGO	Supplier's Name and Address	Quality Plan for Plain Thrust Spherical Bearing Assembly **Item: Spherical thrust washer** **Material: 34CrNiMo6 (EN 10269:1.6582)** **Sub-system: Steam Generator**	**QP No.:** To be filled by Supplier **Rev. No.:** To be filled by Supplier **Date:** To be filled by Supplier **Page No**:2 of 3	**Project: GHAVP 1& 2** **W.O.: D157 to D160-001-1-93-171** **P.O No: To be filled**

3.6	LPE of bottom washer	Material Integrity	NDE of metal	100%	As per BHE:700MWe:SPH BRNG:001 & approved procedure: (LPE Procedure to be submitted)	RD	√	P	W	R	Refer note-5, 6 & 7
3.7	Hardening	Heating and quenching	Verification of HT record.	100%	As per BHE:700MWe:SPH BRNG:001 & approved procedure: (HT Procedure/plan to be submitted)	TC	√	P	R	R	Refer note-4 & 8
3.8	Hardness check	Hardness measurement	Hardness	100%	As per standard	IR	√	P	R	R	Refer note-5
4.0	**Top Washer :**										
4.1	Machining of top washer	Machining	Measurement	100%	Approved Drawing (Drawing to be submitted)	IR	--	P	R	--	Refer note-5
4.2	Drilling of central hole	Drilling	Measurement	100%	Approved Drawing (Drawing to be submitted)	IR	--	P	R	--	Refer note-5
4.3	Grinding of spherical face	Grinding	Measurement	100%	Approved Drawing (Drawing to be submitted)	IR	--	P	R	--	Refer note-5
4.4	LPE of top washer	Material Integrity	NDE of metal	100%	As per BHE:700MWe:SPH BRNG:001 & approved procedure: (LPE Procedure to be submitted)	RD	√	P	W	R	Refer note-5, 6 & 7
4.5	Hardening	Heating and quenching	Verification of HT record.	100%	As per BHE:700MWe:SPH BRNG:001 & approved procedure: (HT Procedure to be submitted)	TC	√	P	R	R	Signed HT Chart shall be submitted (refer note -4)
4.6	Hardness check	Hardness measurement	Hardness	100%	As per standard & Specification BHE:700MWe:SPH BRNG:001	IR	√	P	R	R	Refer note-5

Prepared	**Reviewed & Approved**	**Reviewed & Approved**	**Reviewed & Approved**
SUPPLIER'S NAME: To be filled		**BHEL**	**NPCIL**

LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
** **M:** SUPPLIER **B:** BHEL, **N:** NPCIL/TPI
P: PERFORM R: REVIEW **W:** WITNESS AND H**:** HOLD
TC:TEST CERTIFICATE **RD**: RECORD **HD**: HISTORY DOCKET
IR: INSPECTION REPORT

14/03/19
(CONCR./AHD)

Supplier's LOGO	Supplier's Name and Address	Quality Plan for Plain Thrust Spherical Bearing Assembly									
		Item: Spherical thrust washer **Material: 34CrNiMo6** **(EN 10269:1.6582)** **Sub-system: Steam Generator**		**QP No.:** To be filled by Supplier **Rev. No.:** To be filled by Supplier **Date:** To be filled by Supplier **Page No**:3 of 3		**Project: GHAVP 1& 2** **W.O.: D157 to D160-001-1-93-171** **P.O No: To be filled**					
5.0	**Assembly of top and bottom washer :**										
5.1	Lapping of bottom and top washer	Lapping	Visual check , Surface finish	100%	As per approved procedure (Lapping Procedure to be submitted)	IR	--	P	W	R	Refer note-5
6.0	**Type testing**	Performance	Type test	1 per each melt of forged rod & each heat Treatment batch	As per approved procedure (Type testing Procedure to be submitted)	IR	--	P	H	W	The item subjected to type test, shall not be a part of supply.
7.0	**Packaging**	Rigidity	Verification and Visual	100%	As per approved procedure (Packing Procedure to be submitted)	IR	--	P	R	R	---
8.0	**Documentation**	Compilation of documents	Verification	100%	As per Tender document	HD	--	P	H	R	---

Note:

1. Co-related original material test certificate is acceptable. In the absence of co-related material test certificate, sample per lot (lot means, all material having same heat mark / material specification requirements) for chemical and physical test shall be drawn and witnessed by BHEL. All material verification reports and test reports as per material specification shall be submitted to NPCIL for checking / verification and clearance.
2. Stamping of raw material and stamp transfer shall be done by BHEL.
3. MSTP (Material Sampling Plan), MPP (Manufacturing Process plan), Heat Treatment Plan, Ultrasonic Test Procedure, Liquid penetrant examination procedure, lapping procedure, packing procedures etc. shall be submitted by supplier and the same will be subjected to both BHEL & NPCIL approval.
4. Heat treatment shall be carried out in calibrated furnaces.
5. Calibrated instruments shall be used for inspection, examination and testing.
6. NPCIL approved chemicals for liquid penetrant examination shall be used.
7. Nondestructive examinations shall be done by qualified personnel.
8. Hardening of bottom washer shall be done, only if the material hardness is outside the range specified. Signed HT Chart shall be submitted in case of heat treatment.

				LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **M:** SUPPLIER **B:** BHEL, **N:** NPCIL/TPI **P:** PERFORM R: REVIEW **W:** WITNESS AND **H:** HOLD **TC:**TEST CERTIFICATE **RD**: RECORD **HD**: HISTORY DOCKET **IR**: INSPECTION REPORT
Prepared	**Reviewed & Approved**	**Reviewed & Approved**	**Reviewed & Approved**	
SUPPLIER'S NAME: To be filled		**BHEL**	**NPCIL**	

14/03/19

Bharat Heavy Electricals Limited

Advanced Technology Product
High Pressure Boiler Plant
Tiruchirappalli – 620 014

Specification for Plain Thrust Spherical Bearing Assembly of Steam Generator's Vertical Support

Specification No.: BHEL: 700MWe: SPH BRNG: 001

Contract	:	Nuclear Power Corporation of India Limited (NPCIL)
Project	:	Gorakhpur Haryana Anu Vidyut Pariyojna (GHAVP-1&2)
Work Order	:	D157 to D160-001-1-93-171

BHEL / ATP - Engineering			NPCIL
Prepared by:	Reviewed by:	Approved by:	
21/02/20 M. ARUN KUMAR Sr. Product Engineer Advanced Technology Products BHEL, TRICHY - 620 014. M Arunkumar Sr./Engr.	01/03/20 M. LAKSHMINARASIMHAN Dy. General Manager Engg., Mktg. & Commercial Advanced Technology Products BHEL, Tiruchirappalli - 620 014 M Lakshminarasimhan DGM	R A Kris Lak 21/02/20 R. Ananthakrishnan Addl. General Manager Advanced Technology Products BHEL, TRICHY - 620 014 R Ananthakrishnan AGM	

REVISIONS			
REVISION No.	DATE	DESCRIPTION	ORIGINATOR
00	15-03-2019	Initial Issue	MAK
01	21-06-2019	Revised based on customer comments	MAK
02	09-11-2019	Revised based on customer comments	MAK
03	21-02-2020	Revised based on customer comments	MAK

TABLE OF CONTENTS

1.0 INSTRUCTIONS TO SUPPLIER 3

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1.0 INSTRUCTIONS TO SUPPLIER

1.1 This specification covers the technical requirements for design, procurement of materials, manufacture/fabrication, inspection, testing, guarantee, packing and supply of self-lubricating plain thrust spherical bearing assembly for 700MWe Steam Generator Support.

1.2 The requirements covered under this specification represents the minimum requirements and shall be fully met with.

1.3 This Engineering Specification is applicable for all the orders for plain thrust spherical bearing assembly to be placed under this enquiry.

1.4 No End User Certificate will be furnished by BHEL/NPCIL.

1.5 The Supplier shall complete and submit the Supplier Data Sheets and guarantees as per Section 8.0 of this specification with the equipment offered in full conformance with the specification. All omissions or exceptions to the requirements of this specification must be included in the EXCEPTIONS TO THE SPECIFICATION section of the Supplier data sheet(s). Without the complete data sheets and the EXCEPTIONS TO THE SPECIFICATION sheets, the proposal will not be evaluated.

1.6 The Supplier shall be governed by the following regulations, Codes, and standards, including their respective addenda, amendments, and errata. The design, fabrication, examination and testing shall be as per the latest edition of ASME Sec-III, Sub section –NF, Class-1 supports.

ASME Boiler & Pressure Vessel Code.

- Section II - Material Specification
- Section III Subsection NF - Components Support
- Section V - Non-Destructive Examination
- Section III Division 1 - Appendices

ISO Standards

- ISO 12240-3:1998 (Edn.) Spherical plain bearings — Part 3: Thrust spherical plain bearings.
- EN 10269:1999 Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties or equivalent manufacturing standard.

British Standard

- BS: 970 for Wrought Steel for Mechanical and allied engineering purpose or equivalent manufacturing standard.

1.7 Supplier will defend any suit or proceeding brought against, and will protect, indemnify, save and hold harmless BHEL from and against all liabilities, awards, judgments, losses, costs and expenses (including reasonable attorney's fees) which BHEL incurs or to which BHEL becomes subject, in each case to the extent (i) arising from a claim that any Product or related materials or parts thereof constitute an infringement of any intellectual property or other proprietary right of a third party; or (ii) arising from or relating to any claim that the receipt and use of Products or parts/spares/tools /technical literature /drawings and diagrams thereof or any information provided by Supplier constitute violation of any rights of third party provided under the respective intellectual property laws.

2.0 SCOPE OF EQUIPMENT TO BE SUPPLIED BY SUPPLIER

Each Plain Thrust Spherical Bearing Assembly Set shall include, but is not limited to, the following components.

- Top Spherical Washer
- Bottom Spherical Washer

Important Note:

The configuration of Plain Thrust Spherical Bearing Assembly shall be machined as per BHEL drawing no.: 1-93-171-05223/ latest revision requirements. The dimensions on the spherical mating surface are subject to confirmation from the supplier. Supplier to confirm the overall dimensions (Diameter, Height & Hole size) and surface finish of plain thrust washer indicated in the drawing. Details of greasing groove dimensions are suggestive in nature and to be confirmed by the supplier based on his design and experience. Workmanship and fabrication shall be of high quality and in accordance with best practices permitted to use in the Modern Nuclear Power Plant and shall conform to the requirement of ASME Sec-III, Sub Section-NF (Latest Edition).

Assemblies shall be supplied along with the following.

a) Quantity shall be as per Tender Specification
b) Supplier to include in their scope of supply, if any, complete one set of special tools required for installation and / or maintenance of the Spherical Washer Assembly.
c) Engineering Drawings & Inspection Reports (The inspection report must be approved by the purchaser and the report shall accompany the thrust spherical bearing when they are shipped)
d) Type Test Report (One set of bearing, type tested shall not form part of supply)

3.0 PLAIN THRUST SPHERICAL BEARING FUNCTIONAL REQUIREMENT

3.1 The Steam Generator is suspended from two Girder Beam Assembly resting on the concrete wall. The support arrangement consists of Hanger Rod assembly which suspends Steam Generator at the bottom and rests on the two girder beam. The vertical load (self-weight of the Steam Generator, piping reactions, seismic load) will be taken by these two hanger tie rods. Two set of Spherical Washer Assembly are provided per hanger tie rod (See Drg. No.: 1-93-171-05223/ latest revision)

3.2 The purpose of the specified bearing provisions in the Hanger Tie Rod Assembly is to ensure verticality of Steam Generator while safely transmitting the forces due to self-weight of Steam Generator including those arising due to thermal expansion, earthquakes and pipe rupture events as specified in design data of section 5.0 from the supporting lug of steam generator to Girder Beam Arrangement. The thrust bearing assembly is subjected to constant angular and oscillatory motion under specified forces during its lifetime.

3.3 The bottom one is located below the sleeve of bottom lug support, housed in-between their gussets. The top one is located on top support plate of the girder, from which the hanger rod is suspended. A spacer pipe is provided concentric to the hanger rod in between top of the steam generator support lugs and bottom of the Girder beam to take the upward vertical load due to piping reactions and Seismic reactions. This spacer pipe prevents disengagement of mating surface bearing from the sliding surface of bearing housing during such events. The bottom bearings are retained in their hanger rod position by lock nut arrangement. The top one is retained by nut, filling washer and split pin arrangement.

3.4 During normal operations, bearing has to accommodate the angular movement of hanger rod caused due to radial thermal expansion (up to 1° angular displacement) of the Steam Generator.

3.5 The Spherical Washer Assembly should be designed for 40 years of effective service life without maintenance and for operation with the rated loads and cycles provided in design data of section 5.

4.0 PLAIN THRUST SPHERICAL BEARING CONSTRUCTIONAL REQUIREMENT

4.1 Material of top and bottom washer of Spherical Washer Assembly shall be in forged round condition with additional material test requirement as required under customer specification PC-M-965 Rev.00. The material grades 817M40 (EN 24) or 34CrNiMo6 (EN 10269:1.6582) are suggested for top and bottom washer respectively. However, the supplier may select equivalent or superior material and material combination for meeting the functional requirement. The material shall be melted to the fine grain melting practice and vacuum degassed and shall be fully killed.

4.2 Spherical Washer Assembly Chemical properties and Mechanical properties shall comply with 817M40 (EN 24) or 34CrNiMo6 (EN 10269 :1.6582) or the equivalent or superior material grade standards.

4.3 All material shall be subjected to Non-Destructive examination viz. Visual, Liquid penetrant/ Magnetic particle examination and 100% Ultrasonic examination as per ASME Sec. III Sub Sec.NF (Latest Edition).

4.4.1 Liquid penetrant examination and Magnetic particle examination shall be according to NF-2583.
Acceptance standard: Linear non-axial indications are unacceptable. Linear axial indications greater than 25 mm in length are unacceptable.

4.4.2 Ultrasonic examination shall be according to NF-2584.

a) Ultrasonic Method. Examination shall be carried out by the straight beam, radial scan method.

b) Examination Procedure. Examination shall be performed at a nominal frequency of 2.25 MHz with a search unit not to exceed 650 mm^2 area.

c) Calibration of Equipment. Calibration sensitivity shall be established by adjustment of the instruments so that the first back reflection is 75% to 90% of full screen height.

d) Acceptance Standards. Any discontinuity that causes an indication in excess of 20% of the height of the first back reflection or any discontinuity which prevents the production of a first back reflection of 50% of the calibration amplitude is not acceptable.

4.5 Heat Treatment of Bottom and Top bearing components shall be carried out after proof machining keeping required minimum material on all dimensions.

4.6 The bottom washer shall have hardness between HRC 20 to 25 and the top washer shall have hardness between HRC 35 to 40. The hardness test shall be done according to the standard specified in the material specification to confirm the above hardness values. These values are only recommended. However, the supplier may provide suitable material combination meeting requirements of the specification.

4.7 Final machining shall be carried out after Heat Treatment to meet the final dimension. Axis of both top and bottom part of Spherical Washer Assembly set shall be concentric within 0.2mm.

4.8 Components shall be subjected to Visual and Liquid penetrant examinations as per approved procedure after machining.
Acceptance Standard for visual examination: No visible cracks or pores are acceptable.

4.9 Sliding surface (mating surface) concave / convex shall be lapped to the surface finish of not greater than 1.6 microns and at least 90% bearing contact shall be ensured in each Spherical Bearing Assembly set in final assembly. Then, each assembly shall be identified with proper numbering as pair.

4.10 Type test of Spherical Washer Assembly:

a) Spherical washer assembly is expected to allow movement under specified loads and displacements for Design/Level-A (1000 cycles), Level-B (50 cycles), Level-C/D (10 cycles)
b) Suitable tests shall be carried out to demonstrate the above functionality on sample spherical washer assembly. Test scheme/procedure shall be subject to BHEL & NPCIL approval.
c) Test shall also be carried out to demonstrate rocking of the Spherical Washer Assembly at the Design load / Level-A load to the angle of 1°.
d) After testing, the mating surfaces shall be subject to visual and surface examination to ensure there is no appreciable degradation to affect the functionality.
e) The Spherical Washer Assembly set subjected to type testing shall not be part of supply.
f) Supplier type test certificate, if already carried out previously may be submitted in lieu of testing.

4.11 Workmanship

Workmanship and fabrication shall be of high quality and in accordance with the best practices pertinent to use in a modern nuclear power plant and shall confirm to the requirements for class I component supports as per ASME Sec. III, sub section NF.

4.12 Quality Control (QC) and Quality Assurance

All quality control and quality assurance procedures shall conform to ASME Section III, Division I, Sub section NCA-3800 and NCA-4000 (Latest Edition).

Supplier shall submit a detailed Quality Assurance Plan (QAP) for approval of purchaser / NPCIL.

QAP should describe general practice and sequences of activities (such as non-destructive testing of material, fabrication, inspection heat treatment, control, etc.) to be performed during manufacture of items.

4.13 Spare & Special Tools

Supplier shall supply, if any, complete one set of special tools and spare parts required for installation and / or maintenance of the special spherical bearing.

5.0 DESIGN LOAD DETAILS

Design Conditions					
Loading Conditions	**Units**	**Load**	**Displacement in mm (Swing angle * in °)**		**Cycles**
			East-west	**North-South**	
Design / Level- A	tons	192	+/- 10 (0.12°)	+/- 10 (0.12°)	1000
Level B	tons	280	+/- 15 (0.18°)	+/- 15 (0.18°)	50
Level C	tons	340	+/- 20 (0.24°)	+/- 20 (0.24°)	10
Level D	tons	422	+/- 20 (0.24°)	+/- 20 (0.24°)	10
Operating Conditions					
Temperature	Spherical washer shall be in contact with sleeve which is in contact with SG lug (~ Temperature 200°C) at an ambient temperature of 80°C during normal operation. Ambient temperature during accidental condition shall peak to 175°C within ~ 30 seconds and reduce to 80°C within approx. 3 hours' time.				
Humidity	%	Max 100%			
Environment	**Radiation:** It shall be designed to withstand Gamma and Neutron radiation accumulated dose of 20 mrads over 40 years without degradation in performance.				
*→ These are displacements at SG bottom support lug i.e. at bottom spherical bearing assembly with respect to top spherical bearing assembly.					

6.0 DRAWINGS AND DOCUMENTATION & REPORTS

6.1 Submitted with Quotation

6.1.1 The Supplier to provide dimensional outline drawings of the bearing. The drawings to contain material combination, overall dimensions, finish, lubrication/ coating type, mounting connections, clearances required for proper installation and state the weights of all major components.

6.1.2 List of special tools and equipment as required for assembling, complete dismantling, and maintenance of all equipment supplied.

6.1.3 QAP for Purchaser's for review.

6.1.4 Clause to clause acceptance for the specification

6.2 Submitted During Contract

6.2.1 Detailed engineering arrangement drawings of the bearing assembly unit including interface information, etc. All materials shall be readily identifiable on Supplier's drawings specifically in Bill of Material.

6.2.2 All the fabrication drawings to be submitted to purchaser for approval before commencement of fabrication of Spherical Washer Assembly.

6.2.3 The quality plan to be submitted by supplier for purchaser's **approval prior to manufacture.**

6.2.4 Heat Treatment procedure to be submitted by supplier for purchaser's approval.

6.2.5 Non Destructives Examination (NDE) procedure for Penetrant test and Ultrasonic Examination of forged round bar to be submitted by supplier in line with annexure for purchaser's **approval prior to manufacture.**

6.2.6 Type testing procedure with supporting drawings shall be submitted for purchaser's **approval prior to manufacture.**

6.2.7 The following documents need to be submitted prior to dispatch clearance

6.2.7.1 As-built drawing for each Spherical Washer Assembly

6.2.7.2 Material test certificates

6.2.7.3 Inspection reports as per quality plans as approved by purchaser or his authorized agency before shipment of the bearing assembly

7.0 IDENTIFICATION AND PACKAGING

Identification marking and packaging shall be done as specified below.

7.1 Each bearing housing to be marked by electro etching or by any other suitable permanent marking method with following information as minimum.

a) Manufacturer's Name and Year of Manufacture
b) Material Specification
c) Part Number and / or Serial Number
d) Purchaser order / or Work Order number
e) Design Load and References of National & International standards.

7.2 All surfaces of the bearing assembly should be cleaned and should be free of oil, grease and other impurities before packing. Packing should be suitable for tropical conditions and protect the bearings and accessory parts against external damage during normal handling and shipping. It should be capable of withstanding storage period of about four years before its installation in the plant. Packaging shall be marked for identification, contents, destination, consignee and degree of handling care.

8.0 SUPPLIER DATA SHEET(s)

Design & Constructional Data			
Parameter	Units	Value	Remarks
Bearing Constructional Details			
Top Spherical Washer Material			
Top Spherical Washer Material Hardness	HRC		
Bottom Spherical Washer Material			
Bottom Spherical Washer Material Hardness	HRC		
Dimensional Details			
Overall bearing height	mm		
Bearing Area	mm^2		
Bearing Design Data			
Type of Arrangement		Spherical	
Co-efficient of friction for the given load and operating conditions			
Performance Data			
Type test Load	Ton	422	Level D
Allowable Max. Angular Movement	Degree	1	
Operating Temperature range	°C		

Note: Exceptions to the Specification

We have conformed to Sections 1.0 through 7.0 and Drg. no.: 1-93-171-05223/ Latest revision except as specifically noted as follows:

Enquiry Specification		Deviation	Accepted by BHEL
Clause No	Requirement		
			Yes/ No

Appendix A – Location of Thrust bearing