

**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
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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.

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- 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 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.
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- 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.
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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 mrad 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

