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### 1.1 GENERAL

This specification covers the design, Manufacturing, Inspection & Testing of Bare Rubber Bellows with Retaining Rings of R. E. Joint Assembly at manufacturers work and properly packed for transportation & delivery to BHEL, Bhopal.

### 2.0 DESIGN REQUIREMENT

- 2.1 The expansion joint shall be of abrasion resistant, reinforced, natural or synthetic rubber bellows and shall be suitable for all operating conditions i.e. Design pressure, Axial & Lateral movements etc. as specified under Data Sheet-A enclosed to this specification. The Bellows shall be of single arch construction to suit the above requirement.
- 2.2 The Bellows shall not show any leakage upto the specified Hydrostatic test pressure/vacuum.
- 2.3 The Bellows shall be compressed/elongated by the amount as indicated in data sheet-A under the design pressure/vacuum condition.
- 2.4 The bellows shall be subjected to transverse movement as indicated in the data sheet-A under the design pressure vacuum condition.

### 3.0 GENERAL DESCRIPTION

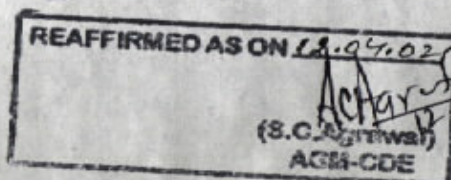
- 3.1 Bare rubber bellows with retaining rings under the scope of this specification are to be assembled with mechanical components manufactured at BHEL Bhopal and are intended for use on C.W. pipes at inlet and outlet of condenser to absorb vibration; linear thermal expansion and contraction and movement of pipes and expansion.

### 4.0 CONSTRUCTION FEATURES

#### 4.1 RUBBER BELLOWS

- 4.1.1 The inner and outer cover of the bellows shall be made of Abrasion Resistant, Reinforced, Synthetic Rubber of adequate thickness.

| REV. 02               | DISTRIBUTION   | QTY. | APPD. PRODUCT STANDARDIZATION COMMITTEE, CDE BHEL BHOPAL. |
|-----------------------|----------------|------|-----------------------------------------------------------|
| PARA 4.1.1; PAGE 1,   | OC             | 1    |                                                           |
| PARA 4.2. ; PAGE 2, & | HCM            | 1    |                                                           |
| PARA 5.2.9; PAGE 4    | STM            | 1    |                                                           |
| CHANGED.              | QC HCH, QC STM | 1,1  |                                                           |
| DATE 2.2.2000         |                |      | ISSUED BY: K.S. PILLAI<br>DATE : 25.08.90                 |



The inner cover shall be made in two layers with staggered circumferential and longitudinal lap joints. The Carcass between the inner and outer cover shall be made of high quality canvass duck and reinforcing material having suitable no. of plies and impregnation with rubber or synthetic compound. Reinforcement consisting of metal rings embedded in the carcass, may be provided if bellows design and construction necessitates such metallic reinforcement. The construction shall be such to have adequate strength to withstand pressure and stiffness to hold movements as specified in data sheet 'A'. If the design of bellows requires an internal strengthening ring with the arch then same shall be provided of stainless steel material.

- 4.1.2 Each rubber bellows shall have integral flanges at both ends. The flanges shall be made of tough, non compressible duck to resist stresses set up when the flange bolts are tightened. The flanges shall be designed to resist flow under bolting condition. The bolt holes drilled on the flanges shall be thoroughly coated with self vulcanizing rubber so that the edges of the plies are not exposed, or damaged while bolting/unbolting.

#### 4.2 RETAINING RINGS

Retaining rings shall be provided on each bellows to increase resistance to pressure. The rings shall be made of Rolled Steel Plate split, bevelled. They are to be placed directly against the flanges of the bellows and bolted through to the metal flanges of the pipe. Retaining rings are to be fully galvanised. Maximum gap between retaining ring segments shall be 4 mm. Match mark and identification marks are to be put on retaining ring with expansion joint. EB Nos. shall be etched on the retaining ring.

#### 5.0 SHOP INSPECTION AND TESTING

##### 5.1 GENERAL REQUIREMENT

- 5.1.1 Examination of material of construction, identification and correlation with material test certificate. In the absence of test certificates and correlation with materials 100% mechanical and chemical test shall be carried out by supplier at their cost as per the applicable code requirement and shall be witnessed by BHEL and their representatives.
- 5.1.2 The manufacturer shall conduct all tests required to ensure that all the components offered conform the requirements of specification and are in compliance with requirements of applicable codes and standards.

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| 5.1.3    | The particulars of the proposed shop tests and procedures for the tests shall be submitted to the BHEL / BHEL's representative for approval along with Quality Plan.                                                                                                                                                                                                                                                                     |                                                   |
| 5.1.4    | BHEL's representative shall be given full access to all tests. Adequate time before the shop tests, the manufacturer shall inform BHEL so that if desired, its representative can witness the tests.                                                                                                                                                                                                                                     |                                                   |
| 5.2      | <u>TESTS AND INSPECTION ON RUBBER BELLOWS</u>                                                                                                                                                                                                                                                                                                                                                                                            |                                                   |
|          | Before the manufacture of rubber bellows the raw material inspection shall be made at following stages.                                                                                                                                                                                                                                                                                                                                  |                                                   |
| 5.2.1    | <u>Polymer Identification</u>                                                                                                                                                                                                                                                                                                                                                                                                            |                                                   |
| 5.2.2    | Hardness as per ASTM D-2240-81. Value shall be 60 $\pm$ 5° Durometer.                                                                                                                                                                                                                                                                                                                                                                    |                                                   |
| 5.2.3    | Tensile strength and elongation at break point shall be 120 Kg/cm <sup>2</sup> and 350% respectively and testing shall be as per ASTM D-412-83 or IS 3400 Part-1.                                                                                                                                                                                                                                                                        |                                                   |
| 5.2.4    | Adhesion of Neoprene Rubber to fabric and metal. The acceptance norms for rubber to metal adhesion shall be 1.08 Kg / Linear mm (60 lbs / Linear inch) without stripping and reference document for test shall be ASTM S-429; 81 or, IS 3400 Part-XIV. The acceptance norms for rubber to fabric shall be 0.45 Kg / Linear mm (25 lbs / Linear inch) without stripping & reference documents shall be ASTM D-413; 82 or, IS 3400 Part V. |                                                   |
| 5.2.5    | Hydrolytic stability test for Neoprene Rubber as per ASTM D-3137, variation from original tensile strength shall be within $\pm$ 10% after 76 Hrs. and 5% change in volume.                                                                                                                                                                                                                                                              |                                                   |
| 5.2.6    | Surface Ozone test as per ASTM D-518 for 72 hours. There should be no crack on bellows surface during testing when ozone content is 50 PPHM.                                                                                                                                                                                                                                                                                             |                                                   |
| 5.2.7    | Blow lamp test on Neoprene as per M.I.L.E. 15330. Neoprene shall be able to extinguish itself within four seconds.                                                                                                                                                                                                                                                                                                                       |                                                   |
| 5.2.8    | Kerosene Dip test on Neoprene after dipping for One hour. There should be no visible defects or crack and no swelling in volume.                                                                                                                                                                                                                                                                                                         |                                                   |

5.2.9 After curing, each Rubber Bellows shall be subjected to the following test at manufacturer's works and held at that pressure for a period as specified in Data Sheet 'A' to check against leakage and any permanent deformation. There should be no visible defects or crack and no change/swelling in volume. During testing it is to be ensured that fasteners do not foul with arch of bellows.

A. HYDROSTATIC TEST

Hydrostatic test in normal position at the test pressure as per Data Sheet 'A'. The test is to be carried out for all Rubber Bellows. Change in circumference at top position of arch shall not exceed 1.5 % of measured circumference at normal position.

B. VACUUM TEST

Vacuum test in normal position at the test pressure as per Data Sheet 'A'. This test is to be carried out for all Bare Bellows. Change in circumference at top position of arch shall not exceed 1.5 % of measured circumference at normal position.

C. AXIAL COMPRESSION AND ELONGATION TEST.

For the purpose of determining axial stiffness rates for compression and elongation, the bellows would be tested under pressure and vacuum, as mentioned in data sheet. During vacuum test stiffness test values observed, shall be recorded for axial compression/elongation in steps of 5 mm from 0 to the maximum limit specified in data sheet 'A'. During pressure test, pressure shall be raised from 0 to the design pressure in steps of 1.0 kg/cm<sup>2</sup> and stiffness value observed shall be recorded for axial compression / elongation in steps of 5 mm from 0 to the maximum limit specified in data sheet 'A'. Twenty four hours after above test, the permanent set shall be measured and it should not be more than 0.5%.

D. TRANSVERSE DEFLECTION TEST

For the purpose of determining stiffness of the bellows in Transverse Direction, each bellows shall be subjected to transverse deflection under guided cantilever condition in which one end of flange is rigidly fixed and the other end is moved in the transverse direction within guided arrangement. For this bellows would be tested under vacuum and

pressurised from  $\emptyset$  to design pressure as specified in data sheet-A at an interval of 1 kg/sq.cm<sup>2</sup>(g) and deflected in the steps of 5 mm upto the limit specified in data sheet-A at each pressure interval.

#### 6.0 PAINTING

The exterior surface of cover of the expansion bellows shall be given a coat of protective coating of rubber based paint compatible with Neoprene for long service life to with stand severe weather conditions and also prevent damage from occasional contact with oil etc.

#### 7.0 DRAWING AND DATA WITH THE BID

The Bidder shall enclose following with the Bid.

- 7.1 Data Sheet 'B' with all the particulars filled in.
- 7.2 Dimensional drawings of bare bellows and retaining rings including weight.
- 7.3 Illustrative literature and pamphlets on the expansion bellows offered.
- 7.4 List of manufacture and supply of similar bellows for similar service.
- 7.5 Standard Quality Plan of the bare bellows and retaining rings showing particulars of shop-test to be conducted during/after manufacture is enclosed with this specification. Supplier to convey concurrence for standard Q. A. Plan. In case of any change supplier to mention the same in offer and forward fresh Q. A. plan. Vendor shall submit Q. A. plan with all references document for BHEL approval.
- 7.6 Curves for stiffness value v/s deflection for each pair of bellows shall be furnished. Curves shall be plotted for stiffness values observed with internal pressure varying from  $\emptyset$  to design pressure at an interval of 1 kg/cm<sup>2</sup> and vacuum, for deflection from  $\emptyset$  to 25 mm at an interval of 5 mm.
- 7.7 Vendor shall offer the material to BHEL / Customer's Inspection Agency for inspection stage. In the Q. A. Plan beyond which work will not proceed without written consent of BHEL or Inspection Agency.
- 7.8 Material shall only be dispatched after inspection & clearance by BHEL / Inspection Agency.

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RUBBER EXPANSION JOINT

DATA SHEET - A

PROJECT :

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| S.NO. | DESCRIPTION                                             | UNITS       | DATA / PARAMETERS       |
|-------|---------------------------------------------------------|-------------|-------------------------|
| 01    | JOINT TYPE                                              | -           | PRESSURE BALANCE TYPE   |
| 02    | SIZE ( ID )                                             | mm          |                         |
| 03    | TYPE                                                    | -           | SINGLE ARCH TYPE        |
| 04    | QUANTITY                                                | nos.        |                         |
| 05    | FLOW                                                    |             |                         |
| 05.1  | NORMAL                                                  | cu.m/hr.    | -                       |
| 05.2  | MAXIMUM                                                 | cu.m./hr.   | -                       |
| 06    | LOCATION                                                | -           | CONDENSER INLET /OUTLET |
| 07    | FLUID HANDLED                                           | -           | COOLING WATER           |
| 08    | LAYING LENGTH OF BELLOWS<br>(FACE TO FACE DIMENSION) mm |             |                         |
| 09    | END CONNECTION DETAILS                                  | -           | FLANGED                 |
| 10    | DESIGN PRESSURE/VACUUM                                  |             |                         |
| 10.1  | DESIGN PRESSURE                                         | kg/sq.cm.g. |                         |
| 10.2  | DESIGN VACUUM                                           | mm Hg(abs)  | FULL VACUUM             |
| 11    | DESIGN TEMPERATURE                                      | Deg. Cent.  |                         |
| 12    | NUMBER OF ARCHES                                        | No(s).      | SINGLE                  |

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| 13                              | MINIMUM JOINT MOVEMENTS                                                                                                                       |        |                                                                                 |            |
| 13.1                            | AXIAL COMPRESSION OF BARE BELLOWS UNDER THE DESIGN PRESSURE                                                                                   | mm     |                                                                                 |            |
| 13.2                            | AXIAL ELONGATION OF BARE BELLOWS UNDER THE DESIGN PRESSURE                                                                                    | mm     |                                                                                 |            |
| 13.3                            | TRANSVERSE MOVEMENTS OF BARE BELLOWS UNDER THE DESIGN PRESSURE                                                                                | mm     |                                                                                 |            |
| 14                              | STIFFNESS RATE FOR BELLOWS                                                                                                                    |        |                                                                                 |            |
| 14.1                            | LATERAL STIFFNESS OF BELLOWS AT SPECIFIED DESIGN PRESSURE & AT A DEFLECTION OF 10 mm, SHALL NOT EXCEED                                        | N / mm |                                                                                 |            |
| 14.2                            | AXIAL STIFFNESS (BOTH FOR ELONGATION & COMPRESSION) OF BARE BELLOWS AT SPECIFIED DESIGN PRESSURE & AT A DEFLECTION OF 10 mm, SHALL NOT EXCEED | N / mm |                                                                                 |            |
| 15                              | BELLOWS COVER ( INNER / OUTER )                                                                                                               | -      | NEOPRENE 3mm THICK<br>SHORE HARDNESS:60+/-5<br>DEG. DUROMETER                   |            |
| 16                              | CARCASS                                                                                                                                       | -      | HIGH QUALITY CANVASS<br>DUCK & POLYSTER CHORD<br>REINFORCED WITH STEEL<br>RINGS |            |
| 17                              | END FLANGES                                                                                                                                   | -      | TOUGH NON-COMPRESSIBLE<br>DUCK SUITABLY REINFORCED                              |            |

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| 18   | RETAINING RINGS                                                                                             |                |                |
| 18.1 | QUANTITY                                                                                                    | Nos. / BELLOWS | TWO            |
| 18.2 | TYPE                                                                                                        | -              | SPLIT TYPE     |
| 18.3 | MATERIAL                                                                                                    | -              | M.S.GALVANISED |
| 19   | HYDROSTATIC TEST (BARE BELLOWS)                                                                             |                |                |
| 19.1 | TEST PRESSURE                                                                                               | Kg/sq.cm.g.    |                |
| 19.2 | DURATION                                                                                                    | Minutes        |                |
| 19.3 | NO. OF BELLOWS TO BE TESTED                                                                                 | Nos.           | ALL            |
| 19.4 | PERMISSIBLE PERMANENT DEFORMATION AFTER THE TEST                                                            | mm             | NIL            |
| 20   | VACUUM TEST (BARE BELLOWS)                                                                                  |                |                |
| 20.1 | TEST PRESSURE                                                                                               | mm of Hg.abs.  | 30             |
| 20.2 | DURATION                                                                                                    | Minutes        | 30             |
| 20.3 | NO. OF BELLOWS TO BE TESTED                                                                                 | Nos.           | ALL            |
| 20.4 | PERMISSIBLE PERMANENT DEFORMATION AFTER THE TEST                                                            | mm             | NIL            |
| 21   | DEFLECTION TEST OF BARE BELLOWS AT THE DESIGNED PRESSURE AT THE TEST VACUUM FOR DEFLECTION SPECIFIED BELOW. |                |                |
| 21.1 | AXIAL COMPRESSION                                                                                           | mm             |                |
| 21.2 | AXIAL ELONGATION                                                                                            | mm             |                |
| 21.3 | TRANSVERSE DEFLECTION                                                                                       | mm             |                |
| 22   | NO OF BELLOWS TO BE TESTED                                                                                  | NOS            | ALL            |

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DATA SHEET 'B'

| S.NO. | DESCRIPTION                                                | UNIT       | DATA/PARAMETER |
|-------|------------------------------------------------------------|------------|----------------|
| 1.    | MANUFACTURER                                               | -          |                |
| 2.    | SIZE (ID)                                                  | mm         |                |
| 3.    | TYPE                                                       | -          |                |
| 4.    | QUANTITY                                                   | Nos        |                |
| 5.    | FLOW                                                       | cu.m/hr    |                |
|       | a) NORMAL                                                  |            |                |
|       | b) MAXIMUM                                                 |            |                |
| 6.    | DESIGN PRESSURE                                            | Kg/sq.cm.g |                |
| 7.    | DESIGN TEMPERATURE                                         | Deg C      |                |
| 8.    | NO OF ARCHES                                               | Nos        |                |
| 9.    | a) LAYING LENGTH<br>(face to face dimension)               | mm         |                |
|       | b) LENGTH OF ARCH                                          | mm         |                |
| 10.   | WEIGHT OF BARE RUBBER BELLOWS                              | Kg         |                |
| 11.   | WEIGHT OF RETAINING RING                                   | Kg         |                |
| 12.   | DUCK SIZE                                                  | mm         |                |
| 13.   | PERMISSIBLE MOVEMENTS                                      |            |                |
| 13.1  | AXIAL ELONGATION OF BARE BELLOWS<br>UNDER DESIGN PRESSURE. | mm         |                |
| 13.2  | AXIAL COMPRESSION OF BARE<br>BELLOWS UNDER DESIGN PRESSURE | mm         |                |

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- 13.3 TRANSVERSE MOVEMENT OF BARE BELLOWS UNDER GUIDED CANTILEVER CONDITION AT DESIGN PRESSURE. mm
14. MATERIAL OF CONSTRUCTION
- 14.1 COVER (INNER/OUTER)
- a) THICKNESS mm
- b) MATERIAL -
- c) SHORE HARDNESS Degrees
- 14.2 CARCASS
- a) NO OF PLIERS Nos
- b) FABRIC TYPE -
- 14.3 WHETHER INNER & OUTER SURFACE PROVIDE THE COVERING OF NEOPRENE SYNTHETIC RUBBER.
- a) THICKNESS OF NEOPRENE COVERING mm
- 14.4 METAL REINFORCEMENTS
- a) TYPE -
- b) SIZE mm
- 14.5 END FLANGES
- a) TYPE -
- b) THICKNESS OF FLANGE mm
- 14.6 SPLIT RETAINING RING
- a) MATERIAL
- b) NO OF SEGMENT IN EACH RING Nos
- c) THICKNESS mm

15. HYDROSTATIC TEST
- a) TEST PRESSURE UNDER NORMAL POSITION. Kg/sq.cm.g
  - b) DURATION minutes
  - c) NOS TESTED Nos
16. VACUUM TEST
- a) TEST VACUUM UNDER NORMAL POSITION mm of Hg (abs)
  - b) DURATION minutes
  - c) NOS TESTED Nos
17. AXIAL AND TRANSVERSE DEFLECTION TESTS
- a) TEST PRESSURE UNDER GUIDED CANTILEVER POSITION Kg/sq.cm.g
  - b) DURATION minutes
  - c) NOS TESTED Nos
18. PARTICULARS OF SHOP TESTS TO BE CONDUCTED DURING/AFTER MANUFACTURING ENCLOSED WITH THE BID
19. PARTICULARS OF Q.A. PLAN FOR MATERIAL STAGES AND FINAL INSPECTION ENCLOSED WITH BID
20. SKETCHES TO ILLUSTRATE TO CONCEPTUAL TESTING ARRANGEMENTS/METHODS ENCLOSED WITH THE BID -
21. GRAPHS FOR THE SPRING RATES OF THE BARE BELLOWS ENCLOSED WITH THE BID -

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22. DETAIL OF PROTECTIVE COATING
  - a) OUTER SURFACE OF COVER
  - b) INNER SURFACE OF COVER
23. ESSENTIAL SPARES
24. DESIGN BURST FACTOR OF BARE BELLOWS
25. DESIGN CYCLE LIFE OF BARE BELLOWS