An ISO 9001 Company

# Bharat Heavy Electricals Limited

**(**High Pressure Boiler Plant**)**
Tiruchirappalli – 620014, TAMIL NADU, INDIA
MATERIALS MANAGEMENT

| **SUPPLY OF SPIRAL FINNED TUBES FOR HRSG APPLICATION.** | Phone: +91 431 2574119, 2574157<br>Fax : +91 431 2520233<br>Email : svsrini@bheltry.co.in<br>Web : www.bhel.com |
|---|---|

| **Reference No: FBC:PUR:SFT:OT/001** | **Date:18.01.2008** | **Due date for submission of quotation: 08.02.2008** |
|---|---|---|
| You are requested to quote the Enquiry number date and due date in all your correspondences. | | |

BHEL/Trichy is looking for supply of SPIRAL FINNED TUBES for HRSG application as per the Quantity & Technical details attached.

S.V. SRINIVASAN
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**Contact Address**

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**( OR)**

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REF: FBC:PUR:SFT/OT/001 DATED 18=01-2008

# SPECIAL CONDITIONS

1) This tender is for the supply of Spiral Finned Tubes AS PER DOC. NO. 4-HV-000-02106. REV.01 and TDC:0:106:Rev 03 dt 23.03.2001.

2) The vendor shall have adequate experience in manufacturing of High Frequency resistance welded Spiral Finned Tubes. The mother tubes shall be procured from Vendors specified in the **Annexure.-A**

3) The total requirement against this tender is around 2083 MT (12372 Nos) which is to be supplied within Six months from the date of purchase order placement. The vendor shall indicate in their offer clearly the monthly tonnage that can be manufactured in their factory against the requirement and also their total manufacturing capacity in M.T/Month.

4) The tender is in two parts. One part consisting of commercial and technical conditions along with Quality Plan for supply in line with our requirements. Techno-Commercial bid and price bid are to be submitted in separate sealed covers. In addition to technical and commercial conditions, vendors have to submit the filled in "Supplier Registration Forms" (available in www.bhel.com) along with the technical bid. Based on this and other conditions, as well as capacity and capability, vendors will be short-listed. Both these covers are to be put in a single cover duly superscribing the Enquiry Number. The technical and commercial bid will be opened on the due date and based on the acceptance of technical bid only, the price bid of the said vendors will be opened on a suitable date with due intimation.

Following will be the criteria for short-listing the vendors..

- Evaluation of the duly filled Supplier Registration Forms.
- Availability of minimum manufacturing, handling, testing and measuring facilities as detailed in the Supplier Registration Form.
- BHEL will have the right for spot assessment of the facilities

5) BHEL reserves the right to increase or decrease the tendered quantity and split the tendered quantity among more than one tenderer and place orders accordingly in any proportion based on commitment, requirement and supplier's capability in terms of delivery and quality as assessed by BHEL.

6) BHEL reserves the right to negotiate the L1 rate.

7) BHEL reserves the right to re-float the tender opened, if L1 price is not the lowest acceptable price to them inter-alia other reasons.

8) BHEL reserves the right to order on more than one vendor at the lowest acceptable price to BHEL.

**Project :**

# Details of Spiral Finned Tubes Per HRSG

| Section | Tube OD | Tube Thk | Tube Material | Fin Density | Fin Height | Fin Thk | Fin Type | Fin Material | No of tubes | Finned Length# | Tube Length | SFT Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mm | mm | | fins/m | mm | mm | | | | m | m | kg |
| HPSH-2 | 31.8 | 4.5 | SA213T91 | 200.0 | 12.5 | 1.25 | Solid | A240T409 | 264 | 22.7 | 23 | 43,183 |
| HPSH-1B | 31.8 | 4.5 | SA213T22 | 95.0 | 12.5 | 1.25 | Solid | A240T409 | 264 | 22.7 | 23 | 30,168 |
| HPSH-1A | 38.1 | 3.6 | SA213T22 | 90.0 | 12.5 | 1.25 | Solid | A240T409 | 264 | 22.7 | 23 | 30,861 |
| RH-2 | 51 | 3.25 | SA213T91 | 150.0 | 12.5 | 1.25 | Solid | A240T409 | 324 | 22.7 | 23 | 52,654 |
| RH-1 | 51 | 3.25 | SA213T22 | 65.0 | 12.5 | 1.25 | Solid | A240T409 | 324 | 22.7 | 23 | 39,781 |
| IP SH | 38.1 | 3.25 | SA210GrA1 | 75.0 | 15.9 | 1.25 | Serrated | IS513GrEDD | 132 | 22.7 | 23 | 15,322 |
| LP SH | 51 | 3.25 | SA210GrA1 | 180.0 | 15.9 | 1.25 | Serrated | IS513GrEDD | 108 | 22.7 | 23 | 17,558 |
| HP Evap | 38.1 | 3.6 | SA210GrA1 | 140.0 | 15.9 | 1.25 | Serrated | IS513GrEDD | 792 | 22.7 | 23 | 131,313 |
| HP Evap | 38.1 | 3.6 | SA210GrA1 | 200.0 | 15.9 | 1.25 | Serrated | IS513GrEDD | 1,452 | 22.7 | 23 | 297,352 |
| IP Evap | 38.1 | 3.25 | SA210GrA1 | 200.0 | 15.9 | 1.25 | Serrated | IS513GrEDD | 1,188 | 22.7 | 23 | 199,286 |
| LP Evap | 38.1 | 3.25 | SA210GrA1 | 200.0 | 15.9 | 1.25 | Serrated | IS513GrEDD | 1,452 | 22.7 | 23 | 243,572 |
| HPEC | 38.1 | 3.6 | SA210GrA1 | 200.0 | 15.9 | 1.25 | Serrated | IS513GrEDD | 3,960 | 22.7 | 23 | 693,921 |
| IP Eco | 38.1 | 3.25 | SA210GrA1 | 90.0 | 15.9 | 1.25 | Serrated | IS513GrEDD | 264 | 22.7 | 23 | 29,707 |
| CPH | 38.1 | 3.25 | SA210GrA1 | 150.0 | 15.9 | 1.25 | Serrated | IS513GrEDD | 264 | 22.7 | 23 | 37,659 |
| CPH | 38.1 | 3.25 | SA210GrA1 | 200.0 | 15.9 | 1.25 | Serrated | IS513GrEDD | 1,320 | 22.7 | 23 | 221,429 |
| | | | | | | | | | 12,372 | | | 2,083,766 |
| Prepared | Shyju | | Checked | ND urairaaj | | App | SP | **Document no- 4-HV-000-02106/Rev.01-10-01-08** | | | | |

**Notes:**

# Mother Tube Length - Finned Length + 300mm for each tube (150mm on each end)

## ANNEXURE-A

**A) Following BHEL approved Vendors**

| | Vendor Name | |
|---|---|---|
| 1 | BHARAT HEAVY ELECTRICALS LTD. | Manufacturer |
| 2 | INDIA METAL OVERSEAS CORPN. | Agent |
| 3 | METAL TUBE INDUSTRIES | Trader |
| 4 | METCHEM CORPORATION | Agent |
| 5 | MITSUBISHI CORPORATION | Agent |
| 6 | NAVRATNA METAL CORPN. | Trader |
| 7 | SANGHVI METALS | Trader |
| 8 | STEELMET INDUSTRIES | Trader |
| 9 | STERLING METAL DISTRIBUTORS | Trader |
| 10 | SUMITOMO CORPORATION INDIA PVT | Agent |
| 11 | ISMT LIMITED | Manufacturer |
| 12 | CHAMPAK STEEL & ENGINEERING CO | Trader |
| 13 | MAHARASHTRA SEAMLESS LTD | Manufacturer |
| 14 | SREEVASTSA TUBE CORPORATION | Trader |
| 15 | HEAVY METAL & TUBES LTD | Manufacturer |
| 16 | REMI METALS GUJARAT LIMITED | Manufacturer |
| 17 | MC STEEL TRADE INC | Trader |
| 18 | SUMITOMO CORPORATION | Trader |
| 19 | VALLOUREC & MANNESMANN TUBES | Manufacturer |
| 20 | BENTELER STAHL/ROHR GMBH & CO.KG. | Manufacturer |
| 21 | TENARIS DALMINE S.P.A | Manufacturer |
| 22 | METAL ONE CORPORATION | Trader |
| 23 | SIDERCA S.A.I.C | Manufacturer |
| 24 | SILCOTUB S.A | Manufacturer |
| 25 | TUBOS REUNIDOS S.A. | Manufacturer |
| 26 | TENARIS GLOBAL SERVICES,S.A., | Manufacturer |
| 27 | DODSAL CORPORATION PVT.LTD | Agent |
| 28 | MITSUBISHI CORPORATION INDIA PVT.LT | Agent |
| 29 | SRIPAD STEELS PVT LTD | Agent |
| 30 | INDIA METAL OVERSEAS CORPN. | Agent |

**OR**

**B)** Any other IBR approved well known tube maker

**OR**

**C)** For any MILL other than A & B BHEL's specific approval is required. For this new vendors their crediential of the MILL shal be submitted along with the offer.

**REVISION RECORD**:
Rev:01:01.01.95: Cl. 1.1, 2.2.2, 2.3.1., 2.3.2, 4.2 modified for including T91, Clauses renumbered .
Rev:02: &effdt&: Cl. 2.5.2.1, 3.2, 3.3, 3.9 to 3.15, 3.15.1, 3.15.2, 3.16, 3.19, 3.20, 5.1, 5.2 modified.
Rev:03: Cl 2.2.2, 3.15.1, 5.2.1 revised & renumbered as 5.3, 5.2.10 revised, 5.3 renumbered as 5.4 & based on CFT recommendation.

## 1.0 SCOPE

1.This Technical Delivery Condition specifies the additional requirements for the delivery of high frequency resistance welded spiral finned steel tubes conforming to the following specifications as per ASME Section IIA (Latest), where the fin is helically wound around the outer periphery of the tubes and welded continuously.

ERW : SA 178 Gr. A
Seamless : SA 192, SA 210 Gr. A1
: SA 209 T1
: SA 213 T11, T22 & T91
: SA 213 TP 304, 304L, 316, 316L & SA 268 TP 430

2. This TDC is supplementary to the mandatory requirements covered in the respective specifications.
3. The size and quantity shall be as specified in the purchase order.

## 2.0 MATERIAL

## 2.1 CHEMICAL COMPOSITION AND PROCESS

1.The tubes and fin materials shall conform to the specification given in the drawing/purchase order.
2.The steel for the tubes shall be made by any one of the processes allowed by the specification. The steel shall be fully killed.
3.The ferritic steel seamless tubes may be made by cold drawing or hot finishing. Stainless steel tubes shall only be cold drawn.
4. SA 178 Gr. A tubes shall be made by a qualified high frequency electric resistance welding process without any undercuts or notches. The weld flash shall be removed mechanically and the flash shall not exceed 0.15 mm in height on the inside of the tube.
5. The chemistry shall meet the specification requirements in both laddle and product analysis with the following restrictions:
a)Carbon content shall not exceed 0.25% for SA 210 Gr. A1 tubes.
b)For stainless steel tubes, the boron and vanadium content shall be limited to maximum 0.01% and 0.10% respectively.

## 2.2 DIMENSIONAL TOLERANCES

1. The dimensional tolerances of cold drawn tubes shall conform to ASME SA 450 in all respects.
2. The dimensional tolerances of hot finished tubes shall be as given below:
Tolerance on OD : +/- 0.4 mm for OD upto 76.1 mm.
Tolerance on thickness :- 0, + 28% for thickness < 3.6 mm
- 0, + 24% for thickness from 3.6to 4.5 mm (both incl.)
- 0, + 22% for thickness > 4.5 mm
3. SA 178 Gr. A tubes shall conform to the dimensional tolerances of SA 450 in all respects.

2.3 **HEAT TREATMENT**

1.Carbon steel tubes to SA 192 & SA 210 Gr. A1 may be supplied in sub critical annealed, fully annealed or normalised condition. Alloy steel tubes to SA 213 T11, T22 & T91 shall be supplied in normalised and tempered condition. Other tubes shall be heat treated as per the specification requirements.

2.4 **MECHANICAL TEST**

1. All tubes shall be subjected to mechanical tests as per the requirements of the respective specifications and SA 450. For carbon steel seamless tubes, the selection of test samples shall meet the requirements of A 520 over and above the specification requirements.

2.5 **NON DESTRUCTIVE TEST**

**I.ULTRASONIC TEST (For wall thickness 3.6mm and above)**

1. For tubes of wall thickness 3.6 mm and above, each length of tube shall be subjected to ultrasonic test in accordance with ASTM E213 for seamless tubes and E273 for ERW tubes with calibration notch of depth 5% of the wall thickness of the tube or 0.3 mm whichever is greater.
2. The calibration tube shall contain two longitudinal notches not exceeding 50 mm, which have been accurately machined along with longitudinal axis of the tube. For tubes of outer diameter exceeding 30 mm, one notch shall be on the outside and the other notch shall be on the inside separated by at least 75 mm. For ERW tubes, the reference notch shall be located at the centre of the weld.
3. Each tube shall be scanned so that the sound beam is propagated in both the clockwise and counter clockwise directions as observed from one end of the tube.

. **II.EDDY CURRENT TEST(For wall thickness below 3.6mm)**

1.For tubes of wall thickness below 3.6 mm, each length of tube shall be subjected to eddy current test in accordance with ASTM E309 with longitudinal calibration notch of depth 5% of the wall thickness of the tube, with a minimum of 0.3 mm. For ERW tubes the weld shall additionally be tested by UT as per Cl. 2.5.1.1 of this TDC.

. **III.HYDRAULIC TEST**

1. In addition to eddy current testing, each length of the tube of wall thickness below 3.6 mm shall be subjected to hydraulic test as per SA 450, to the pressure (P) calculated using the formula:

$$P = \frac{2 \times S \times t}{D}$$

Where, S = Stress, which is equal to 80% of the minimum specified yield strength of the material at room temperature.
t = Wall thickness of the tube.
D = Outside diameter of the tube

2.6 **REPAIRS AND FINISH**

1. The tubes shall be free from mill scales both on the inside and outside and shall present a workman like finish.
2. Repairs involving fusion welding is prohibited on the tube material.
3. Wherever defects are rectified by mechanical means, the wall thickness requirements shall be satisfactorily met with, and the surfaces shall be smoothly dressed up without any sharp edges.

3.0 **WELDING**

1.Prior to application of fins, the tubes and fins shall be cleaned properly to obtain the desired weld quality.

2. The fin shall be helically wound and cold formed around the bare tube in such a manner as to leave the major height of the welded fin in a position normal to the tube within a tolerance of +/- 10 degrees. The tolerance on the bare section shall be - 0, + 6 mm.

3. Thickness of the applied fin to be as specified in the drawing within the tolerance below:

| Specified thickness | Tolerance |
|---|---|
| 0.81 - 1.0 | 0.10 |
| 1.01 - 1.60 | 0.13 |
| 1.61 - 2.00 | 0.15 |
| 2.01 - 2.50 | 0.17 |
| 2.51 - 3.50 | 0.20 |

4. Tolerance on diameter over the fin shall be +/- 1.2 mm.

5. The tolerance on the number of fins on each tube shall be plus 5%, minus 2%.

6. The fin spacing and location of the fins shall be as specified in the drawing.

7. The attachment weld between the fin and the tube is to provide a continuous solid metal joint to improve heat transfer between the fin and the tube. This weld is not to be considered a strength or pressure containing weld.

8. The attachment weld shall be a continuous high frequency resistance weld, using a qualified welding procedure.

9. The weld fusion between the fin and the tube shall be to a minimum of 95% of the fin thickness.

10. The total width of corrugation at the fin base excluding weld expulsion shall not exceed 3 times the specified thickness of fin.

11. Interruptions in welding are permissible provided they do not exceed 2.5% of the finned length on each tube, do not exceed 5 consecutive wraps and do not occur within 150 mm. of another interruption or the end of a finned section along the axial length of the tube.

12. Any Tube having unwelded areas greater in extent than those defined in clauses 3.11 shall be rejected.

13. The finished finned tube shall be straight within 5 mm in any 3 metre section of the tube.

14. After fin welding, SA 213 T91 tubes shall be heat treated at 730 - 760 oC for 30 minutes soaking followed by air cooling, if the following conditions are not met:

a) The fin thickness is <= 3.2 mm.

b) Manufacturer shall demonstrate that the Heat Affected Zone does not encroach upon the minimum wall thickness of tube through Welding procedure qualification.

15.0.Process samples shall be made during manufacturing as given below, in addition to usual quality control measures. The samples shall be tested after heat treatment in the case of SA 213 T91 material if the product requires heat treatment as above.

15.1.Test samples shall be processed at the time of establishing welding parameters for each size of P.O and whenever the estsblished parameters are changed during normal welding period.Each weld samples shall be identified to actual job.It is preferable that samples are taken from actual job itself. In case separate test pieces are made, the supplier should ensure and maintain records to confirm that the test pieces are identical to the actual job. In case of failure of test samples to meet the requirements, 2 more samples shall be taken from the lot produced in the shift and the results shall meet the requirements. If the requirements are not met in an one of the samples , the lot shall be rejected.

15.2 BHEL reserves the right to conduct audit checks on samples cut out from the consignment recieved at our stores. Any major weld defect like crack or excessive unwelded area noticed will be the cause for rejection.

15.3. Test samples of about 200 mm length are to be taken from finned tubes for macro examination tensile strength. The frequency of test samples is as given above.

16. Results of macro examination and tensile strength are to be incorporated in the certificates and countersigned by the Inspecting Authority.

17. The macro test tube shall be sectioned at appropriate place and the cross section shall be macro etched to examine the fusion of the weld with a magnification factor of 10X. The fusion of the weld should not reveal any lack of fusion or cracks.

18. The hardness of the parent metal, weld and heat affected zone (HAZ) shall be measured at a minimum of two points each on the specimen. The hardness shall not exceed 270 VHN for carbon steel and 350 VHN for others.

19. The soundness of the weld shall be tested with a 25 mm length of fin weld cut from samples, and these test samples shall display a minimum tensile strength of 25 Ksi. calculated with the area of the fin.

20. The completed finned tubes shall be free from injurious defects like cracks and shall have a workman like finish.

## 4.0 MARKING AND PACKING

4.1 1. Each tube shall be marked by paint stenciling in the bare portion with the following details. (For stainless steel tubes, the paint must be free from corrosion promoting agents like Sulphur).

1. Size
2. Specification and grade
3. Heat number
4. Supplier's emblem

4.2 1. In addition, each length of the tube shall be colour coded circumferentially on both ends as per SIP:PP:21(latest)

2. Tubes other than stainless steel shall be coated with translucent resin type rust preventive oil outside and shall be provided with a rust inhibitor like VCI pellets inside.

3. Stainless steel tubes do not require either rust preventive coating outside or rust inhibitor inside.

4.3 The ends of the tubes shall be closed with end caps, which shall be securely held, so that it Will not fall off during transit.

4.4 The finned tubes shall be packed in wooden crates in such a way that the tubes are intact during transportation and handling. The tubes should not move individually during shipment. Also they should be shipped properly so that items are received at our stores without any damage.

## 5.0 INSPECTION AND CERTIFICATION

5.1 The bare as well as the finned tube shall be subjected to inspection by an Authorised Inspecting Authority recognised under IBR. All the test certificates (in respective IBR Form) shall be countersigned by the Authorised Inspecting Authority.

5.2 The certificates shall furnish the following details in ENGLISH language only.

1. Purchase Order reference (BHEL)
2. Test certificate number
3. Specification and grade with applicable year of code.
4. Quantity & Size
5. Heat number
6. Steel making process
7. Ladle analysis heat-wise
8. Product analysis heat-wise
9. Heat treatment details
10. Mechanical and applicable metallurgical test results for bare tubes,fins and finned tubes

11.NDT results with reference standard
12.Hydraulic test results
13.Dimensional reports

5.3 Copy of raw material TC for bare tubes, fin material shall be enclosed.

5.4 Wherever specified in Purchase Order, the tubes shall be subjected to inspection by Authorities nominated by BHEL and the test certificates shall be countersigned by them.

6.0 **END USE**

6.1 These spiral finned tubes are intended for use in the header modules of industrial boilers at stress levels and temperatures allowed as per IBR and ASME Section I.

| R.Rajasekar | G.S.N.Murthy | K.Rengachari |
|---|---|---|
| Prepared | Reviewed | Approved |