

**Bharat Heavy Electricals Limited-Trichy**  
**Product Engineering/FB/Ducts**

Ref No: PE/FB/DUCTS/STEEL

Date: 28.11.2019, Rev.01

Technical Specification for Procurement of S-TEN 1 or better material for Duct from FGD Biplane  
(By-pass) damper up to Chimney Inlet

Project: PANKI, UPRVUNL-1x660 MW Pulverized Coal Fired Power Plant

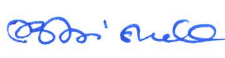
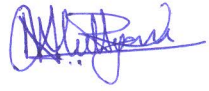
**Intention of Specification:**

In the Panki TPS Extension project, Flue Gas Desulfurization(FGD) Plant Gas outlet will be let into the boiler portion of induced draft fan ducting to chimney after a biplane (By-pass) damper. This technical specification is made for inviting tenders for the supply of plates to fabricate the duct from FGD Biplane (By-pass) damper entering into the Chimney and up to the terminal point as customer's applicable contract specification / amendment calls for usage of S-TEN 1 or better material.

As customer specification calls for S-TEN 1 or better material, customer approval is to be obtained by BHEL Trichy, in case if any better material is selected / recommended by the probable vendor other than S-TEN 1 material. The following are the salient points to be noted and vendors are requested to submit the proposal.

| Sl. No. | BHEL Requirements                                                                                                                                                                                                                                                                                                                                                            | Supplier's Reply |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| 1       | The Material shall be Steel based allotropy (hereafter called as Steel), Monolithic and Isotropic in strength. Any kind of coatings / painting or lining material including Glass flakes, borosilicate, special plastics, GRP and bimetallic materials etc. are not acceptable. An elevation sketch is added to illustrate the usage of applicable portion as in Annexure-1. |                  |
| 2       | The steel shall be corrosion resistant at dew points of sulfuric acid and hydrochloric acids also as per usual practices followed in selection of material in any FGD outlet ducting with Gas to Gas Air Heater as part in FGD Plant.                                                                                                                                        |                  |
| 3       | The steel should be suitable for withstanding low temperature acid dew corrosion due to contents of gases passing through the ducts made up of steel wall plates while FGD is in operation and FGD is not in operation also. These service conditions are tabulated in Annexure-2.                                                                                           |                  |
| 4       | The offered steel shall be S-TEN 1 or better material with wall plate thickness of 9mm.<br>In case of better steel, justification shall be furnished by the vendor with respect to codes/standards.                                                                                                                                                                          |                  |
| 5       | The Name and Type of steel and its specification, Vendor shall furnish above details with respect to applicable codes/standards and to include copy of applicable portions of standards.                                                                                                                                                                                     |                  |
| 6       | The vendor shall furnish the mechanical properties and chemical composition of the offered steel. Graph for high temperature tensile test including tensile strength and yield strength test are to be furnished.<br>Percentage of elongation shall also be furnished.                                                                                                       |                  |
| 7       | Special Requirement:                                                                                                                                                                                                                                                                                                                                                         |                  |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 7a | Duct Size is around height of 8750mm & 5000mm wide and hence plate to plate joint to attain the above size, internal Truss, Corner Angle, struts are also to be fabricated as plate formed section with same steel. The typical cross section used are enclosed in Annexure-3. Hence selected material shall be suitable for fabricating above shapes.                                                                                                                                                                             |  |
| 7b | For strength of the steel duct as per in-house design, external stiffeners are used as integral part of steel duct. External stiffeners and external supports are of built up section/rolled I-beams etc. are made up of IS2062 E250 Gr A and equivalent (Yield strength of 250 Mpa). Offered steel should be weldable with above stiffeners and supports material and vendor to specify welding electrodes and care to be taken during welding.<br>Refer Annexure-5 for Chemical and Mechanical properties of IS2062 E250 Gr A.   |  |
| 8  | Corrosion Rates from Mass Loss Measurement:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| 8a | A Graph for acid concentration in X-axis and corrosion-rate(mm/year) of thickness of plate in Y-axis with acid concentration from 0 to 10% shall be furnished for H <sub>2</sub> SO <sub>4</sub> and HCl acid concentration separately for scrutiny. A typical curve for H <sub>2</sub> SO <sub>4</sub> and HCl is indicated in Annexure-4 for reference. (The curves which are indicated to express the axis usage and hence vendor may furnish the curve in similar way and the curve shown does not show any specific material) |  |
| 8b | A corrosion test method shall be used for the above and a write-up shall also be furnished.                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| 9  | Recommended maximum and minimum flue gas operating temperature are to be indicated for the offered steel.                                                                                                                                                                                                                                                                                                                                                                                                                          |  |
| 10 | Vendor to provide test certificates to prove that offered material will satisfy the service condition as per Annexure-2.                                                                                                                                                                                                                                                                                                                                                                                                           |  |
| 11 | Vendor to provide proven track record for similar application for reference.                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| 12 | Strength, Workability and Weldability shall be comparable to ordinary steel/Carbon Steel.                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |

| Prepared By                                                                         | Checked By                                                                          | Approved By                                                                                                                                                                 |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  |  |   |
| Abhishek Kamal                                                                      | M. Rajasekar                                                                        | M. Shanmugam/N. Murugan                                                                                                                                                     |



Steel to be offered

**UPRVUNL/Panki-1x660MW**

**Annexure - 2**

**Flue gas Conditions- FGD NOT in Operation**

| Sl no | Description                                           | Unit | LOAD    |         |         |         |         |            |            |            |            |            |
|-------|-------------------------------------------------------|------|---------|---------|---------|---------|---------|------------|------------|------------|------------|------------|
|       |                                                       |      | BMCR-DC | BMCR-WC | BMCR-BC | TMCR-DC | TMCR-WC | 60%TMCR-DC | 60%TMCR-WC | 50%TMCR-WC | 40%TMCR-DC | 40%TMCR-WC |
| 1     | Predicted Flue gas temperature                        | °C   | 133     | 140     | 130     | 130     | 135     | 123        | 122        | 120        | 120        | 120        |
| 2     | Maximum Flue Gas temperature                          | °C   | ← 160 → |         |         |         |         |            |            |            |            |            |
| 3     | Maximum Flue gas temperature excursion for 15 minutes | °C   | ← 200 → |         |         |         |         |            |            |            |            |            |
| 4     | Flue gas constituents, Wet Basis - % By Weight        |      |         |         |         |         |         |            |            |            |            |            |
| i     | CO <sub>2</sub>                                       | %    | 18.983  | 17.829  | 18.080  | 20.173  | 18.396  | 19.476     | 18.290     | 18.290     | 18.983     | 17.829     |
| ii    | N <sub>2</sub>                                        | %    | 69.790  | 69.193  | 70.055  | 69.415  | 69.385  | 69.635     | 69.422     | 69.422     | 69.790     | 69.582     |
| iii   | O <sub>2</sub>                                        | %    | 6.398   | 6.389   | 6.411   | 5.364   | 5.863   | 5.970      | 5.962      | 5.962      | 6.398      | 6.389      |
| iv    | SO <sub>2</sub>                                       | %    | 0.120   | 0.131   | 0.112   | 0.120   | 0.135   | 0.116      | 0.134      | 0.134      | 0.113      | 0.131      |
| v     | H <sub>2</sub> O                                      | %    | 4.715   | 6.070   | 5.342   | 4.928   | 6.221   | 4.803      | 6.193      | 6.193      | 4.715      | 6.070      |
| 5     | SO <sub>3</sub> Content-Dry basis                     | ppm  | 8.3     | 9.8     | 8.3     | 8.9     | 10.2    | 8.6        | 10.1       | 10.1       | 8.3        | 9.8        |
|       |                                                       |      |         |         |         |         |         |            |            |            |            |            |
|       |                                                       |      |         |         |         |         |         |            |            |            |            |            |
|       |                                                       |      |         |         |         |         |         |            |            |            |            |            |
|       |                                                       |      |         |         |         |         |         |            |            |            |            |            |



UPRVUNL/Panki-1x660MW

Annexure - 2

Flue gas Conditions - FGD /N Operation

| Sl no | Description                                    | Unit                     | LOAD            |         |         |         |         |            |            |            |            |            |
|-------|------------------------------------------------|--------------------------|-----------------|---------|---------|---------|---------|------------|------------|------------|------------|------------|
|       |                                                |                          | BMCR-DC         | BMCR-WC | BMCR-BC | TMCR-DC | TMCR-WC | 60%TMCR-DC | 60%TMCR-WC | 50%TMCR-WC | 40%TMCR-DC | 40%TMCR-WC |
| 1     | Predicted Flue gas temperature                 | °C                       | 98              | 104     | 97      | 97      | 101     | 92         | 93         | 92         | 90         | 92         |
| 2     | Minimum Flue Gas temperature                   | °C                       | ← 80 →          |         |         |         |         |            |            |            |            |            |
| 3     | Flue gas constituents, Wet Basis - % By Weight |                          |                 |         |         |         |         |            |            |            |            |            |
| i     | CO <sub>2</sub>                                | %                        | 18.71           | 17.57   | 17.83   | 19.89   | 18.15   | 19.19      | 18.06      | 18.04      | 18.71      | 17.58      |
| ii    | N <sub>2</sub>                                 | %                        | 68.64           | 68.64   | 68.95   | 68.36   | 68.29   | 68.65      | 68.65      | 68.50      | 68.85      | 68.66      |
| iii   | O <sub>2</sub>                                 | %                        | 6.31            | 6.29    | 6.32    | 5.30    | 5.78    | 5.93       | 5.92       | 5.94       | 6.36       | 6.36       |
| iv    | SO <sub>2</sub>                                | %                        | 0.0060          | 0.0059  | 0.0059  | 0.0064  | 0.0061  | 0.0061     | 0.006      | 0.006      | 0.006      | 0.0059     |
| v     | H <sub>2</sub> O                               | %                        | 6.34            | 7.76    | 6.88    | 6.44    | 7.77    | 6.20       | 7.54       | 7.51       | 6.07       | 7.39       |
| 4     | SO <sub>3</sub> Content-Dry basis              | ppm                      | ← < 5 ppm-Dry → |         |         |         |         |            |            |            |            |            |
| 5     | H <sub>2</sub> SO <sub>4</sub>                 | mg/Nm <sup>3</sup> (Dry) | 12.7            | 19.9    | 11.9    | 10.92   | 16.6    | 6.6        | 6.75       | 3.71       | 3.9        | 4.5        |
| 6     | HCl                                            | ppm-dry                  | 2.6             | 2.4     | 2.7     | 2.61    | 2.4     | 2.71       | 2.32       | 2.31       | 2.7        | 2.31       |

**Note:**

1) Flue gas conditions at FGD NOT in operation and FGD /N operation shall be considered while selecting Duct material from FGD bypass damper to Chimney inlet.

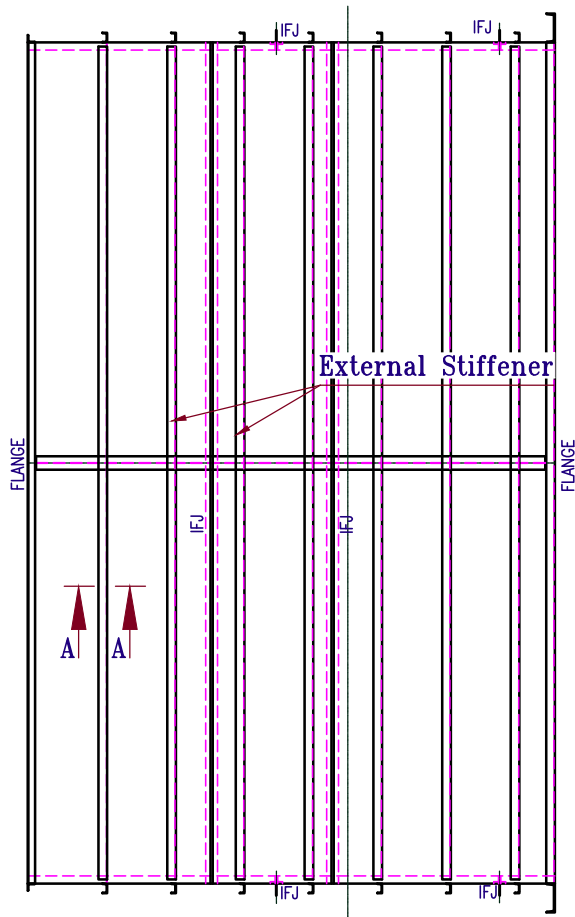
**Rev01:** H<sub>2</sub>SO<sub>4</sub> and HCl content in flue gas when FGD in operation included.

Date 27.11.19/Rev.01

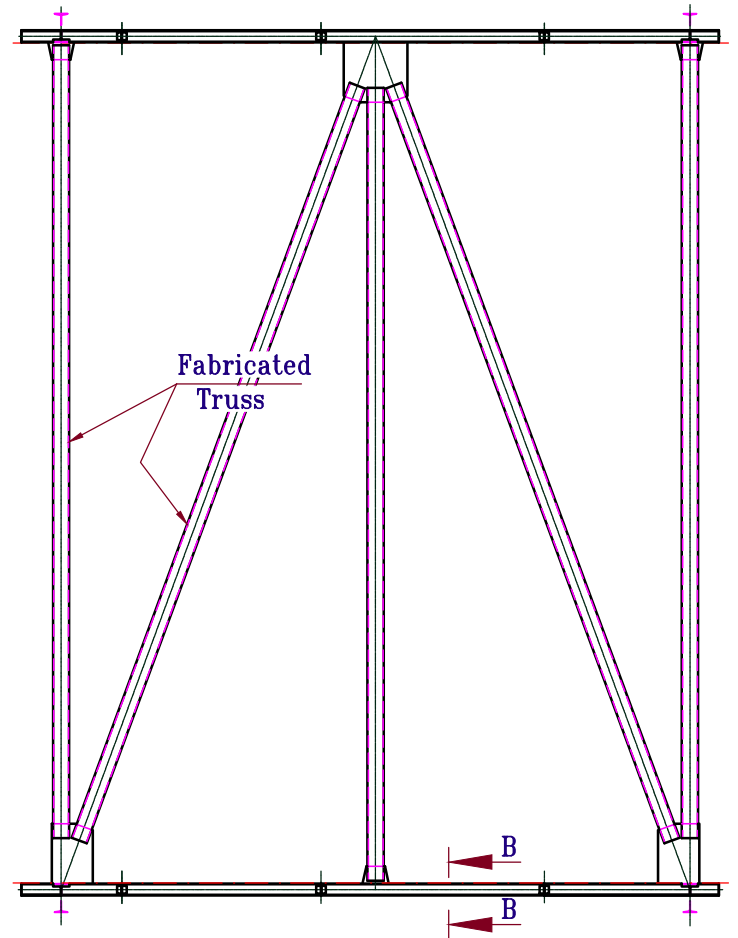
## **Annexure - 2**

### **Legend:**

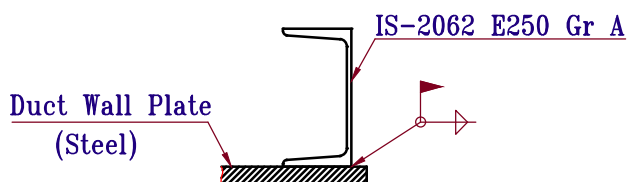
1. **BMCR-DC**=Boiler Maximum Continuous Rating while firing Design Coal.
2. **TMCR-DC**=Turbine Maximum Continuous Rating while firing Design Coal.
3. **BMCR-WC**=Boiler Maximum Continuous Rating while firing Worst Coal.
4. **TMCR-WC**=Turbine Maximum Continuous Rating while firing Worst Coal.
5. **BMCR-BC**= Boiler Maximum Continuous Rating while firing Best Coal.



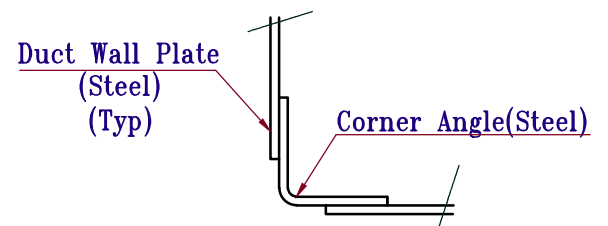
Typical Duct Section



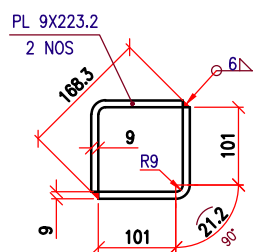
Typical Internal Truss Arrangement (Steel)



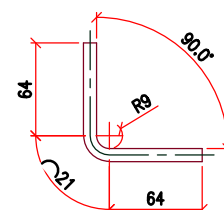
SECTION - AA  
(Typical Stiffener)



SECTION - BB  
(Typical Corner Construction)



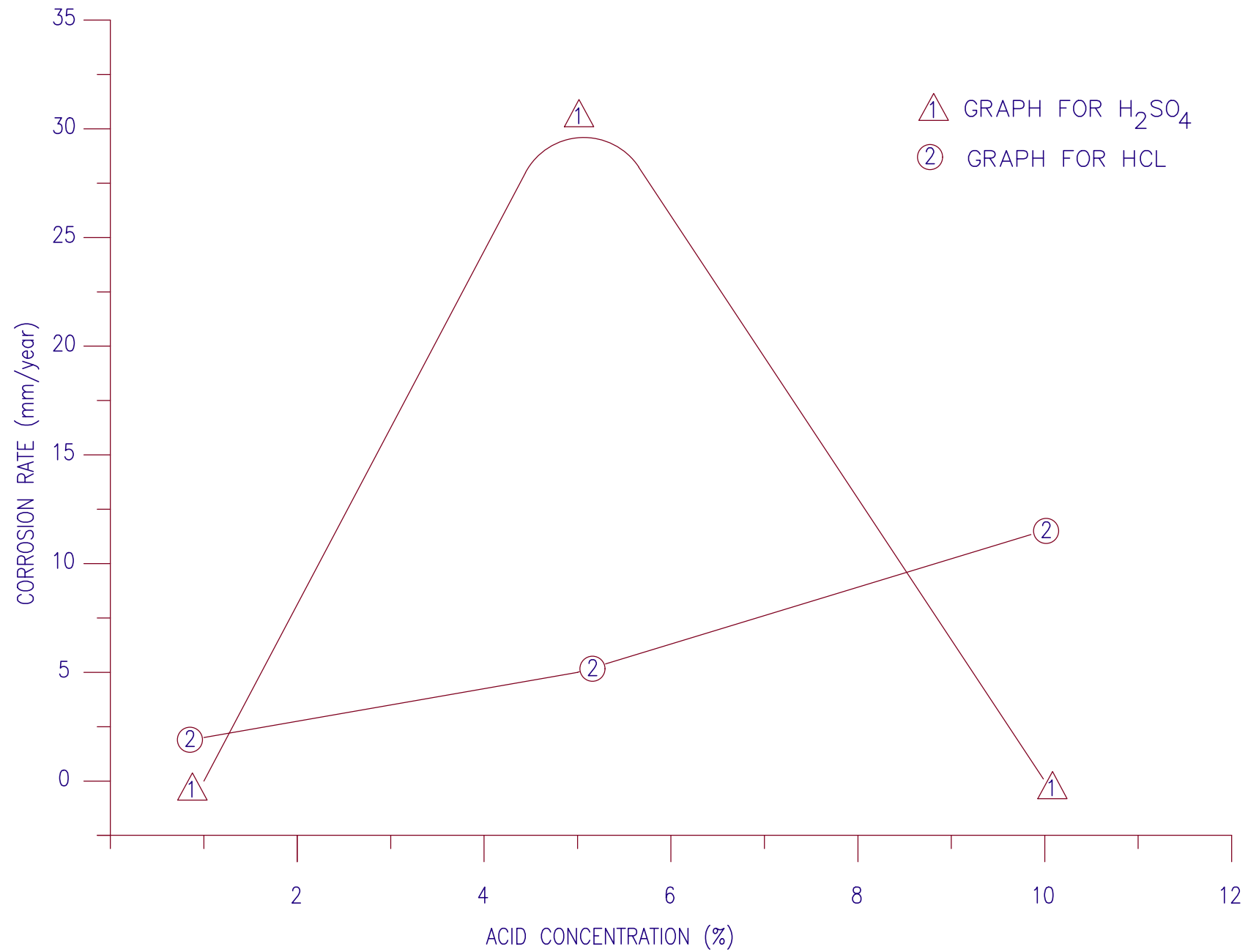
Fabricated Truss  
Hollow Section(Steel)  
(Typical)



Corner Angle(Steel)  
(Typical)

Legend:

IFJ: Internal Field Joint





## Annexure - 5

### Chemical and Mechanical Property for IS-2062 E250 Gr A

IS 2062 : 2011

**Table 1 Chemical Composition**  
(Clauses 5, 8.1 and 8.2)

| Grade Designation | Quality  | Ladle Analysis, Percent, Max |      |       |       |      | Carbon Equivalent (CE), Max | Mode of Deoxidation |
|-------------------|----------|------------------------------|------|-------|-------|------|-----------------------------|---------------------|
|                   |          | C                            | Mn   | S     | P     | Si   |                             |                     |
| (1)               | (2)      | (3)                          | (4)  | (5)   | (6)   | (7)  | (8)                         | (9)                 |
| E 250             | A        | 0.23                         | 1.50 | 0.045 | 0.045 | 0.40 | 0.42                        | Semi-killed/killed  |
|                   | BR<br>B0 | 0.22                         | 1.50 | 0.045 | 0.045 | 0.40 | 0.41                        | Semi-killed/killed  |
|                   | C        | 0.20                         | 1.50 | 0.040 | 0.040 | 0.40 | 0.39                        | Killed              |

**Fig.1: Chemical Properties**

IS 2062 : 2011

**Table 2 Mechanical Properties**  
(Clauses 5, 10.3, 10.3.1, 11.3.1, 12.2 and 12.4)

| Grade Designation | Quality | Tensile Strength<br>$R_m$ , Min<br>MPa <sup>1)</sup><br>(See Note 1) | Yield Stress<br>$R_{eH}$ , Min<br>MPa <sup>1)</sup> |       |     | Percentage Elongation<br>$A$ , Min<br>at Gauge Length,<br>$L_0=5.65$ | Internal Bend Diameter<br>Min<br>(See Note 2) |     | Charpy Impact Test<br>(See Note 3) |       |
|-------------------|---------|----------------------------------------------------------------------|-----------------------------------------------------|-------|-----|----------------------------------------------------------------------|-----------------------------------------------|-----|------------------------------------|-------|
|                   |         |                                                                      | <20                                                 | 20-40 | >40 |                                                                      | ≤ 25                                          | >25 | Temp °C                            | Min J |
|                   |         | (3)                                                                  | (4)                                                 | (5)   | (6) | (7)                                                                  | (8)                                           | (9) | (10)                               | (11)  |
| E 250             | A       | 410                                                                  | 250                                                 | 240   | 230 | 23                                                                   | 2t                                            | 3t  | —                                  | —     |
|                   | BR      |                                                                      |                                                     |       |     |                                                                      |                                               |     | RT                                 | 27    |
|                   | B0      |                                                                      |                                                     |       |     |                                                                      |                                               |     | 0                                  | 27    |
|                   | C       |                                                                      |                                                     |       |     |                                                                      |                                               |     | (-) 20                             | 27    |
| E 275             | A       | 430                                                                  | 275                                                 | 265   | 255 | 22                                                                   | 2t                                            | 3t  | —                                  | —     |
|                   | BR      |                                                                      |                                                     |       |     |                                                                      |                                               |     | RT                                 | 27    |
|                   | B0      |                                                                      |                                                     |       |     |                                                                      |                                               |     | 0                                  | 27    |
|                   | C       |                                                                      |                                                     |       |     |                                                                      |                                               |     | (-) 20                             | 27    |
| E 300             | A       | 440                                                                  | 300                                                 | 290   | 280 | 22                                                                   | 2t                                            | —   | —                                  | —     |
|                   | BR      |                                                                      |                                                     |       |     |                                                                      |                                               |     | RT                                 | 27    |
|                   | B0      |                                                                      |                                                     |       |     |                                                                      |                                               |     | 0                                  | 27    |
|                   | C       |                                                                      |                                                     |       |     |                                                                      |                                               |     | (-) 20                             | 27    |
| E 350             | A       | 490                                                                  | 350                                                 | 330   | 320 | 22                                                                   | 2t                                            | —   | —                                  | —     |
|                   | BR      |                                                                      |                                                     |       |     |                                                                      |                                               |     | RT                                 | 27    |
|                   | B0      |                                                                      |                                                     |       |     |                                                                      |                                               |     | 0                                  | 27    |
|                   | C       |                                                                      |                                                     |       |     |                                                                      |                                               |     | (-) 20                             | 27    |
| E 410             | A       | 540                                                                  | 410                                                 | 390   | 380 | 20                                                                   | 2t                                            | —   | —                                  | —     |
|                   | BR      |                                                                      |                                                     |       |     |                                                                      |                                               |     | RT                                 | 25    |
|                   | B0      |                                                                      |                                                     |       |     |                                                                      |                                               |     | 0                                  | 25    |
|                   | C       |                                                                      |                                                     |       |     |                                                                      |                                               |     | (-) 20                             | 25    |
| E 450             | A       | 570                                                                  | 450                                                 | 430   | 420 | 20                                                                   | 2.5t                                          | —   | —                                  | —     |
|                   | BR      |                                                                      |                                                     |       |     |                                                                      |                                               |     | RT                                 | 20    |
| E 550             | A       | 650                                                                  | 550                                                 | 530   | 520 | 12                                                                   | 3t                                            | —   | —                                  | —     |
|                   | BR      |                                                                      |                                                     |       |     |                                                                      |                                               |     | RT                                 | 15    |
| E 600             | A       | 730                                                                  | 600                                                 | 580   | 570 | 12                                                                   | 3.5t                                          | —   | —                                  | —     |
|                   | BR      |                                                                      |                                                     |       |     |                                                                      |                                               |     | RT                                 | 15    |
| E 650             | A       | 780                                                                  | 650                                                 | 630   | 620 | 12                                                                   | 4t                                            | —   | —                                  | —     |
|                   | BR      |                                                                      |                                                     |       |     |                                                                      |                                               |     | RT                                 | 15    |

#### NOTES

1 In case of product thickness/diameter more than 100 mm, lower minimum limit of tensile strength may be mutually agreed to between the purchaser and the manufacturer/supplier.

2 Bend test not required for thickness > 25 mm for grades E 300 to E 650. 't' is the thickness of the test piece.

3 For sub-quality BR, impact test is optional; if required, at room temperature (25 ± 2°C).

<sup>1)</sup> 1MPa = 1N/mm<sup>2</sup> = 1MN/m<sup>2</sup> = 0.102 kgf/mm<sup>2</sup> = 144.4 psi.

**Fig.2: Mechanical Properties**

**Note:** For other details refer IS-2062(latest).