APPENDIX 1

45T EOF PHOTOGRAPHS

Figure A1.1  45T EOF submerge tuyere

Figure A1.2  45T EOF atmospheric injector & hot metal pouring hole
Figure A1.3  45T EOF tap hole

Figure A1.4  45T EOF scrap preheater
Figure A1.5 45T EOF water cooled shell & roof panels

Figure A1.6 45T EOF scrap charging into furnace
Figure A1.7 45T EOF gas cleaning plant - venturi

Figure A1.8 45T EOF hot metal pouring
Figure A1.9  45T EOF hand lancing through working door

Figure A1.10  45T EOF opening the tap hole
Figure A1.11  45T EOF steel tapping
APPENDIX 2

TECHNICAL SPECIFICATION OF 65 MT EOF EQUIPMENTS

A2.1 Water Cooled Elements

The cooled water elements for EOF have the form of panels (tubular or box type with internal labyrinths in steel plates), tubes, beams and pieces with special shapes according to the project. The water flow rate has to be defined for each circuit as shown in Tables A2.1, A2.2, A2.3 and A2.4 in order to guaranty during the operation a Maximum $\Delta t = 15^\circ C$.

Table A2.1  Furnace W.C. elements – bottom and shell (Circuit 1)

<table>
<thead>
<tr>
<th>Type</th>
<th>Qt.</th>
<th>Exp. Area m² elem.</th>
<th>Spec Flow l/min.m²</th>
<th>Flow m³/h.el</th>
<th>Tot. Flow m³/h</th>
<th>Acum. Flow m³/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shell and Bottom</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supersonic lances</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>25.00</td>
<td>50.00</td>
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<tr>
<td>Bottom Flange</td>
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<td>0.78</td>
<td>200.7</td>
<td>9.39</td>
<td>9.39</td>
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</tr>
<tr>
<td>Upper panel – U1</td>
<td>5</td>
<td>1.63</td>
<td>200.7</td>
<td>19.63</td>
<td>98.15</td>
<td></td>
</tr>
<tr>
<td>Upper panel – U2</td>
<td>3</td>
<td>1.79</td>
<td>200.7</td>
<td>21.55</td>
<td>64.65</td>
<td></td>
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<tr>
<td>Upper panel – U3</td>
<td>1</td>
<td>1.79</td>
<td>200.7</td>
<td>21.55</td>
<td>21.55</td>
<td></td>
</tr>
<tr>
<td>Upper panel – U4</td>
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<td>1.63</td>
<td>200.7</td>
<td>19.63</td>
<td>19.63</td>
<td></td>
</tr>
<tr>
<td>Upper panel – U5</td>
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<td>1.79</td>
<td>200.7</td>
<td>21.55</td>
<td>21.55</td>
<td></td>
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<tr>
<td>Upper panel – U6</td>
<td>1</td>
<td>1.79</td>
<td>200.7</td>
<td>21.55</td>
<td>21.55</td>
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<tr>
<td>Lower panel – L1</td>
<td>5</td>
<td>1.63</td>
<td>200.7</td>
<td>19.63</td>
<td>98.15</td>
<td></td>
</tr>
<tr>
<td>Lower panel – L2</td>
<td>1</td>
<td>1.75</td>
<td>200.7</td>
<td>21.07</td>
<td>21.07</td>
<td></td>
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<tr>
<td>Lower panel – L3</td>
<td>1</td>
<td>1.75</td>
<td>200.7</td>
<td>21.07</td>
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<td>Lower panel – L4</td>
<td>1</td>
<td>1.34</td>
<td>200.7</td>
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<td>16.13</td>
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<tr>
<td>Lower panel – L5</td>
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<td>1.08</td>
<td>200.7</td>
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<td>13.00</td>
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<td>Lower panel – L6</td>
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<td>1.08</td>
<td>200.7</td>
<td>13.00</td>
<td>13.00</td>
<td></td>
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<tr>
<td>Lower panel – L7</td>
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<td>1.34</td>
<td>200.7</td>
<td>16.13</td>
<td>16.13</td>
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<tr>
<td>Door frame</td>
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<td>Working door</td>
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<td>9.69</td>
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<td>8.00</td>
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<td>Burners</td>
<td>2</td>
<td>0.29</td>
<td>401.3</td>
<td>7.00</td>
<td>14.00</td>
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<tr>
<td>Roof</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof panel I</td>
<td>4</td>
<td>1.26</td>
<td>200.7</td>
<td>15.17</td>
<td>60.68</td>
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<tr>
<td>Roof panel II</td>
<td>4</td>
<td>1.58</td>
<td>200.7</td>
<td>19.02</td>
<td>76.08</td>
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<tr>
<td>Roof panel III</td>
<td>4</td>
<td>1.58</td>
<td>200.7</td>
<td>19.02</td>
<td>76.08</td>
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<tr>
<td>Roof panel IV</td>
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<td>200.7</td>
<td>15.17</td>
<td>60.68</td>
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<tr>
<td>Roof upper piece I</td>
<td>4</td>
<td>3.41</td>
<td>200.7</td>
<td>41.06</td>
<td>164.24</td>
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<td>Roof upper piece II</td>
<td>4</td>
<td>1.98</td>
<td>200.7</td>
<td>23.84</td>
<td>95.36</td>
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<tr>
<td><strong>Sub-total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>1104.7</strong></td>
<td><strong>1104.7</strong></td>
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**Table A2.2  Sealing and W.C. elements (Circuit 2)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Qt</th>
<th>Exp. Area m² elem.</th>
<th>Spec Flow L/min.m²</th>
<th>Flow m³/h.elem.</th>
<th>Tot. Flow m³/h</th>
<th>Acum. Flow m³/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sliding skirt</td>
<td>4</td>
<td>3.00</td>
<td>200.7</td>
<td>36.12</td>
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<tr>
<td>SPH Lower Piece</td>
<td>4</td>
<td>4.12</td>
<td>200.7</td>
<td>49.60</td>
<td>198.42</td>
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</tr>
<tr>
<td>Tube for additions</td>
<td>1</td>
<td>1.15</td>
<td>143.3</td>
<td>9.89</td>
<td>9.89</td>
<td></td>
</tr>
<tr>
<td>Lime Chute Gate</td>
<td>1</td>
<td>0.13</td>
<td>200.7</td>
<td>1.57</td>
<td>1.57</td>
<td></td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>354.4</td>
<td>1459.1</td>
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**Table A2.3  SPH W.C. panels – lower part (Circuit 3)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Qt</th>
<th>Exp. Area m² elem.</th>
<th>Spec Flow L/min.m²</th>
<th>Flow m³/h.elem.</th>
<th>Tot. Flow m³/h</th>
<th>Acum. Flow m³/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel A1</td>
<td>4</td>
<td>2.11</td>
<td>200.7</td>
<td>25.40</td>
<td>101.60</td>
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</tr>
<tr>
<td>Panel A2</td>
<td>4</td>
<td>2.11</td>
<td>200.7</td>
<td>25.40</td>
<td>101.60</td>
<td></td>
</tr>
<tr>
<td>Panel A3</td>
<td>1</td>
<td>1.96</td>
<td>200.7</td>
<td>23.60</td>
<td>23.60</td>
<td></td>
</tr>
<tr>
<td>Panel A4</td>
<td>1</td>
<td>1.96</td>
<td>200.7</td>
<td>23.60</td>
<td>23.60</td>
<td></td>
</tr>
<tr>
<td>Panel A5</td>
<td>2</td>
<td>2.11</td>
<td>200.7</td>
<td>25.40</td>
<td>50.80</td>
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<tr>
<td>Panel A6</td>
<td>2</td>
<td>2.11</td>
<td>200.7</td>
<td>25.40</td>
<td>50.80</td>
<td></td>
</tr>
<tr>
<td>Panel A7</td>
<td>1</td>
<td>2.11</td>
<td>200.7</td>
<td>25.40</td>
<td>25.40</td>
<td></td>
</tr>
<tr>
<td>Panel A8</td>
<td>1</td>
<td>2.11</td>
<td>200.7</td>
<td>25.40</td>
<td>25.40</td>
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</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td></td>
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<td></td>
<td></td>
<td>402.8</td>
<td>1861.9</td>
</tr>
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</table>
Table A2.4  SPH W.C. panels – upper part (Circuit 4)

<table>
<thead>
<tr>
<th>Type</th>
<th>Qt</th>
<th>Exp. Area $m^2$ ele.</th>
<th>Spec Flow L/min.m$^2$</th>
<th>Flow $m^3$/h.elem.</th>
<th>Tot. Flow $m^3$/h</th>
<th>Acum. Flow $m^3$/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel B1</td>
<td>6</td>
<td>1.57</td>
<td>200.7</td>
<td>18.90</td>
<td>113.40</td>
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<tr>
<td>Panel B2</td>
<td>6</td>
<td>1.57</td>
<td>200.7</td>
<td>18.90</td>
<td>113.40</td>
<td></td>
</tr>
<tr>
<td>Panel B3</td>
<td>1</td>
<td>0.70</td>
<td>200.7</td>
<td>8.43</td>
<td>8.43</td>
<td>8.43</td>
</tr>
<tr>
<td>Panel B4</td>
<td>1</td>
<td>0.70</td>
<td>200.7</td>
<td>8.43</td>
<td>8.43</td>
<td>8.43</td>
</tr>
<tr>
<td>Panel B5</td>
<td>1</td>
<td>0.27</td>
<td>200.7</td>
<td>3.25</td>
<td>3.25</td>
<td>3.25</td>
</tr>
<tr>
<td>Panel B6</td>
<td>1</td>
<td>0.41</td>
<td>200.7</td>
<td>4.94</td>
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</tr>
<tr>
<td>Panel B7</td>
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<td>0.70</td>
<td>200.7</td>
<td>8.43</td>
<td>8.43</td>
<td></td>
</tr>
<tr>
<td>Panel B8</td>
<td>1</td>
<td>0.70</td>
<td>200.7</td>
<td>8.43</td>
<td>8.43</td>
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</tr>
<tr>
<td>Top sliding door</td>
<td>2</td>
<td>5.31</td>
<td>181.6</td>
<td>57.84</td>
<td>115.70</td>
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</tr>
<tr>
<td>Top Sliding frame1</td>
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<td>0.64</td>
<td>152.9</td>
<td>5.87</td>
<td>11.74</td>
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<tr>
<td>Top sliding frame2</td>
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<td>0.64</td>
<td>152.9</td>
<td>5.87</td>
<td>11.74</td>
<td></td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>407.9</strong></td>
<td><strong>2269.8</strong></td>
</tr>
</tbody>
</table>

A2.1.1 Cooling water quality

- pH : 7 - 8  
- Conductivity (25°C - ms/cm) : 2000 max.  
- M-alkalinity (ppm CaCO$_3$) : 150 max.  
- Total hardness (ppm CaCO$_3$) : 150 max.  
- Chlorides (ppm Cl-) : 150 max.  
- Residual chlorine (ppm) : 0.5 – 1.0  
- Silica (ppm SiO$_2$) : 150 max.  
- Total iron (ppm Fe) : 2.0 max.  
- Total suspended solids (ppm S.S.) : 60 max.  
- Turbidity (NTU) : 10 max.  


A2.2 OIL BURNER

- Fluid : LDO
- LDO flow (l/min) : 3.0 (min.) per burner
  : 7.0 (max.) per burner
- Atomization air flow (Nm3h) : 250 per burner
- Pressure (Kgf/cm²) : 8 (max.)
  : 5 (min.)
- Flame length (mm) : 2500-3000 per burner
- Capacity : 1.5 to 4 MW per burner
- Cooling fluid : water
- Number of burners : 2

A2.3 ATMOSPHERIC OXYGEN INJECTOR

- Fluid : O₂ (99.5% purity)
- Oxygen flow (Nm³/min) : 20 per injector
- Cooling fluid : Water
- Water flow (m³/h) : 6.7 per injector
- Oxygen operation pressure (bar) : 12.0
- Number of injectors : 4

- The injector must have adjustable support.
- All the injectors must be fitted at lower part of shell’s upper panels.
- Inert gas must be provided in case of O₂ blowing out
  – N₂ Flowrate = 5 Nm³/min per injector.
A2.4 SUPERSONIC LANCE

The objective of the Supersonic Lance is to inject oxygen into the liquid bath at supersonic speed in a vertical angle with the aim to achieve the desired blowing time in the EOF.

Structure:

The lance is in pipe form with internal compartments for water-cooling and a central hole for oxygen/inert gas injection.

The lance is built in steel with a tip in copper approximately 1.2 meters length. This copper part will effectively work inside the furnace during the process.

When is out of operation, at the parking position the lance has to be fully out of the furnace, in order to avoid any damage for the copper tip.

The lance has in its rear extreme connections for oxygen, inlet and outlet for water.

The total length of the lance is adjustable to attend its position related to the bath during operation and when out of operation.

The lance is mounted in a car driven by an electric motor reducer with a chain attached to its extreme and brake arrangement.

The lance along with the car is mounted in a structure with support to be fixed in the furnace.
This structure keeps the lance in an angle of approx. 45 degrees that combining with the angle in the lance tip will guarantee the oxygen injection direct in the liquid bath in vertical direction.

The structure and lance support is designed to attend the following points:

- There are two lances, located with respect to the center lining of working door, the first one will be fixed at 30 degrees clock wise and another to 330 degrees clock wise.
- When inside the furnace at operation position the tip of the lance shall be at 250mm height from the liquid bath.
- The lance structure contains the proper rack for water and fluids hoses, electrical cables, etc.
- The supersonic lance is mounted close to the furnace shell, the fixing system shall be easy to fix and to remove for bottom change /maintenance.
- The Supersonic lance drive system is equipped with different limit switches to attend the logistic of operation through the PLC.
- A temperature sensor for return water-cooling is provided for each lance.

Fluids:

The used fluids have the following characteristics.
The water shall be supplied for lance cooling with the following characteristics:

- Flow rate : 25 m$^3$/h
- Water Pressure : 80 mWC with buster pump
- Water Quality
  - pH : 7 - 8
  - Conductivity (25°C - $\mu$s/cm) : 2000 max.
  - M-alkalinity (ppm CaCO$_3$) : 150 max.
  - Total hardness (ppm CaCO$_3$) : 150 max.
  - Chlorides (ppm Cl-) : 150 max.
  - Residual chlorine (ppm) : 0.5 – 1.0
  - Silica (ppm SiO$_2$) : 150 max.
  - Total iron (ppm Fe) : 2.0 max.
  - Total suspended solids : 60 max.
  - Turbidity (NTU) : 10 max

The oxygen shall be supplied for lance cooling with the following characteristics:

- Purity : 99.5 % O$_2$
- Injection Speed : 360 m/sec.
- Operating Pressure : 12 bars.
- Flow rate : minimum 15 Nm$^3$/min.
  : maximum 20 Nm$^3$/min.

The nitrogen shall be supplied for lance cooling with the following characteristics:

- Operating Pressure : 8 bars.
- Flow rate : 180 Nm$^3$/h.
A2.5 GAS CLEANING SYSTEM

The data for the scrap pre-heater outlet is given below:

Gas flow and temperature : As shown in the Figure A2.1
Fluid : off gas

Chemical composition

(dry basis) - average : CO₂ – 21.6% / N₂ – 59.8% / CO
   – 5.4% / O₂ – 13.2%

Moisture - average : 10%

Particle concentration (g/Nm³) : 5 to 10

Particle size distribution : 100% < 500 µ
95% < 100 µ
85% < 50 µ
60% < 15 µ
25% < 1 µ

Dust type : iron oxide

Dust apparent density g/cm³ : 1.27

Pressure required : varying from (-) 100 to (-) 300 mm WG, to be automatically adjusted, according to furnace pressure. Adjustment has to be done at gas cleaning system exhaust fan.
Figure A2.1 Gas flow characteristic curve (Dry basis)

Dust concentration (mg/Nm³) : 50
in clean gas

A2.5.1 Gas Cleaning System – I.D. Fan

Fluid : Off gas

<table>
<thead>
<tr>
<th>Chemical composition</th>
<th>(% Vol)</th>
<th>Dry Basis</th>
<th>Wet Basis</th>
</tr>
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<tbody>
<tr>
<td>CO₂</td>
<td>21.6</td>
<td>17.0</td>
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</tr>
<tr>
<td>N₂</td>
<td>59.8</td>
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</tr>
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<td>CO</td>
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</tr>
<tr>
<td>O₂</td>
<td>13.2</td>
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<tr>
<td>H₂O</td>
<td>-</td>
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</tr>
</tbody>
</table>

Gas moisture : Saturated
Inlet temperature (°C) : 60
Elevation above sea level (m) : 350

<table>
<thead>
<tr>
<th>Inlet gas flow (Nm$^3$/h)</th>
<th>Dry Basis</th>
<th>Wet Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>maximum</td>
<td>48,000</td>
<td>61,435</td>
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<td>normal</td>
<td>43,600</td>
<td>55,900</td>
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<tr>
<td>minimum</td>
<td>13,090</td>
<td>16,755</td>
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</table>

Project gas flow (Nm$^3$/h) : 62,000 (saturated at 60ºC)

Inlet static pressure (mmWC) : - 2200
Outlet pressure (mmWC) : + 100
Number of I.D. fan (nr.) : 2 operating in series and 1 stand by
Speed (rpm) : 1500
Gas dust load (wet basis) (mg/Nm$^3$) : 50 (max.)

Remarks:

- Pressure variation allowed between minimum and normal flow is 10%.
- Flow rate during the heat – Figure A2.2.
- Impeller shall be open type with radial blades, fully in SS 304, including the fan hub.
- Double sided supported bearing.
- Motor directly coupled.
- Monobloc bearing is required with forced lubrication system. Oil shall be cooled down in a water-cooling system.
- Inspection door shall be provided at casing.
- Casing shall be split type.
- Propeller for heat dispersion between bearing and casing is provided.
- Shaft sealing shall be leak proof type.
- The pipes plate thickener should be 10mm, and material IS 226 with low sulphur.
Figure A2.2 Gas flow characteristic curve (Wet basis)

A2.5.2 Gas Cleaning System – Venturi Scrubber

- Venturi scrubber type: Adjustable throat
- Adjustable throat type: Pear shaped
- Throat drive: Motor Gear Box
- Throat pressure drop control system: Automatic loop control
- Venturi material: Carbon steel lined with chromium Carbide, thick, 2 mm, hardness 70 HRC
Adjustable throat material: Carbon steel lined with chromium Carbide, thick, 2 mm, hardness 70 HRC

Fluid: Off gas

Chemical composition (% vol.)

<table>
<thead>
<tr>
<th></th>
<th>Dry Basis</th>
<th>Wet Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂</td>
<td>21.6</td>
<td>10.6</td>
</tr>
<tr>
<td>N₂</td>
<td>59.8</td>
<td>29.5</td>
</tr>
<tr>
<td>CO</td>
<td>5.4</td>
<td>2.7</td>
</tr>
<tr>
<td>O₂</td>
<td>13.2</td>
<td>6.5</td>
</tr>
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<td>H₂O</td>
<td>-</td>
<td>50.7</td>
</tr>
</tbody>
</table>

Inlet gas flow (Nm³/h)

<table>
<thead>
<tr>
<th></th>
<th>Dry Basis</th>
<th>Wet Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>48,000</td>
<td>97,463</td>
</tr>
<tr>
<td>Normal</td>
<td>43,600</td>
<td>88,620</td>
</tr>
<tr>
<td>Minimum</td>
<td>13,090</td>
<td>26,592</td>
</tr>
</tbody>
</table>

Inlet temperature (°C): 80

Pressure inlet: (-) 400 mmWG
Outlet: (-) 1,800 mmWG

Dust type: iron oxide

Granulometry (inlet)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>100% &lt; 50 μ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70% &lt; 15 μ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30% &lt; 1 μ</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dust apparent density (gr/cm³): 1.27

Inlet particle concentration (wet basis) (mg/Nm³): 2,000

Max outlet particle concentration allowed (mg/Nm³): 50
Maximum pressure drop at venturi throat : 1.400 (mmWC)
Water flow available (m$^3$/h) : 165
Inlet water pressure at spray nozzle (kg/cm$^2$) : 3

Remarks:

- The adjustable throat is powered by one motor gear box for pressure loss modulation according to gas flow.
- The scrubbing system shall maintain the final efficiency within the given flow range.
- The available water is treated in a thickener and pumped back to the system. Suspended solid in water is 80 mg/l.
- Inspection door is provided at the following locations:
  - Throat inlet
  - Cyclone.

A2.5.3 Gas Cleaning System – Spray Nozzle

The data for vaporizing water is given below:

- Spray nozzle : Fogjet
- Type : small droplet size
  - multiple orifice
  - full cone
- Spray no. : 2
- Nominal Flow rate per spray (LPM) : 125 at 2.8 bar
- Max Flow rate per spray (LPM) : 130 at 3.0 bar
- Code : 1 - 7G - 316SS - 25
- Connection : 1” BSPT female
- Material : 316 stainless steel
- The system will operate along the off-gas down comer in order to reduce the waste gas temperature by water vaporizing.
- Due to the small opening of the spray nozzle, adequate water filters shall be installed in this circuit.

The data for saturation water is given below:

Spray nozzle : Spiral jet
Type : compact
- one piece
- large flow rate
- hallow cone
Spray no. : 5
Nominal Flow rate per spray (LPM) : 243 at 2.5 bar
Max Flow rate per spray (LPM) : 270 at 3 bar
Angle spray (deg) : 120
Code : 1 BSJ - SS 120340
Connection : 1” BSPT - male
Material : 316 stainless steel

Flow rate/pressure : LPM bar
79 1
108 2
125 2.8
130 3
130 0.7
190 1.5
243 2.5
270 3
• The nozzles will be fitted at the ascending outlet of the quench chamber, i.e. at gas counter-flow. This will assure the saturation of waste gas before entering the venturi scrubber by means of water spray.

The data for venturi in gas cleaning system is as follows:

<table>
<thead>
<tr>
<th>Spray nozzle</th>
<th>Spiral jet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Compact</td>
</tr>
<tr>
<td></td>
<td>one piece</td>
</tr>
<tr>
<td></td>
<td>large flow rate</td>
</tr>
<tr>
<td></td>
<td>full cone</td>
</tr>
<tr>
<td>Spray number</td>
<td>12</td>
</tr>
<tr>
<td>Nominal Flow rate per spray (LPM)</td>
<td>230 at 2.3 bar</td>
</tr>
<tr>
<td>Max Flow rate per spray (LPM)</td>
<td>270 at 3.0 bar</td>
</tr>
<tr>
<td>Angle spray (deg)</td>
<td>120</td>
</tr>
<tr>
<td>Code</td>
<td>1 HHSJX - SS 120340</td>
</tr>
<tr>
<td>Connection</td>
<td>1” BSPT - male</td>
</tr>
<tr>
<td>Material</td>
<td>316 stainless steel</td>
</tr>
<tr>
<td>Flow rate/pressure</td>
<td>LPM bar</td>
</tr>
<tr>
<td></td>
<td>130 0.7</td>
</tr>
<tr>
<td></td>
<td>190 1.5</td>
</tr>
<tr>
<td></td>
<td>230 2.3</td>
</tr>
<tr>
<td></td>
<td>270 3.0</td>
</tr>
</tbody>
</table>

The nozzles will be fitted at the ascending inlet of the Venturi Scrubber, i.e. at the same direction of gas flow. This will assure the cleaning of waste gas before through the venturi scrubber by means of water spray.
A2.5.4 Gas Cleaning System – Pumps

The pumping system data for the recirculation water pump P1 is given under:

No. of Pumps : 2 (1 pump working + 1 stand by)
From : Clean Water Tank
To : Cooling Water + Downcomer +
Quench Chamber + Venturi
Scrubber
Flow : 320 m$^3$/h
Delivery pressure : 50 mWC
Fluid : Clean Water
Solid Suspended : 80 mg/l
Dust Type : Iron oxide
Total Hardness (CaCO$_3$) : 150 ppm Maximum
Temperature : 50 °C
Material of construction : Compatible with the fluid to be handled
Type of pump : Centrifugal, horizontal suction and discharge at the top

The pumping system data for the thickner underflow pump P2 is given under:

No. of Pumps : 2 (1 pump working + 1 stand by)
From : Thickener
To : Slurry Concentrator Tank
Flow : 6 m$^3$/h
Delivery pressure : 20mWC,
Fluid : Slurry (70% water, 30% dust)
Dust Type : Iron Oxide
Dust Granulometry : 100% < 50µ
: 74% < 15µ
Dust Apparent Density : 1.27 gr/cm³
pH Water : 6 to 7
Temperature : 50°C
Material of construction : High chrome
Type of pump : semi-open, Non-clog type.

The pumping system data for the slurry dewatering pump P3 is given under:

No. of Pumps : 2 (1 pump working + 1 standby)

**First Pump:**
From : Slurry Concentrator Tank
To : Slurry Storage Tank

**Second Pump:**
From : Slurry Storage Tank
To : Filter Press
Flow : 4 m³/h
Delivery pressure : 20 mWC,
Fluid : Slurry (50% water, 50% dust)
Dust Type : Iron Oxide
Dust Granulometry : 100% < 50µ
: 74% < 15µ
Dust Apparent Density : 1.27 gr/cm³
PH Water: : 6 to 7
Temperature : 40°C
Material of construction : High chrome
Type of pump : Semi-open, Non-clog type
Quantity of pump : 4 nos (2 to Slurry Concentrator Tank and 2 to Slurry Storage Tank).

The pumping system data for the dewatering system return water pump P4 is given under:

No. of Pumps : 2 (1 pump working + 1 stand by)

**Clean Water Pump**
From : Clean Water Tank
To : Thickener

**Back Wash Water Pump:**
From : Back Wash Water Tank
To : Thickener
Flow : 4 m³/h
Delivery pressure : 10 mWC
Fluid : Dirty Water
Solid Suspended : 80 mg/l
Dust Type : Iron Oxide
Total Hardness (CaCO₃) : 150 ppm Maximum
Temperature : 40°C
Type of pump : Centrifugal, horizontal suction and discharge at the top
Quantity of pump : 4 Numbers
The schematic diagram of the pumps used in the gas cleaning system is shown in the Figure A2.3 as under.

![Figure A2.3 Gas cleaning water system pumps](image)

The motor specification for all the above pumps:

- **Rated voltage**: 415 V ± 10%
- **Frequency**: 50 Hz
- **Frequency variation**: ± 5%
- **Combine variation**: ± 10%
- **Insulation**: class F, temperature raise limited to class B
- **Type of mounting**: horizontal, foot mounted
Type of motor : SQIM (Squirrel Cage Induction Motors)
Type of coupling : direct coupling

A2.5.5 Gas Cleaning System – Thickner

The inlet data for thickner:
- Water flow : 300 m$^3$/h
- Dust concentration in water: 7.2 kg/m$^3$
- Dust granulometry : 100% < 50 µ : 74% < 15 µ
- Dust type : iron oxide
- Dust apparent density : 1.27 gr/cm$^3$
- pH : 6 to 7
- Chemical products to add : to be specified by a chemical product supplier

The specific data for the thickner is as follows:
- Settling rate : 2.5 / 3 m$^3$ of thickener volume per m$^3$ of inlet water
- Thickener inlet volume : 750 / 900 m$^3$
- Tank dimension:
  • Diameter : 15 / 16 m
  • Center hight : 4.2 m
  • Bottom angle : 8°
- Thickener type:
  • Type : Standard bridge - support thickener
The outlet data for thickner:

- Overflow:
  - Maximum solids suspended allowed is 100 mg/l.

In case of total hardness is higher than 150 ppm CaCO₃, a dispersant shall be used.

- Underflow:
  - Slurry flow: 6 m³/hr (maximum)
     4 m³/hr (normal)
  - Slurry consistency: 70% water, 30% dust
  - Dry dust continuous settling: 2.3 MT/hr (maximum)
     rate 1.1 MT/hr (normal)
  - Pump capacity: 6 m³/hr (maximum)
     4 m³/hr (normal)
  - Pump type: Semi-open, Non-Clog
  - Pump quantity: one in operation
     one in stand by
  - Pump discharge head: 20mWC

The specific data for auto wash sand filter:

- Water flow: 300 m³/h
- Max. inlet solids suspended: 100 mg/l.
- Max. outlet solids suspended allowed: 80 mg/l.
- pH: 6 to 7
A2.6 OFF GAS ANALYSER

The aim of gas analyzer is to measure CO and CO₂ content on flue gas and issue a 4 - 20 mA signal to be used in a supervisory system. This equipment will run continuously, 24 hours a day. Samples will be taken from two points, which will be selected by operator. Once selected the sampling point, gas from this point will be analyzed continuously. Analyzer will be installed at a panel inside furnace control room.

Data for Analyzer:
- CO₂ range : 0 to 60%
- CO range : 0 to 20%
- Type : infrared
- Output signal : 4 to 20 mA
- CO output signal : 4 to 20 mA
- CO₂ output signal : 4 to 20 mA
- Accuracy : better than 2%
- Power supply : 230 V/50 Hz

Data for Gas:
- Sampling Point 1 :
  - Location : Scrap Preheater Outlet
  - Off gas analysis (average)
    - dry basis : 
      - CO₂ : 21.6%
      - CO : 5.4%
      - N₂ : 59.8%
      - O₂ : 13.2%
    - Moisture (max.) : 10%
    - Temperature : 1400°C
Dust content : 5 to 10 g/Nm³
Dust type : iron oxide
Dust granulometry : 100% < 500 µ
: 95% < 100 µ
: 85% < 50 µ
: 60% < 15 µ
: 25% < 1 µ
Pressure : (-) 300 mmWG

• Sampling Point 2:
Location : Stack
Gas analysis (average)
-dry basis : CO₂ : 21.6%
: CO : 5.4%
: N₂ : 59.8%
: O₂ : 13.2%
Moisture : Saturated
Temperature : 70°C
Dust content : 50 mg/Nm³
Dust type : iron oxide
Dust granulometry : 100% < 50 µ
: 90% < 15 µ
: 50% < 1 µ
Pressure : (+) 80 mmWG

A2.7 FURNACE ALLOY AND FLUXES FEEDING SYSTEM

• Alloy and fluxes feeding system in the EOF aims the supply of material required for steel production.
• Usually, this addition is done during the heat, it can start even before charging the solid charge and in intervals during the heat according to the process requirement for the different steel grades.

Table A2.5 and Table A2.6 shows the technical details of various vibrating feeders and conveyor belts respectively for the furnace alloy and feeding system.

Table A2.5 Furnace alloy and fluxes feeding – vibrating feeder

<table>
<thead>
<tr>
<th>Feeder</th>
<th>Capacity m³/h</th>
<th>Material</th>
<th>Bulk Density MT/m³</th>
<th>Granulometry (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC1</td>
<td>20 to 30</td>
<td>Dolomite Lime</td>
<td>0.85/1.4</td>
<td>10/40</td>
</tr>
<tr>
<td>VC2</td>
<td>4.5 to 7.5</td>
<td>FeMn</td>
<td>3.0/4.5</td>
<td>30/70</td>
</tr>
<tr>
<td>VC3</td>
<td>4.5 to 7.5</td>
<td>FeSi</td>
<td>1.9/2.8</td>
<td>30/70</td>
</tr>
<tr>
<td>VC4</td>
<td>4.0 to 6.0</td>
<td>Iron Ore</td>
<td>2.5</td>
<td>20/60</td>
</tr>
<tr>
<td>VC5</td>
<td>40 to 60</td>
<td>Lime</td>
<td>0.85/1.0</td>
<td>10/40</td>
</tr>
<tr>
<td>VC6</td>
<td>40 to 60</td>
<td>Lime</td>
<td>0.85/1.0</td>
<td>10/40</td>
</tr>
</tbody>
</table>

Table A2.6 Furnace alloy and fluxes feeding – conveyor belt

<table>
<thead>
<tr>
<th>Belt Width (mm)</th>
<th>Speed (m/sec.)</th>
<th>Capacity (m³/h)</th>
<th>Material</th>
<th>Bulk Density (MT/m³)</th>
<th>Granulometry (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB1</td>
<td>400 Variable</td>
<td>15</td>
<td>DRI</td>
<td>2.0/2.5</td>
<td>5/20</td>
</tr>
<tr>
<td>CB2</td>
<td>1000</td>
<td>1.5</td>
<td>80</td>
<td>**</td>
<td>-</td>
</tr>
<tr>
<td>CB3</td>
<td>1000</td>
<td>1.5</td>
<td>80</td>
<td>**</td>
<td>-</td>
</tr>
</tbody>
</table>
• CB1 is a dosing conveyor belt for continuous dosing of DRI.
• CB2 and CB3 will convey all material handled by CB1, VC1 to VC6.

- Mechanical Equipments:

  01 Dosing conveyor belt 400 mm wide (CB1) for DRI 01 no.
  02 Conveyor belt 1000 mm wide (CB2) 01 no.
  03 Conveyor belt 1000 mm wide (CB3) 01 no.
  04 Vibrating chute VC1 to VC6 for Lime and fluxes/alloys bins 06 nos.
  05 Weight bins with pneumatic undercut gates 02 nos.
  06 Day bins with rod and slide gates 08 nos.

Table A2.7 shows the working volume of various day bin (storage hoppers) which stores the materials and feeding it to the furnace.

Table A2.7 Storage hopper details

<table>
<thead>
<tr>
<th>TAG Nr.</th>
<th>Material</th>
<th>Working Volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB1</td>
<td>Dolomite Lime</td>
<td>7.0</td>
</tr>
<tr>
<td>DB2</td>
<td>FeMn</td>
<td>7.0</td>
</tr>
<tr>
<td>DB3</td>
<td>FeSi</td>
<td>7.0</td>
</tr>
<tr>
<td>DB4</td>
<td>Iron Ore</td>
<td>7.0</td>
</tr>
<tr>
<td>DB5A and DB5B</td>
<td>DRI</td>
<td>20</td>
</tr>
<tr>
<td>DB6A and DB6B</td>
<td>Lime</td>
<td>20</td>
</tr>
</tbody>
</table>

A2.8 LADLE ALLOY AND FLUXES FEEDING SYSTEM

• Alloy and fluxes feeding system in the ladle aims the supply of material required for steel production and will change according to the different steel grades to be produced.
• Usually, this addition has to start few seconds after furnace tapping starts and finish before finishing the furnace tapping.

Tables A2.8 and A2.9 show the technical details of various vibrating feeders and conveyor belts respectively for the ladle alloy and feeding system.

**Table A2.8 Ladle alloy and fluxes feeding – vibrating feeder**

<table>
<thead>
<tr>
<th>Feeder</th>
<th>Capacity (\text{m}^3/\text{h})</th>
<th>Material</th>
<th>Bulk Density (\text{MT/m}^3)</th>
<th>Granulometry (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC7</td>
<td>12 to 18</td>
<td>FeSi</td>
<td>1.9/2.8</td>
<td>30/70</td>
</tr>
<tr>
<td>VC8</td>
<td>20 to 30</td>
<td>FeSiMn</td>
<td>1.8/30</td>
<td>30/70</td>
</tr>
<tr>
<td>VC9</td>
<td>12 to 18</td>
<td>FeMn</td>
<td>3.0/4.5</td>
<td>30/70</td>
</tr>
<tr>
<td>VC10</td>
<td>12 to 18</td>
<td>Fesi spl</td>
<td>1.9/2.8</td>
<td>30/70</td>
</tr>
<tr>
<td>VC11</td>
<td>12 to 18</td>
<td>Dolomite Lime</td>
<td>0.85/1.4</td>
<td>10/40</td>
</tr>
<tr>
<td>VC12</td>
<td>12 to 18</td>
<td>Lime</td>
<td>0.85/1.0</td>
<td>10/40</td>
</tr>
<tr>
<td>VC13</td>
<td>12 to 18</td>
<td>FeCr</td>
<td>1.9/2.8</td>
<td>30/70</td>
</tr>
<tr>
<td>VC14</td>
<td>20 to 30</td>
<td>Spare</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

**Table A2.9 Ladle alloy and fluxes feeding – conveyor belt**

<table>
<thead>
<tr>
<th>Belt Width (mm)</th>
<th>Speed (m/sec.)</th>
<th>Capacity (\text{m}^3/\text{h})</th>
<th>Material</th>
<th>Bulk Density (MT/m(^3))</th>
<th>Granulometry (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB4</td>
<td>1000</td>
<td>1.5</td>
<td>80</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>CB5</td>
<td>1000</td>
<td>1.5</td>
<td>80</td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>
• CB4 and CB5 will convey all material handled by VC7 to VC14.

- Mechanical Equipments:

  01 Conveyor belt 1000 mm wide (CB4 and CB5)  02 nos.
  02 Vibrating chutes VC7 to VC14 fluxes/alloys bin  08 nos.
  03 Weight bins with pneumatic undercut gates  04 nos.

The working volume of weight bin and storage hopper is shown in the Table A2.10 and Table A2.11 respectively.

Table A2.10  Weight bin details

<table>
<thead>
<tr>
<th>TAG Nr.</th>
<th>Material</th>
<th>Working Volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WB3</td>
<td>FeSi/FeSiMn</td>
<td>0.5</td>
</tr>
<tr>
<td>WB4</td>
<td>FeMn/FeSi spl</td>
<td>0.5</td>
</tr>
<tr>
<td>WB5</td>
<td>Dolomite Lime/Lime</td>
<td>1.0</td>
</tr>
<tr>
<td>WB6</td>
<td>FeCr/Spare</td>
<td>1.0</td>
</tr>
</tbody>
</table>

04 Day bins with rod and slide gates  8 nos.
### Table A2.11 Storage hopper details

<table>
<thead>
<tr>
<th>TAG Nr.</th>
<th>Material</th>
<th>Working Volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB7</td>
<td>FeSi</td>
<td>7</td>
</tr>
<tr>
<td>DB8</td>
<td>FeSiMn</td>
<td>7</td>
</tr>
<tr>
<td>DB9</td>
<td>FeMn</td>
<td>7</td>
</tr>
<tr>
<td>DB10</td>
<td>FeSi spl</td>
<td>7</td>
</tr>
<tr>
<td>DB11</td>
<td>Dolomite Lime</td>
<td>8</td>
</tr>
<tr>
<td>DB12</td>
<td>Lime</td>
<td>8</td>
</tr>
<tr>
<td>DB13</td>
<td>FeCr</td>
<td>7</td>
</tr>
<tr>
<td>DB14</td>
<td>Spare</td>
<td>7</td>
</tr>
<tr>
<td>WTB1</td>
<td>All</td>
<td>1</td>
</tr>
</tbody>
</table>

05 Waiting bins with pneumatic undercut gates 1 no.

### A2.9 SCRAP REQUIREMENT AND LOGISTICS

Introduction – The aim of this technical specification is to calculate the quantity of scrap required for EOF operation, according to defined operational parameters and based on a regular scrap generation in an integrated steel plant, as well as to define the requirement of purchased scrap.

Assumptions to calculate the EOF production

- EOF refractory lining................................. 750 heats
- Number of heats per day in EOF.................... 30 heats
- Bottom change (750/30=25)............................ 25 days
- No. of campaign per year (365/25=14.6)............. 14.6
- Actual time required for a regular maintenance...... 1.0 day
- Annual maintenance for the entire steel plant....... 10 days
- Effective operation days per year (365-15-10=340). 340 days
- EOF production based on the above parameters will be:
  340 days/year * 30 heats/day * 65 MT/heat =
  663,000.00 MT/annum.

- Regular Scrap Generation in an Integrated Steel Plant:
  - Skulls from BF production - 2% of BF production
  - Skulls from EOF production - 2% of EOF production
  - Steel scrap from CCM - 2% of billet/bloom production
  - Return Scrap from rolling mill - 2% of production

  Following the above parameters one may consider that around 8% of the entire plant production will return to EOF.

  For a plant with EOF production of 663,000 MT per annum, it can be estimated that 8% of overall plant production will be returned scrap, which corresponds to approx. 7% of total EOF charge.

- EOF Scrap Required – Purchased scrap / Internal scrap

  Based on EOF production of 663,000 MT per annum the scrap requirement is worked out for various scrap percentage in the charge as shown in Table A2.12 hereunder:

  - Quality of Scrap for EOF solid charge.
    - Steel Scrap : S < 0.05%, P < 0.05%, Fe > 95%
    - Max. weight per piece : 400 kg
    - Max dimension per piece : 1000 mm
    - Min. dimension per piece : 150 mm
- Iron Scrap: S < 0.05 %, P < 0.2 %, Si < 1.0 %, Fe > 92.0 %
- Max. weight per piece: 400 kg
- Max. dimension per piece: 1000 mm
- Min. dimension per piece: 150 mm

The percentage of solid charge and the requirement of internal and purchased scrap for 65 MT EOF is shown in Table A2.12.

Table A2.12 Scrap requirement for 65 MT EOF

<table>
<thead>
<tr>
<th>Liquid Steel</th>
<th>Total charge</th>
<th>% solid charge</th>
<th>Internal scrap(t)</th>
<th>Purchased scrap(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>663,000</td>
<td>753,500</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>52.750</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14</td>
<td>52.750</td>
<td>52.750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21</td>
<td>52.750</td>
<td>105.500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>28</td>
<td>52.750</td>
<td>158.250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35</td>
<td>52.750</td>
<td>211.000</td>
</tr>
</tbody>
</table>
APPENDIX 3

65T EOF PHOTOGRAPHS

Figure A3.1 65T EOF pre-heating of furnace

Figure A3.2 65T EOF scrap charging bucket
Figure A3.3  65T EOF hot metal pouring

Figure A3.4  65T EOF oxygen blowing
Figure A3.5  65T EOF supersonic lance

Figure A3.6  65T EOF hand lancing through work door
Figure A3.7  65T EOF slag flushing

Figure A3.8  65T EOF alloy feeding system
Figure A3.9 65T EOF valve stand for supersonic lance

Figure A3.10 65T EOF ID fan
Figure A3.11  65T EOF control room

Figure A3.12  65T EOF opening the tap door
Figure A3.13   65T EOF steel tapping