1.0 MATERIAL:
Specification: ASME / ASTM (Latest on date of Purchase Order (PO)):
CARBON STEEL (CS): SA / ASTM A216 WCB, WCC & 352 LCB, LCC
ALLOY STEEL (AS): SA / ASTM A217 WC6, WC9, C12A.
STAINLESS STEEL (SS): SA / ASTM A351 CF3M, CF8, CF8C & CF8M.
Additional Requirement: As listed below (Supplementary to Specification)
Size, Qty, Grade/Class: As per Purchase order & Drawing / Pattern.

2.0 CHEMICAL COMPOSITION AND PROCESS:
Melting: As per the Specification, Fully Killed.
Carbon = 0.25% maximum: for SA / ASTM A216 WCB only.
Carbon = 0.15% maximum: for SA / ASTM A217 WC6 & WC9 (For the castings used in QCNRV, CRHNRV, TOA Valves & Conventional valves having contours for welding.)
Product Analysis on test bar for each melt including residual elements shall be carried out.

Additional requirements for API-6D materials:
CS: Carbon=0.23% max. (in ladle) and 0.25% max. (in Product analysis)
Carbon Equivalent=0.43 max. (in ladle) and 0.45 max. (in Product analysis)
Carbon Equivalent =%C+(%Mn/8)+(%Cr+%Mo+%V)/5+(%Ni+%Cu)/15
SS: Carbon=0.03% max. except as below.
Carbon=0.08% max. for stabilized steels with Nb >10xC.
for stabilized steels with Nb and Ta mass of (Nb+Ta)>8xC.

3.0 DIMENSIONS AND TOLERANCES:
Tolerances as per the Drawing.
Non tolerance Dimensions for valve components as per the Drawing: VL/STDC:023 (Latest)

4.0 HEAT TREATMENT : (HT)
CS. Castings of High Pressure Valve. (Cl.1500 & above), QCNRV & CRHNRV: Shall be in Annealed Condition.
AS. Castings: Normalized and Tempered.
Others: Heat Treated as per the Specification.

5.0 MECHANICAL TESTS:
Test bars to be cast integral with the casting or separately. If cast separately, they shall be cast at the same time as the castings and from the same ladle. A metal strip with heat number stamped shall be fused with the test bar during casting, to maintain traceability. If one(1) casting is made from more than one heat, separate test bars for each cast to be poured & all test bars shall satisfy the requirements. Following tests to be conducted per heat / Heat treatment batch, as per ASTM A370.

<table>
<thead>
<tr>
<th>S. NO</th>
<th>TEST</th>
<th>Material specification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SA/ASTM A216, 217</td>
</tr>
<tr>
<td>1</td>
<td>Tension Test</td>
<td>As per the Specification</td>
</tr>
<tr>
<td>2</td>
<td>Hardness Test</td>
<td>As per the Specification</td>
</tr>
<tr>
<td>3</td>
<td>Bend Test Specimen 1&quot;x ¾&quot;</td>
<td>Angle of Bend</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WCB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WCC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WC6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WC9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C12A</td>
</tr>
<tr>
<td>4</td>
<td>Charpy - U Impact for all QCNRV, CRHNRV BODIES FOR IBR.</td>
<td>As per IBR, at Room temperature. Acceptance: Avg / Single=36/32J min.</td>
</tr>
<tr>
<td>6</td>
<td>Charpy - V Impact for API-6D items if design temperature below minus 29°C (-29 °C)</td>
<td>Test Temperature=As per specification Acceptance: Avg / Single=34/25J</td>
</tr>
<tr>
<td>7</td>
<td>Charpy - V Impact for LPBP BODIES</td>
<td>At 20 Deg.C temperature. Acceptance: Avg / Single=27/21J min.</td>
</tr>
</tbody>
</table>
6.0 FETTLING, DRESSING & CLEANING:
- Dressing of castings - Free from risers, in gates, notches, undercuts and deep marks etc.
- Fused wires, parting line fins, chills etc. shall be removed by grinding.
- Gas cutting if employed shall be done before Heat treatment.
- Preheat the material to 200 Deg. C. before gas cutting the Alloy steels.
- Castings shall be blast cleaned both inside and outside for the removal of fused sand, scales etc.
- Visual inspection of castings for surface quality as per MSS-SP-55 shall be carried out.

7.0 NON DESTRUCTIVE TESTING (NDT) AFTER HEAT TREATMENT:
The NDE requirements for the castings shall meet the following as shown in Table-1 below.
Casting shall be free from surface and internal defects like porosity, shrinkage, sand inclusion, crack, cold shut and other harmful defects. All castings shall be of Radiographic Quality.

<table>
<thead>
<tr>
<th>Radiographic Testing Procedure</th>
<th>Magnetic Particle Inspection (MPI)</th>
<th>Liquid Penetrant Inspection (LPI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>As per ASME B16.34</td>
<td>As per ASTM E709</td>
<td>As per ASTM E165</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table: 1</th>
<th>Product Components</th>
<th>Characteristics</th>
<th>Type of NDE Check</th>
<th>RT</th>
<th>RT Area</th>
<th>RT Acc. Std</th>
<th>MT $</th>
<th>MT Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Valves (Gate, Globe &amp; Check) and API 6D Gate Valves</td>
<td>Body, Bonnet, Pr. part Yoke</td>
<td>&lt; 600 Class</td>
<td>10% #</td>
<td>ASME B16.34 (latest) / On critical area as indicated in the Drawing.</td>
<td>As per Table: 2</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Body, Bonnet, Cover</td>
<td>600 Class &amp; above</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Body, Bonnet, Cover</td>
<td>1500 Class &amp; above</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wedge</td>
<td>All Special Class Valves</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Valve</td>
<td>Base</td>
<td>All</td>
<td>10% #</td>
<td>Critical Zones as given in the Drawing/ area shown in the sketch in Page-5. The areas where RT cannot be carried out MPI shall be done.</td>
<td>Class-4 of ASTM E446/ E186. For Butt weld ends</td>
<td>100%</td>
<td>All accessible surfaces.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weld ends of All Castings</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety Relief Valve</td>
<td>Base &amp; Bonnet</td>
<td>All</td>
<td>10% #</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SRV Nozzle</td>
<td>All</td>
<td>100%</td>
<td>All area</td>
<td>Class-2 of ASTM E446/ E186</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>QC NRV, CRH NRV</td>
<td>Body</td>
<td>150 &amp; 300 Class</td>
<td>10%</td>
<td>Butt Weld Ends,</td>
<td>As per Table: 2</td>
<td>100%</td>
<td>All accessible surfaces including belly</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>600 Class &amp; above</td>
<td>Critical Zones as given in the Drawing/ area shown in the sketch in Page-5. The areas where RT cannot be carried out MPI shall be done.</td>
<td>As per Table: 2</td>
<td>100%</td>
<td>All accessible surfaces including belly</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Body (Special)</td>
<td>All</td>
<td>100%</td>
<td>Critical Zones as given in the Drawing/ area shown in the sketch in Page-5. The areas where RT cannot be carried out MPI shall be done.</td>
<td>As per Table: 2</td>
<td>100%</td>
<td>All accessible surfaces including belly</td>
<td></td>
</tr>
<tr>
<td>Soot Blower Valve</td>
<td>Body</td>
<td>All</td>
<td>10% #</td>
<td>Critical Zones as given in the Drawing/ area shown in the sketch in Page-5. The areas where RT cannot be carried out MPI shall be done.</td>
<td>As per Table: 2</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>CRH Isolating Device</td>
<td>Body</td>
<td>&lt; 600 Class</td>
<td>100%</td>
<td>Critical Zones as given in the Drawing/ area shown in the sketch in Page-5. The areas where RT cannot be carried out MPI shall be done.</td>
<td>As per Table: 2</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>600 Class &amp; above</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1500 Class &amp; above</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LP Bypass Valve</td>
<td>Body</td>
<td>All</td>
<td>100%</td>
<td>Critical Zones as given in the Drawing/ area shown in the sketch in Page-6. The areas where RT cannot be carried out MPI shall be done.</td>
<td>As per Table: 2</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
</tbody>
</table>

$LPI$ Can be substituted for MPI in all inaccessible area and for stainless steel castings. $#$ Refer Cl 7.1
7.1 # 10% Sampling shall be done as follows: (Wherever specified):

The vendor shall select 10% the Casting from the lot consisting of same size and type, (along with melt number and Sl.nos of the castings covered in the lot ) for Radiography. A lot to be specified as the total number of castings as above, supplied in 4 months period (Jan-Apr, May-Aug, Sep-Dec). The vendor shall radiograph these specified castings and incorporate the lot size and melt no and Sl.no in the RT reports along with the other sl.nos of the other castings covered in the lot. If the identified casting is defective then 2 more castings shall be radiographed. If these 2 castings are defect free then the lot is acceptable. If any one of these castings is defective then all the remaining castings shall be radiographed and all defective areas shall be repaired. BHEL will carry out audit on the lots at the vendor works at any time.

7.2 Acceptance for MPI & LPI: ASME B16.34.

1. Cracks are not permitted.
2. For linear indications (with length > 3 times width) other than cracks, indications must be separated by a distance greater than the length of an acceptable indication. Maximum allowable length of the indication shall be:
   (a) For thickness (t) up to 13mm=8mm,
   (b) For thickness from 13 to 25mm =13mm
   (c) For thickness above 25mm =18mm.
3. For rounded indications (circular or elliptical with length < 3 times width), 4 or more indications in a line separated by 1.5 mm or less edge to edge are unacceptable. Maximum allowable diameter of the indication shall be:
   (a) For thickness up to 13mm =8mm, and
   (b) For thickness above 13mm =13mm

8.0 Development Stage of Casting:

a. During developmental stage, Foundry to ensure, first sample pieces meet dimensional, NDE & Quality requirements in this TDC before starting bulk production. Sample castings, 3 Castings with nominal bore (NB) ≤100mm, & 1 casting with NB > 100mm for each type of casting shall be inspected for dimension and RT requirements at BHEL/Vendor works. RT shall be carried out on entire area of the casting to the acceptance requirement of Table-1 & 2. In addition 100% MPI on all critical areas like change of sections, riser & in gate portions shall be carried out. Casing to be inspected for dimensions after proof machining wherever necessary. If machining operation is involved the same shall be done and defect free condition shall be ensured. If any defect noticed in RT and machining, the type of defect shall be analysed and accordingly size of gate, runner, riser and pouring methodology to be modified to get defect free casting. Sampling shall be continued till achieving sound casting. After satisfactory development of sampling bulk production shall be started. However weld repaired areas identified in visual examination for doubtful indications to be probed by MPI. Accepted sample castings may be considered for fixing the nominal weight of the castings.

b. During developmental stage RT on sample castings of yoke, yoke clamp & wedge/disc shall meet Level-3 of ASTM E446/E186/E280

c. Radiography not required after satisfactory development of casting & production based on established method for following parts: SRV Bonnet, Disc holder, Upper and Lower adjusting rings, Packed cap, Cover plate, Yoke and SRV guide flanges
9.0 REPAIR:
Castings with unacceptable cracks, hot tears, shrinkage, etc. to be rectified by grinding & if required by welding. Welding to be done by qualified welder and qualified procedure as per ASME Section IX. For IBR items welder shall be qualified as per IBR.

Guidelines for repair of Steel castings shall be as per SIP:VS:17 (latest). for activities like defects require/ not require weld repair, welding, Post weld heat treatment, NDE and surface treatment. All repaired areas after PWHT shall NDE tested and Hardness tested. Hardness shall meet material specification.

For CE-Marking (PED) casting, permanent joining (welding and weld repair) of components must be carried out by suitably qualified personnel according to suitable operating procedures. Also Non-destructive tests of permanent joints must be carried out by suitable qualified personnel. The procedures and personnel must be approved by a competent third party which, at the manufacturer's discretion, may be:
- a notified body,
- a third-party organization recognized by a Member State of European Community

10.0 SURFACE TREATMENT:
SS castings to be pickled & passivated (after repair & HT if any) as per ASTM A380. Satisfactory passivity of the surface to be checked using SS passivity test kit (Free iron test). After passivation, rinsing & test, the rinsed demineralised water to be checked for chloride with 1% Silver nitride, which shall not exceed 0.5 PPM

11.0 DIMENSIONAL CHECK:
For all QCNRV & CRHNRV Body Castings: Thickness of the body shall be checked throughout the surface on a grid of 100mm x 100mm and recorded & submitted to BHEL.

12.0 MARKING AND PACKING:
Following details to be marked on each casting on a raised pad using low stress stamps and Castings shall be suitably packed to avoid damage during transit.

1. Foundry code, 2. Specification, grade & Melt number, 3. Other details as per drawing.

13.0 INSPECTION AND CERTIFICATION:

13.1: For IBR items
   a) If the Foundry is recognized as "Well known Foundry" under IBR, Items shall be inspected by foundry and works certificate along with IBR Form III F shall be issued.
   b) If the Foundry is not recognized as "Well known Foundry" under IBR, Items shall be inspected by an Inspecting Authority approved by IBR and work certificate along with IBR Form III G shall be issued.

13.2: For CE-marking items, the materials shall be inspected by M/s. Lloyd's/ TUV/ BVQI or any other agency approved for PED of CE-marking, if the foundry is not certified to ISO 9000 by any of the above organisation.

13.3 For API items, the castings shall be inspected by the foundry and works certificate with details like PSL No., Temperature class rating, size shall be issued.

13.4 Test certificates shall contain the following details.
1. Purchase Order No.(BHEL), TDC No. & Test certificate number
2. Specification and Grade with applicable year of code, Heat Number, Quantity & Size
4. Heat treatment details of the material and test bars.
5. Mechanical test results, NDE test results with reference & acceptance standard.
6. Repair details including HT, if any, Cleaning & Surface treatment details.
7. Any other information like clearance of sample casting.
8. Dimensional Inspection Report where applicable.
14.0 **AUDIT CHECKS AT BHEL:**

BHEL reserves the right to carry out audit checks for chemistry, HT condition, mechanical test and NDT on representative test bars or job. Items found defective during check or subsequent processing at BHEL are liable for rejection.

15.0 **END USE:**

For use in valves and other components like flanges, fittings etc. for high temperature & high pressure applications meeting IBR, ASME Section I, ASME B 16.34, PED and API.

---

**Sketch of zones for RT**

**SV and SRV Base castings**

---

**Reheater Isolating Device Body**
**Soot Blower Valve Body**

![Diagram of Soot Blower Valve Body]

- Radiography Area

---

**Quick Closing Non Return Valve Body**

![Diagram of Quick Closing Non Return Valve Body]

- Section-XX
- Radiography Area

---

**Cold Re Heat Non Return Valve Body**

![Diagram of Cold Re Heat Non Return Valve Body]

- Section-XX
- Radiography Area
Product: **STEEL CASTINGS.(VALVES)**

Document No: **TDC:0:412**  
Rev No: 18  
Effective Date: **25.01.2012**

---

**LP Bypass Stop cum Control Valve Body**

![Diagram of LP Bypass Stop cum Control Valve Body]

- Radiography Area

---

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.SUDHAKARAN</td>
<td>QUALITY ASSURANCE</td>
<td></td>
</tr>
<tr>
<td>M. RAJAKUMAR</td>
<td>ENGG/VALVES</td>
<td></td>
</tr>
<tr>
<td>S.SELVARAJAN</td>
<td>QUALITY ASSURANCE</td>
<td></td>
</tr>
<tr>
<td>V.RAVIKUMAR</td>
<td>QUALITY ASSURANCE</td>
<td></td>
</tr>
</tbody>
</table>

**PREPARED BY**

**REVIEWED BY**

**APPROVED BY**