Revision record: Rev 16: 27.04.2011 (1) Modified in entirety.
Rev.17 – 1) Cl.7.0 Table-1 NDE requirements, 2) Cl.7.1, Cl.9, Cl.11.0 – Revised. RT zone Sketch added.

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/6)+(%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.and
for stabilized steels with Nb and Ta mass of (Nb+Ta)>8xC.

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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.
Normalizing Temperature: for SA/ASTM A217 WC6, WC9: 920-950 ºC and for C12A: 1050-1080 ºC.
Tempering temperature (Minimum): SA/ASTM A217 WC6: 680ºC; WC9: 720 ºC; C12A: 750-780ºC
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. .

S. NO	TEST	Material specification				
		SA/ASTM A216, 217			SA/ASTM A352	SA/ASTM A 351
1	Tension Test	As per the Specification				
2	Hardness Test	As per the Specification			225 BHN. max.	Not applicable
3	Bend Test Specimen 1"x ¾"		Angle of Bend	Dia of Pin	Not applicable	S3 of SA703
		WCB	90º	2t		
		WCC	90º	2t		
		WC6	120º	3t		
		WC9	90º	3t		
		C12A	90º	2t		
4	Charpy- U Impact for all QCNRV.CRHNRV BODIES FOR IBR.	As per IBR. at Room temperature. Acceptance: Avg /Single=36J/32J min.			Not applicable	Not applicable
5	Charpy- V Impact for CE Marking-Pressure Equipment Directive (PED) items as Specified in the Purchase Order.	At 20 Deg.C temperature. Acceptance: Avg /Single=40J/27J min.			As per Specification	Not applicable
6	Charpy- V Impact for API -6D items if design temperature below minus 29ºC (-29 ºC)	Test Temperature=As per specification Acceptance: Avg/Single=34J/25J			As per Specification	Not applicable
7	Charpy- V Impact for LPBP BODIES	At 20 Deg.C temperature. Acceptance: Avg /Single=27J/21J min.			Not applicable	Not applicable

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. Castings 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.

Radiographic Testing Procedure: As per ASME B16.34.
Magnetic Particle Inspection (MPI): As per ASTM E709
Liquid Penetrant Inspection (LPI): As per ASTM E165

Table: 1

Product	Components	Charecteristics	Type of NDE Check				
			RT	RT Area	RT Acc. Std	MT $	MT Area
Conventional Valves (Gate, Globe & Check) and API 6D Gate Valves	Body,Bonnet Pr.part Yoke	< 600Class	10%#	ASME B16.34 (latest) / On critical area as indicated in the Drawing.	As per Table: 2	--	--
	Body,Bonnet	600Class & above	100%			--	
	Body,Bonnet & Wedge	1500Class & above	100%			100%	All accessible surfaces including belly
		All Special Class Valves	100%			100%	
Safety Valve	Base	All	10%#	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.	Class-4 of ASTM E446/ E186. For Butt weld ends Table-2	100%	All accessible surfaces .
		Weld ends of All Castings	100%			--	--
Safety Relief Valve	Base & Bonnet	All	10%#			--	--
	SRV Nozzle	All	100%	All area	Class-2 of ASTM E446/ E186	--	--
QC NRV, CRH NRV	Body	150 & 300 Class	10%	Butt Weld Ends,	As per Table: 2	100%	All accessible surfaces including belly
		600Class & above	100%	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.	As per Table: 2	100%	All accessible surfaces including belly
	Body (Special)	All					
Soot Blower Valve	Body	All	10%#	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.	As per Table: 2	--	--
CRH Isolating Device	Body	< 600Class	100%	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.	As per Table: 2	--	All accessible surfaces including belly
		600Class & above				--	
		1500Class & above				100%	
LP Bypass Valve	Body	All	100%	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.	As per Table: 2	--	--

$ LPI Can be substituted for MPI in all inaccessible area and for stainless steel castings. # Refer Cl 7.1

Table: 2

TYPE OF DISCONTINUITY	ACCEPTANCE LEVEL CATEGORY	< 600 CLASS		≥ 600 CLASS	
		Thickness ≤2"	Thickness >2"	Thickness ≤2"	Thickness >2"
Gas Porosity	A	A2	A3	A1	A2
Sand/Slag inclusion	B	B3	B3	B2	B2
Shrink Type-1	C	CA2	CA3	CA1	CA2
Shrink Type-2	C	CB3	CB3	CB2	CB2
Shrink Type-3	C	CC3	CC3	CC2	CC2
Crack	D	NONE	NONE	NONE	NONE
Hot Tear	E	NONE	NONE	NONE	NONE
Unfused Inserts (Chills/Chaplets)	F	NONE	NONE	NONE	NONE

a. Butt welding ends shall be free of shrinkage, crack & hot tear.

b. For butt weld ends Gas hole/Porosity and sand inclusions to be within level A1 &B1 respectively

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 meltno 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. Casting 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. .

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 materails shall be inspected by M/s. LLoyd's/ TUV/ BVQI or anyother agengy approved for PED of CEmarking, 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
3. Steel making process, Chemistry including incidental elements - Heat wise.
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:

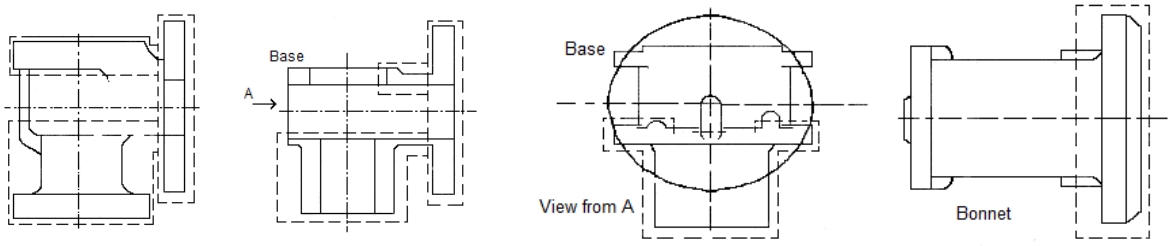
BHEL reserves the right to carry out audit checks for chemistry, HT condition, mechanical test and NDT on representative test bars or job. Items found defective during check or subsequent processing at BHEL are liable for rejection.

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.

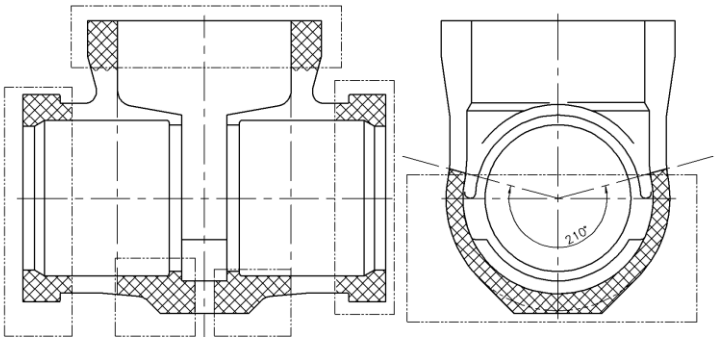
Sketch of zones for RT

SV and SRV Base castings



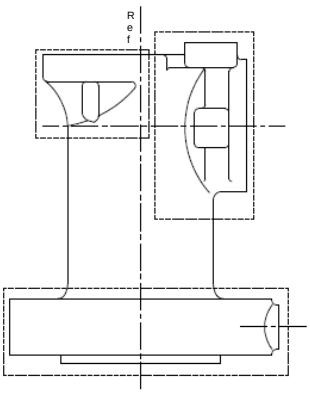
Radiography Area

Reheater Isolating Device Body



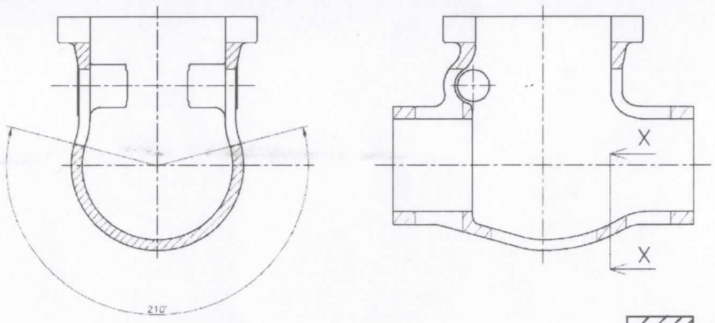
Radiography Area

Soot Blower Valve Body



Radiography Area

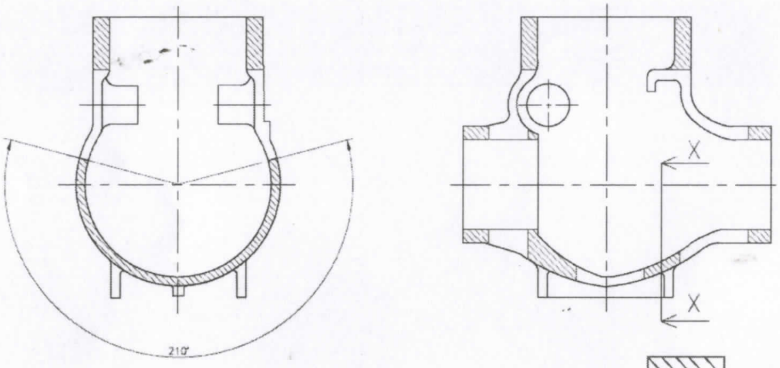
Quick Closing Non Return Valve Body



Section-XX

Radiography Area

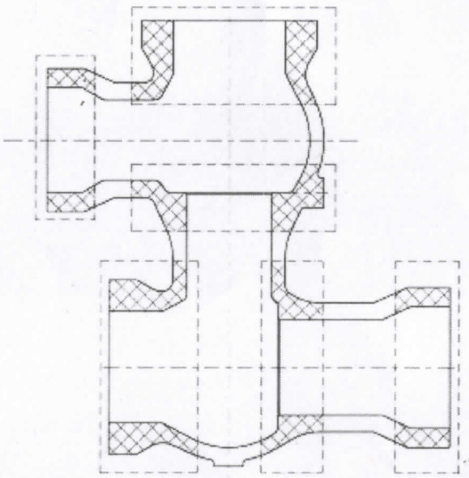
Cold Re Heat Non Return Valve Body



Section-XX

Radiography Area

LP Bypass Stop cum Control Valve Body



Radiography Area

D.SUDHAKARAN QUALITY ASSURANCE	M.RAJAKUMAR ENGG/VALVES	S.SELVARAJAN QUALITY ASSUARANCE	V.RAVIKUMAR QUALITY ASSURANCE
PREPARED BY	REVIEWED BY		APPROVED BY