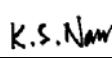


DOCUMENT SUBMISSION STATUS: FC

NOTE:

4	8 Apr. 2013	Revised as marked	H. Patel	K.H.Lee	K.S.Nam	Y.H.Kim
3	13 Mar. 2013	Revised as marked	H. Patel	K.H.Lee	K.S.Nam	Y.H.Kim
2	04 Jan. 2013	Revised as marked	H. Patel	K.H.Lee	K.S.Nam	Y.H.Kim
1	26 Nov. 2012	Revised as marked	H. Patel	S.H.Song	K.H.Lee	Y.H.Kim
0	05 Nov. 2012	Issued for Construction	H. Patel	S.H.Song	K.H.Lee	Y.H.Kim
REV	DATE	DESCRIPTION	PREP	CHKD	APRD	APRD
OWNER  VIETNAM OIL AND GAS GROUP (PVN)			OWNER'S CONSULTANT FICHTNER GmbH & Co. KG  PV Power PCC FICHTNER PVPOWER PCC			
EPC CONTRACTOR  PETROVIETNAM CONSTRUCTION JOINT STOCK CORPORATION (PVC)			EPC CONTRACTOR'S CONSULTANT  resources & energy WORLEYPARSONS			
POWER ISLAND PACKAGE SUPPLIER  SOJITZ CORPORATION			 DAELIM INDUSTRIAL CO., LTD.			
PROJECT TITLE THAI BINH 2 THERMAL POWER PLANT 2 x 600MW						
WORK TITLE / DRAWING / DOCUMENT TITLE TECHNICAL SPECIFICATION FOR FEEDWATER HEATERS						
 			FUNCTION	NAME	SIGN	DATE
			DRWN	H. Patel		08.04.13
			CHKD	K.H.Lee		08.04.13
			APPD	K.S.Nam		08.04.13
			APPD	Y.H.Kim		08.04.13
DOCUMENT No: TB2-SDC-01LAD-M-M1B-SPC-0001			SHEET No: 50 Pages		SCALE	REV. 4

This document has been approved through the electronic approval system of **DAELIM**

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Document Review Comment Sheet			Ref. No TB2-SDC-PEB-TE-0154			
No.	Document No.	Rev	Title	Purpose	Approval Status	
					In	Out
1	TB2-SDC-01LAD-M-M1B-SPC-0001	3	Technical Specification for Feedwater Heaters	FC	-	B
2	TB2-SDC-01LAA-M-M1 B-SPC-0001	3	Technical Specification for Deaerator & Storage Tank	FC	-	B
No	TB2PEB's Comments	Item status	Contractor's Response			
1	TB2-SDC-01LAA-M-M1B-SPC-0001: Technical specification for deaerator& storage tank.					
1.1	5.2.16-Remove references in imperial units. Use SI/ISO.		NA			
1.2	5.2.17.2-Remove references in imperial units. Use SI/ISO.		NA			
1.3	5.2.27.5-Remove references in imperial units. Use SI/ISO.		NA			
2	TB2-SDC-01 LAD-M-MI B-SPC-0001: Technical specification for feedwater heaters.					
2.1	5.6.9.3- Joules per inch??? Please use SI/ISO units.		Document revised (Refer Cl. No. 5.6.9.3, Page 39 of 48). However, FEED values are retained in bracket to maintain consistency.			
2.2	5.6.11.5-Mils??? Is not an ISO/SI unit. Please replace.		Document revised (Refer Cl. No. 5.6.11.5, Page 40 of 48). However, FEED values are retained in bracket to maintain consistency.			

Legend

Contractor Purpose:

A = For Approval

R = For Reference

FC = For Construction

AB = As Built

INFO = For Information

TB2PEB Approval Status:

For AP:

A = Approved

B = Approved with Comments

C = Returned for Correction

D = Rejected

For RE:

I=Accepted for Reference



IB=Accepted for Reference with Comments
R= Returned for Correction



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REVISION LOG

Rev. No.	Rev. Date	Revised Page	Revision Description
A	25 Sep.12	-	For Approval
0	05 Nov. 12	-	Revised as commented. Refer above document review comment sheet.
1	26 Nov. 12	-	Revised as marked
2	04 Jan. 13	-	Revised as marked
3	13 Mar. 13	-	Revised as marked
4	04 Apr. 13	39 & 40 of 48	Revised as commented. Refer above document review comment sheet.



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1.0 GENERAL

1.1 Purpose

- 1.1.1. This specification defines the scope and minimum requirements for design, materials, and fabrication of feedwater heaters complete with all accessories described herein, to be used in the thermal power plant in Thai Binh 2.
- 1.1.2. It is not the intent of this specification to specify all details of design requirements. It shall be the responsibility of the supplier to supply the equipment that is in accordance with high standards of engineering and workmanship, suitable for the intended service as described herein, and consistent with general accepted standards and practice.



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2.0 **SCOPE**

2.1 The scope of work and equipment described in this specification is for sub critical thermal power plant. The power plant consists of two (2) x 600 MW power generating units.

2.2 Scope of supply

2.2.1 The Supplier's scope of supply shall consist of feedwater heaters and associated accessories and appurtenances required for safe, reliable and efficient operation of the power plant. The scope of supply shall consist of, but not limited to, the following:

- A. Two (2) sets of low pressure closed feedwater heater #1 without integral drain cooler (mounted on condenser neck)
- B. Two (2) sets of external drain cooler for low pressure closed feedwater heater #1
- C. Two (2) sets of low pressure closed feedwater heaters #2 with integral drain cooler (mounted on condenser neck)
- D. Two (2) sets of low pressure closed feedwater heaters # 3 with integral drain cooler
- E. Two (2) sets of low pressure closed feedwater heaters # 4 with integral drain cooler
- F. Two (2) sets of high pressure closed feedwater heaters # 6 with integral drain cooler
- G. Two (2) sets of high pressure closed feedwater heaters # 7 with integral drain cooler
- H. Two (2) sets of high pressure closed feedwater heaters # 8with integral drain cooler
- I. Bidder shall provide all necessary compensation for thermal expansion for low pressure feedwater heater No.1, 2 heaters located within the condenser neck
- J. Carriages required for installation and removal of tube bundles for LP FWH#1 and #2
- K. Heavy gage stainless steel lagging for condenser neck mounted LP FWH#1, #2 to prevent steam impingement on heater shell
- L. Fixed end closure seal plates for condenser neck mounted LP FWH#1, #2 to seal the heater to the condenser
- M. Internal shielding plate for protecting tube bundle from damage during cutting and re welding of the shell for maintenance
- N. Design and supply of support accessories such as sole plates, sub-sole plates, shims, wedges, anchor bolts and nuts
- O. Impingement plate (stainless steel) at the steam nozzle inlet



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- P. Impingement plate (stainless steel) at the inlet of the cascaded heater drains
- Q. Tube and shell side safety relief valve for each feedwater heaters (Except LP#1,2 heater shell side safety relief valve)
- R. Shell and channel side body drains including necessary piping and isolation valves
- S. Start up vent shell side including necessary piping and isolation valve
- T. Continuous shell side vent line, upto isolation valves with orifice plate
- U. Channel side vent including necessary piping and isolation valve
- V. Lifting lugs as required
- W. Name plate and labeling
- X. Start-up and commissioning spares and consumables.
- Y. Spare parts for two (2) years operation (Optional)
- Z. Wheel or roller type supports for each heater including rails
- AA. Insulation clips
- BB. All flanges for flanged connections
- CC. Blanking flanges for pre-operational cleaning and flushing
- DD. Separate connections for gauge glasses, level transmitter (three connection), nitrogen gas connection (two connection per shell and one connection tube side) as required
- EE. Final painting at shop.
- FF. Furnishing touch-up paints for site touch-up painting
- GG. ASME stamped by an authorized inspector on completion of manufacturing at shop
- HH. Shop test and inspection
- II. Furnishing of all documentation
- JJ. Packing and Shipping (FOB Basis)

2.3 Terminal point

- A. Equipment foundation : All embedded material shall be supplier's scope of supply
- B. Extraction steam : At heater inlet steam side nozzle
- C. Feedwater : At heater inlet and outlet tube size nozzle



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- D. Emergency drain : At heater outlet nozzle
- E. Cascade drain of previous heater: At heater inlet nozzle
- F. Cascade drain of a heater : At heater outlet nozzle
- G. Relief valve : At outlet of relief valve
- H. Start up vent : At isolation valve discharge
- I. Continuous vent : At orifice outlet
- J. Shell and tube side drains : At isolation valve discharge

2.4 Equipment and Services by others

The following items will be provided by the others.

- A. External connecting pipes
- B. Level and pressure instruments
- C. Field erection
- D. Foundation and civil works



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3.0 **CODES AND STANDARDS**

- 3.1. The Work shall comply with Laws, Rules, and Regulations of Vietnam and with the current editions of relevant internationally recognized Codes, Standards, and Regulations. Where the supplier's standards differ from those specified but comply with the standards of the country of origin, a complete list of such standards shall be included in the schedule of deviations of the Bid Proposal including a comparison with the specified Standards. The supplier shall submit five complete sets and one CD of the proposed Standard(s) together with cross-indexed references for each item of deviations with the specified Standard(s) during engineering stage for approval.
- 3.2. In the event of conflict between Standards, the prevailing ruling shall be the one which requires the highest quality of workmanship and materials and the highest degree of safety to personnel, or as interpreted by the Employer, the decision of which shall be final.
- 3.3. Where no Standards or Codes are specified, the Equipment shall be designed, manufactured, installed, and tested in accordance with the best current power station practice.
- 3.4. Where a Standard is specified, that Standard shall be the latest published edition thereof, unless otherwise stated. It shall be the responsibility of the Contractor to adopt the latest editions even if these editions should be published after the Commencement date.
- 3.5. The Equipment shall comply with the local authorities' Rules, Regulations, and statutory requirements including but not limited to health, safety, environmental protection, civil, building, and structural works. The firefighting and protection shall comply with NFPA codes and of local fire authority requirements.
- 3.6. The latest edition and addenda of the following publications in effect on the date of contract award are part of the specification and, where referred to by title or basic designation only, are applicable to the extent indicated by the specific reference. The equivalent codes and standards may be used. However, the equivalency must be demonstrated to the satisfaction of the purchaser.
 - A. American National Standards Institute (ANSI) B 16.5
 - B. American Society of Mechanical Engineers (ASME)
 1. ASME BPVC Sec. II – Ferrous material specifications – Materials
 2. ASME BPVC Sec. V – Nondestructive Examination
 3. ASME BPVC Sec. VIII – Rules for construction of pressure vessels
 4. ASME BPVC Sec. IX – Qualification standard for welding and brazing procedures, welders, brazers, and welding and brazing operators
 5. ASME B 31.1 – Power piping
 6. ASME PTC 12.1 – Performance test code – closed feedwater heaters



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- C. American Society for Testing and Materials (ASTM)
- D. American Welding Society (AWS) D1.1
- E. Heat Exchange Institute (HEI) for Feed water heaters
- F. Manufacturers Standardization Society (MSS)
- G. Occupational Safety and Health Act./Administration (OSHA)
- H. American Society of Non-Destructive Testing (ASNT)
- I. Instrument Society of America (ISA)
- J. International Electrotechnical Commission (IEC)
- K. Steel Structure Painting Council (SSPC)
- L. Tubular Exchanger Manufacturers Association (TEMA) Class C
- M. National Electrical Manufacturers Association (NEMA)
- N. British Standards Institution (BSI)
- O. Deutsches Institut für Normung (DIN)
- P. Japanese Industrial Standards (JIS)
- Q. Pipe Fabrication Institute (PFI)

In the event of any apparent conflict among codes, standards, or this specification, the Supplier shall refer the conflict to the Purchaser for written resolution.

All equipment covered by this specification shall comply with all applicable laws and regulations of Vietnam.



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4.0 **CONDITIONS OF SERVICES**

4.1. Description of service

4.1.1 The feedwater heaters will be used for regenerative heating of feed water using steam extracted from the turbine.

4.1.2 The feedwater heaters shall conform to the design requirements specified in the specification.

4.2. Site conditions

4.2.1 Site data

The site data provided in this specification thereto are to assist the supplier in assessing site conditions in general. Such information is provided to the supplier in good faith and the supplier accepts responsibility for interpretation of such data. The supplier shall decide the extent of additional testing and studies necessary to confirm the site data.

4.2.1.1 Site ambient conditions (basic parameters for metrology design)

A. Air temperature based on thai binh station

Extremely low air temperature	4.80	°C
Extremely high air temperature	38.0	°C
Yearly mean air temperature	23.3	°C
Mean air temperature in the coldest month	16.2	°C (January)
Mean air temperature in the hottest month	29.1	°C (July)

B. Air moisture based on thai binh station

Extremely low air relative moisture	20.0	%
Extremely high air relative moisture	100.0	%
Yearly mean air relative moisture	86.0	%
Mean air relative moisture in the driest month	83.0	% (Jul. & Nov.)
Mean air relative moisture in the moistest month	91.0	% (March)

C. Barometric pressure based on thai binh station

Extreme low atmospheric pressure	99.32	kPa
Extreme high atmospheric pressure	103.45	kPa
Yearly mean atmospheric pressure	101.08	kPa



4.2.2 Seismic Data

According to the seismic investigation and evaluation report produced in march 2008 by the institute of geophysics of the national institute of technologies and sciences, the seismic features of the project Site are as follows:

- 4.2.2.1 Among the faults (fractures) within a radius of 100 km or more from the studied area, the most noticeable the linh son – cam pha fault that runs at a distance of 8 or 9 km northwest of the Site.
- 4.2.2.2 The maximum seismic level at the Site is $I_{max} = 7$ (MSK-64; MM), and the peak ground acceleration (PGA) $a_{max} = 142 \text{ cm/s}^2$ ($a_{max} = 0.145g$ where g is gravitational acceleration); this is caused by the maximum earthquake intensity $M_{max} = 5.5$, damping depth $h = 12\text{km}$ may happen on the linh son – cam pha fault at a distance of 8.1km from the Site.
- 4.2.2.3 It is recommended the maximum design earthquake (MDE) be the maximum earthquake at a probability of occurrence of more than 10% in 1,000 years and a repeat cycle of 9,500 years, that translates to $IMDE = 7$ (MSK-64; MM) and $aMDE = 131.63\text{cm/s}^2$; and the operation basic earthquake (OBE) be the maximum earthquake at a probability of occurrence of more than 10% in 50 years and a repeat cycle of 475 years, that translates to $IOBE = 7$ (MSK-64; MM) and $aOBE = 90.85\text{cm/s}^2$.

4.2.3 Demineralised water:

Analysis of DM water is as below:

No.	Content	Unit	Value
1	Chloride	$\mu\text{g/l Cl}$	< 3
2	Silica	$\mu\text{g/l SiO}_2$	< 10
3	Specific conductivity	$\text{uS/cm at } 25^\circ\text{C}$	< 0.1
4	Sulfate	$\mu\text{g/l SO}_4$	< 3
5	Total organic carbon	$\mu\text{g/l}$	< 100
6	Total dissolved solids	$\mu\text{g/l}$	< 25
7	Sodium	$\mu\text{g/l Na}$	< 3
8	Iron	$\mu\text{g/l Fe}$	< 20
9	pH		6.5 to 7.5



4.3. Design and operation conditions

4.3.1 Each feedwater heater shall be designed for following conditions:

The feedwater heater shall be designed as per BMCR condition heat balance diagrams. Definitions of BMCR will follow conclusion of technical deviation K-5.

4.3.1.1 Low pressure feedwater heater #1 (with external drain cooler)

1. Number of heater	Two (2) set					
2. Type of heater	Horizontal, U-tube with 1 zone (Condensing zone) , condenser neck mounted with removable tube bundle					
Type of external drain cooler	Horizontal straight tube,					
3. Performance required	100 % RO		VVO (Design condition)		HP Heater#8 out of service	
Shell side						
- Fluid (steam/drain)	Steam	Drain	Steam	Drain	Steam	Drain
- Flow rate (kg/h)	41,230	176,973	45,989	189,575	34,029	187,533
- Shell pressure – bar (a)	0.1857		0.1949		0.194	
- Inlet temperature (°C)	58.49	61.3	59.52	62.3	59.42	62.2
- Enthalpy (kJ/kg)	2518	256.5	2519.5	260.8	2522.4	260.4
- Other steam flow rate (kg/h)	2,806		3,158		2,145	
- Other steam enthalpy (kJ/kg)	3129.2		3135.1		3135.8	
- Drain outlet temp. (°C)	42.2		42.2		47.4	
- Drain outlet enthalpy (kJ/kg)	176.8		176.7		198.6	
Tube side						
- Fluid	Condensate		Condensate		Condensate	
- Flow rate (kg/h)	1,391,287		1,473,018		1,469,545	
- In/Out temp. (°C)	36.6 / 55.7		36.6 / 56.7		41.8 / 56.6	



- In/Out enthalpy (kJ/kg)	155.2 / 234.8	155.1 / 239.1	177 / 238.7
- Allow. pres. drop (bar)	1**	1.12	Supplier to indicate
- Condensate water connection size (inlet / outlet)	450 NB		
Design pressure / temperature			
Shell side			
- Design pressure (bar (g))	3.5 & FV		
- Design temperature (°C) – main barrel	150		
- Design temperature (°C) – skirt barrel	NA		
Tube side			
- Design pressure (bar (g))	41		
- Design temperature (°C) – Tube side	150		
- Design temperature (°C) – Desuperheating zone	NA		
5. Materials	Refer to section 5.3.32		
6. Terminal temp. difference (°C)	2.8		
7. Drain cooler approach (°C)	5.6		

* Information is min. value required. Supplier shall correct with supplier's data.

4.3.1.2 Low pressure feedwater heater #2

1. Number of heater	Two (2) set
2. Type of heater	Horizontal, U-tube with 2 zones (Condensing and subcooling zone), condenser neck mounted with removable tube bundle



3. Performance required	100 % RO		VWO (Design condition)		HP Heater#8 out of service	
Shell side						
- Fluid (steam/drain)	Steam	Drain	Steam	Drain	Steam	Drain
- Flow rate (kg/h)	53,219	123,754	57,416	132,159	56,046	131,487
- Pressure – bar (a)	0.516		0.547		0.533	
- Inlet temperature (°C)	82.13	84.9	83.59	86.4	82.94	85.7
- Enthalpy (kJ/kg)	2610.8	355.6	2613.2	361.8	2610	359.1
- Drain outlet temp. (°C)	61.3		62.3		62.2	
- Drain outlet enthalpy (kJ/kg)	256.5		260.8		260.4	
Tube side						
- Fluid	Condensate		Condensate		Condensate	
- Flow rate (kg/h)	1,391,287		1,473,018		1,469,545	
- In/Out temp. (°C)	55.7 / 79.3		56.7 / 80.8		56.6 / 80.1	
- In/Out enthalpy (kJ/kg)	234.8 / 333.6		239.1 / 339.8		238.7 / 337.1	
- Allow. pres. drop (bar)	1**		1.12		Supplier to indicate	
- Condensate water connection size (inlet / outlet)	450 NB					
Design pressure and temperature						
Shell side						
- Design pressure (bar (g))	3.5 & FV					
- Design temperature (°C) – main barrel	150					
- Design temperature (°C) – skirt barrel	NA					
Tube side						

- Design pressure (bar (g))	41
- Design temperature (°C) – Tube side	150
- Design temperature (°C) – Desuperheating zone	NA
5. Materials	Refer to clause 5.3.32
6. Terminal temp. difference (°C)	2.8
7. Drain cooler approach (°C)	5.6

* Information is min. value required. Supplier shall correct with supplier's data.

4.3.1.3 Low pressure feedwater heater #3

1. Number of heater	Two (2) set					
2. Type of heater	Horizontal, U-tube with 2 zones (Condensing and subcooling zone), removable shell					
3. Performance required	100 % RO		VWO (Design condition)		HP Heater#8 out of service	
Shell side						
- Fluid (steam/drain)	Steam	Drain	Steam	Drain	Steam	Drain
- Flow rate (kg/h)	46,667	77,087	49,428	82,731	49,297	82,190
- Pressure – bar (a)	1.094		1.151		1.125	
- Inlet Temperature (°C)	123.92	104.9	124.81	106.4	123.25	105.7
- Enthalpy (kJ/kg)	2723.3	440	2724.6	446.2	2721.7	443.4
- Drain outlet temp. (°C)	84.9		86.4		85.7	
- Drain outlet enthalpy (kJ/kg)	355.6		361.8		359.1	
Tube Side						
- Fluid	Condensate		Condensate		Condensate	



- Flow rate (kg/h)	1,391,287	1,473,018	1,469,545
- In/Out temp. (°C)	79.3 / 99.3	80.8 / 100.8	80.1 / 100.1
- In/Out enthalpy (kJ/kg)	333.6 / 417.7	339.8 / 423.9	337.1 / 421.1
- llow. pres. drop (bar)	1**	1.12	Supplier to indicate
- Condensate water connection size (inlet / outlet)	450 NB		
Design pressure / temperature			
Shell side			
- Design pressure (bar (g))	3.5 & FV		
- Design temperature (°C) – main barrel	150		
- Design temperature (°C) – skirt barrel	NA		
Tube side			
- Design pressure (bar (g))	41		
- Design temperature (°C) – Tube side	150		
- Design temperature (°C) – Desuperheating zone	NA		
5. Materials	Refer to clause 5.3.32		
6. Terminal temp. difference (°C)	2.8		
7. Drain cooler approach (°C)	5.6		

* Information is min. value required. Supplier shall correct with supplier's data.

4.3.1.4 Low pressure feedwater heater #4

1. Number of heater	Two (2) set
2. Type of heater	Horizontal, U-tube with 2 zones (Condensing and subcooling zone), removable shell



3. Performance required	100 % RO		VWO (Design condition)		HP Heater#8 out of service	
Shell side						
- Fluid (steam/drain)	Steam	Drain	Steam	Drain	Steam	Drain
- Flow rate (kg/h)	77,087	-	82,731	-	82,190	-
- Pressure – bar (a)	3.09		3.25		3.18	
- Inlet temperature (°C)	224.75	-	225.76	-	224.15	-
- Enthalpy (kJ/kg)	2916	-	2917.4	-	2914.4	-
- Drain outlet temp. (°C)	104.9		106.4		105.7	
- Drain outlet enthalpy (kJ/kg)	440		446.2		443.4	
Tube Side						
- Fluid	Condensate		Condensate		Condensate	
- Flow rate (kg/h)	1,391,287		1,473,018		1,469,545	
- In/Out temp. (°C)	99.3 / 131.7		100.8 / 133.5		100.1 / 132.7	
- In/Out enthalpy (kJ/kg)	417.7 / 554.9		423.9 / 562.6		421.1 / 559.3	
- Allow. pres. drop (bar)	1**		1.12		Supplier to indicate	
- Condensate water connection size (inlet / outlet)	450 NB					
Design pressure / temperature						
Shell side						
- Design pressure (bar (g))	4 & FV					
- Design temperature (°C) – main barrel	240					
- Design temperature (°C) – skirt barrel	NA					
Tube side						



- Design pressure (bar (g))	41
- Design temperature (°C) – Tube side	155
- Design temperature (°C) – Desuperheating zone	NA
5. Materials	Refer to clause 5.3.32
6. Terminal temp. difference (°C)	2.8
7. Drain cooler approach (°C)	5.6

* Information is min. value required. Supplier shall correct with supplier's data.

4.3.1.5 High pressure feedwater heater #6

1. Number of heater	Two (2) set					
2. Type of heater	Horizontal, U-tube with 3 zones (Desuperheating, condensing and subcooling zone), removable shell					
3. Performance required	100 % RO		VWO (Design condition)		HP Heater#8 out of service	
Shell side						
- Fluid (steam/drain)	Steam	Drain	Steam	Drain	Steam	Drain
- Flow rate (kg/h)	56,120	309,314	60,226	334,739	56,571	
- Pressure – bar (a)	16.69		17.62		17.26	
- Inlet temperature (°C)	431.59	210	431.86	212.7		211.7
- Enthalpy (kJ/kg)	3322.3	898.4	3321.7	910.6	3321.2	906
- Drain outlet temp. (°C)	188		190.4		189.4	
- Drain outlet enthalpy (kJ/kg)	798.9		809.5		805.2	
Tube Side						
- Fluid	Feedwater		Feedwater		Feedwater	
- Flow rate (kg/h)	1,792,914		1,896,507		1,617,407	



- In/Out temp. (°C)	182.4 / 204.4	184.8 / 207.1	183.8 / 206.1
- In/Out enthalpy (kJ/kg)	784.1 / 880.3	794.4 / 892	790.2 / 887.6
- Allow. pres. drop (bar)	1**	1.14	Supplier to indicate
- Feedwater water connection size (inlet / outlet)	500 NB		
Design pressure / temperature			
Shell side			
- Design pressure (bar (g))	20 & FV		
- Design temperature (°C) – main barrel	215		
- Design temperature (°C) – skirt barrel	450		
Tube side			
- Design pressure (bar (g))	300**		
- Design temperature (°C) – Tube side	215		
- Design temperature (°C) – Desuperheating zone	235		
5. Materials	Refer to clause 5.3.32		
6. Terminal temp. difference (°C)	-1		
7. Drain cooler approach (°C)	5.6		

* Information is min. value required. Supplier shall correct with supplier's data.

** Preliminary information. The value shall be rechecked with supplier during technical clarification stage.

4.3.1.6 High pressure feedwater heater #7

1. Number of heater	Two (2) set
2. Type of heater	Horizontal, U-tube with 3 zones (Desuperheating, condensing and subcooling zone), removable shell



3. Performance required	100 % RO		VWO (Design condition)		HP Heater#8 out of service	
Shell side						
- Fluid (steam/drain)	Steam	Drain	Steam	Drain	Steam	Drain
- Flow rate (kg/h)	150,111	159,203	161,221	173,518	150,427	-
- Pressure – bar (a)	37.8		40		39.1	
- Inlet temperature (°C)	325.35	253.6	331.42	256.9	331.17	-
- Enthalpy (kJ/kg)	3037.8	1103.3	3047.6	1119.2	3049.3	-
- Drain outlet temp. (°C)	210		212.7		211.7	
- Drain outlet enthalpy (kJ/kg)	898.4		910.6		906	
Tube side						
- Fluid	Feedwater		Feedwater		Feedwater	
- Flow rate (kg/h)	1,792,914		1,896,507		1,617,407	
- In/Out temp. (°C)	204.4 / 248		207.1 / 251.3		206.1 / 250	
- In/Out enthalpy (kJ/kg)	880.3 / 1077.6		892 / 1092.8		887.6 / 1086.9	
- Allow. pres. drop (bar)	1**		1.14		Supplier to indicate	
- Feedwater water connection size (inlet / outlet)	500 NB					
Design pressure / temperature						
Shell side						
- Design pressure (bar (g))	47 & FV					
- Design temperature (°C) – main barrel	265					
- Design temperature (°C) – skirt barrel	350					
Tube side						



- Design pressure (bar (g))	300**
- Design temperature (°C) – Tube side	265
- Design temperature (°C) – Desuperheating zone	285
5. Materials	Refer to clause 5.3.32
6. Terminal temp. difference (°C)	-1
7. Drain cooler approach (°C)	5.6

* Information is min. value required. Supplier shall correct with supplier's data.

** Preliminary information. The value shall be rechecked with supplier during technical clarification stage.

4.3.1.7 High pressure feedwater heater #8

1. Number of heater	Two (2) set			
2. Type of heater	Horizontal, U-tube with 3 zones (Desuperheating, condensing and subcooling zone), removable shell			
3. Performance required	100 % RO		VWO (Design condition)	
Shell side				
- Fluid (steam/drain)	Steam	Drain	Steam	Drain
- Flow rate (kg/h)	159,203	-	173,518	-
- Pressure – bar (a)	68.6		72.7	
- Inlet temperature (°C)	411.92	-	419.15	-
- Enthalpy (kJ/kg)	3195	-	3206.7	-
- Drain outlet temp. (°C)	253.6		256.9	
- Drain outlet enthalpy (kJ/kg)	1103.3		1119.2	
Tube Side				



- Fluid	Feedwater	Feedwater
- Flow rate (kg/h)	1,792,914	1,896,507
- In/Out temp. (°C)	248 / 286.4	251.3 / 290.4
- In/Out enthalpy (kJ/kg)	1077.6 / 1263.3	1092.8 / 1283.8
- Allow. pres. drop (bar)	1**	1.14
- Feedwater water connection size (inlet / outlet)	500 NB	
Design pressure / temperature		
Shell side		
- Design pressure (bar (g))	86 & FV	
- Design temperature (°C) – main barrel	305	
- Design temperature (°C) – skirt barrel	440	
Tube side		
- Design pressure (bar (g))	300**	
- Design temperature (°C) – Tube side	305	
- Design temperature (°C) – Desuperheating zone	325	
5. Materials	Refer to clause 5.3.32	
6. Terminal temp. difference (°C)	- 2	
7. Drain cooler approach (°C)	5.6	

* Information is min. value required. Supplier shall correct with supplier's data.

** Preliminary information. The value shall be rechecked with supplier during technical clarification stage.



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4.4. Performance guarantee

4.4.1 The supplier shall guarantee that the feedwater heaters shall operate without exceeding the vibration and noise limits, as specified in this specification and the relevant codes and standards, throughout the range of operation. The feedwater heaters and auxiliaries shall be capable of continuous and satisfactory operation, shall meet the following guarantee parameters as specified in the data sheets by the Supplier at VWO and 100% RO condition.

- A. Terminal temperature difference
- B. Drain cooler approach
- C. Tubeside pressure drop



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5.0 **DETAIL DESIGN**

5.1 General

The design, manufacture, installation and testing of the equipment, material and work shall be in accordance with the requirements and recommendations of all appropriate internationally recognized and accepted codes and standards.

5.2 Operating conditions

5.2.1 The feedwater heaters shall be capable of operating in conjunction with the turbine generator specified in this specification.

5.2.2 The feedwater heaters shall be designed to accept the additional steam load should preceding heaters (except the deaerator) be out of service. Performance data shall be submitted for each feedwater heater in operation when the heaters directly preceding are being bypassed. The supplier shall also submit, in tabular form, the maximum machine load with a combination of 1 or more feedwater heaters out of service.

5.3 Feedwater heater design requirements

5.3.1 The feedwater heaters shall be of the U-tube surface type with drain cooler and desuperheating sections arranged for horizontal installation. Heaters, except for the LP Heater No.1, 2 shall be arranged to facilitate shell withdrawal and tube replacement. The LP Heater No.1, 2 shall be arranged for horizontal mounting in the exhaust neck of the surface condenser and designed to facilitate channel and tube bundle withdrawal from the shell. Carriages required for installation and removal of tube bundles shall be supplied and handed over upon completion.

5.3.2 The shell and tube side design temperatures of the heaters shall be in accordance with the standards of the Tubular Exchanger Manufacturers Association and the HEI Standards for closed feedwater heaters.

5.3.3 The shell side design pressure shall be the same as the bleed steam piping design pressure for the respective heater. Feedwater heater shells shall also be designed for full vacuum conditions.

5.3.4 The tube side design pressure of the LP heaters shall be based on the larger pressure determined by either a minimum design pressure of 3.5 bar (g) or 105% of the piping design pressure. The tube side design pressure of the HP heaters shall be about 5% greater than the pipe design pressure to prevent lifting of the heater channel relief valves during operation.

5.3.5 The velocities of the condensate passing through the various feedwater heater tubes shall not exceed those as stipulated in the HEI Standards for closed feedwater heaters.

5.3.6 Tube inlets shall be designed to provide optimum hydraulic flow conditions. Entrance velocity shall be limited to values which prevent tube inlet erosion.



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- 5.3.7 The heater shells shall be reinforced to withstand the thermal reaction forces and moments from the bleed steam, condensate, and feedwater piping.
- 5.3.8 The HP heater water boxes shall be provided with pressure seal type covers of a proven design. Jacking devices required for installation and removal shall be handed over in a refurbished condition. The supplier shall also supply heater tube leak detection and tube repair equipment.
- 5.3.9 The HP and LP heater baffles and seal plates shall be designed and constructed to prevent short circuiting and leakage between passes, including reheat of condensate in the drain cooler zone by heat flow from other portions of the heater at higher temperatures.
- 5.3.10 The water seal to the drain cooling section shall be designed so it will be maintained during all operating conditions in order to prevent flashing.
- 5.3.11 The pass partition in the water box shall be independent of the cover.
- 5.3.12 The heater impingement plates, shrouds and other internals shall be designed to provide resistance to erosion and corrosion.
- 5.3.13 The drains inlet shall be provided with impingement plates to protect against tube erosion.
- 5.3.14 The supplier shall be required to submit full details of the proposed measures to prevent erosion and corrosion from occurring in feedwater heaters.
- 5.3.15 Full information shall be submitted which substantiates the supplier's cognizance of the erosion-corrosion phenomena occurring in feedwater heaters. Information shall be submitted which demonstrates the proposed design and construction will minimize or eliminate the phenomena. The supplier shall submit recommendations for construction features and supplemental devices to control the erosion-corrosion phenomena.
- 5.3.16 The shell shrouds, steam inlet and drains inlet impingement plates shall be fabricated from stainless steel.
- 5.3.17 It shall be the supplier's responsibility to prepare documentation for submission to Local Authorities for registration of these heaters. The supplier shall refer to relevant section of the specification for more details.
- 5.3.18 The tube sides of heaters shall be provided with relief valves to prevent the rise of excess pressure due to thermal expansion in the event the heater feedwater inlet and outlet valves close.
- 5.3.19 Heater shells shall be provided with relief valves to protect the shell in case of a tube failure and shall be of adequate capacity to limit the shell pressure to 110% of design pressure sized to pass a minimum of 10% of the design feedwater flow at 10% accumulation.
- 5.3.20 Air vent openings in heater shells shall be provided by the supplier to remove non-condensable vapors from the heaters. Internal baffles and piping shall be stainless steel. Heaters shall be provided with a stainless steel vent orifice constructed integrally with the vent connection, with a



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bypass provided around the orifice for use during startup. Air vents for LP Heater No.1 shall be internally piped to connections located near the tube sheet.

- 5.3.21 LP Heater No.1, 2 shall be provided with heavy gage stainless steel lagging to prevent steam impingement on the heater shells within the condenser neck.
- 5.3.22 High pressure piping connections on the removable shell sections of the heaters shall be welded. The main feedwater inlet and outlet connections shall be butt welded, prepared in accordance with ASME Standards.
- 5.3.23 Heaters shall be provided with 2 connections per heater shell and 1 connection per heater on the tube side for connection to a source of nitrogen gas for long term storage.
- 5.3.24 Circumferential butt welds to obtain the required heater tube lengths shall not be permitted.
- 5.3.25 The supplier shall also indicate the expected pressure loss through the HP feed line and heaters to enable the desuperheating water spray system to be designed.
- 5.3.26 A minimum fouling resistance shall be applied to the feedwater heater tube side and an additional fouling resistance shall be applied for the outer tube surfaces in the desuperheating and drain cooling zones as recommended by HEI Standards for Closed Feedwater Heaters.
- 5.3.27 Internal surfaces of the heaters, except for tubes and machined surfaces, shall be cleaned by blasting with steel grit or shot in accordance with the requirements of SSPC-SP 6 "Commercial Blast Cleaning". Tube sheets, tube support plates and baffles shall be blast cleaned prior to drilling. After fabrication of the shell and prior to assembly of the unit, the shell shall be blast cleaned. Immediately after cleaning, surfaces shall be coated with an oil free, water soluble, rust preventive material.
- 5.3.28 The exterior portions of the LP Heater No.1, 2 which are within the surface condenser shall also be cleaned by blasting with surfaces coated with water soluble material after cleaning, as specified above.
- 5.3.29 Hydrostatic tests in the works shall be conducted with clean chloride free, potable quality water to which an oil free rust inhibitor has been added. After testing, the heaters shall be drained and shall be dried by heating with hot, dry air. After the drying operation, connections and openings shall be sealed.
- 5.3.30 The shell and tube sides of the heaters shall be purged with nitrogen while under vacuum. After purging, both sides of the heaters shall be pressurized to 1 bar (g) with nitrogen. Pressure gages, valves and connections shall be provided to monitor and restore nitrogen pressure. The heaters shall be checked for leakage within 24 hours after pressurization. After the leakage check, the nitrogen pressure shall be reduced to 0.7 bar (g) for shipment. Maintenance of the nitrogen pressure in the heaters shall be the responsibility of the supplier until the heaters have been positioned at the plant site ready for attachment to piping. If nitrogen purging of heaters is required before take over of the unit by the others, the supplier shall supply the nitrogen and the maintenance of the system.



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5.3.31 The dew point of the nitrogen atmospheres within each side shall be measured periodically. The supplier shall maintain a record of the dew point readings from packing for shipment until the seals are broken for piping connections.

5.3.32 The feedwater heaters shall designed and constructed in accordance with ASME and TEMA specifications and the stresses shall be those permitted by the ASME B&PVC Section VIII, Pressure Vessels. An ASME code stamp is required. The shell side and the tube side shall have a minimum of 1.6 mm corrosion allowance. Tubesheets shall have a minimum of 3 mm corrosion allowance. The materials to be used for heater components shall be as follows:

Tubes		
HP heaters		SA556 Gr. C2
LP heaters		SA688 TP304N
Shell, Cover, Flash Boxes and Water Boxes		SA 516, Gr 70
Bolts and Studs:	External	Alloy Steel ASME SA 193 Gr.B7
	Internal	Stainless Steel ASME SA 198 Gr.8
Nuts		Alloy Steel SA 194 Class 2H
Tubesheets LP Heater 1		SA 266, Gr 2
Tubesheets Heater 2 thru 8		SA 350, Gr LF2
Support Plates		SA 516, Gr 70
Impingement Plates		SA 240, TP 304

5.4 I&C requirement

5.4.1 Control:

5.4.1.1 The supplier shall provide and install the equipment and services to execute the specified control and monitoring functions for the major modulating control systems. All measurement sensors and output modules for the major control loops shall be redundant. Redundant signals shall use high select, low select or signal average as appropriate for the specific application and service.

5.4.1.2 The modulating control shall include, but not be limited to the control systems for Condenser Deaerator Level Control, LP bypass temperature control & Condenser Hotwell level control. All systems listed herein shall be included in the Supplier's DCIS. Systems which are proprietary in nature and provided as an integral part of process equipment have not been included in the descriptions. The operator interface for all these control loops shall be the DCIS operator workstations. Control loops schematic with dynamic status display shall be accessible to the operator at the workstations.

5.4.2 Instruments:

5.4.2.1 Pressure gauges



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5.4.2.1.1 Local Gauges accuracy tolerance shall be the manufacture's standard but not greater than +/- 0.5% of full scale range.

5.4.2.1.2 Pressure gauges with ranges below atmospheric shall be related to absolute pressure while other pressure ranges shall be expressed as gauge pressure. Pressure gauges shall be calibrated in kPa. Manometers shall be calibrated in mmH₂O or mmHg.

5.4.2.1.3 Normal operating point shall be approximately 70 percent of the dial range.

5.4.2.1.4 Locally mounted pressure gauges shall have a dial size of 150 mm minimum with black on white markings and 15 mm connection. The connections (male and female) shall be uniformed.

5.4.2.2 Temperature Detectors

5.4.2.2.1 Temperature detectors shall preferably be thermocouples as required by the following paragraphs and the detailed specification; however, RTD's may be used. Temperature detectors equipped with thermowells shall be spring loaded and shall be furnished as complete assemblies, each including a well, nipple, and dust tight and weather proof connection head. Thermowells shall be as specified in this section under Thermowells.

5.4.2.2.2 Thermocouples shall be dual element, 316 stainless steel sheathed, compacted magnesium oxide insulated type, with ungrounded measuring junction. Thermocouples and shielded extension wires shall meet the standard limits of error specified in ISA MC96.1. Cold junction compensation shall be carried out at DCIS I/O cabinets.

5.4.2.2.3 Temperature detectors for bearing thermocouples, metal temperatures, and fluid system temperatures shall be ISA Type E (chromel-constantan) thermocouples with Type EX extension wires or Type K (chromel-alumel) thermocouples with type KX extension wires

5.4.2.2.4 RTD's shall be a dual element, 3 wire encased in 316 stainless steel sheath. RTD shall be calibrated to nominal 100 ohm platinum conforming to the International Resistance versus Temperature Curve with an alpha coefficient of 0.00385 ohms/ohm/°C.

5.4.2.2.5 Temperature detectors shall be provided with a Stainless Steel nipple-union-nipple extension for easy removal of element without disconnecting field wiring.

5.5 Painting

5.5.1 The plant is located in an area close to the sea. Environmental conditions encountered in the plant locality shall be considered when selecting and applying coatings.

5.5.2 The specific type of coating and surface preparation required for each category of equipment or structure shall be determined by the supplier. Coating applications shall meet SSPC-PA 1, Paint application specification No. 1 – shop, field, and maintenance painting of steel.

5.5.3 For vessels, equipment, piping and tanks, coatings shall be applied to those areas which are not insulated.

5.5.4 A prime coat (125 ± 25 microns DFT) shall be in place on surfaces prior to a top or finish coat application unless noted otherwise below.



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- 5.5.5 Supplier shall protect items that are not to be coated such as stainless steel and galvanized pipe, rubber expansion joints or hoses, equipment tags, load buttons or information of any kind unless required by codes and standards .
- 5.5.6 The supplier shall not paint over name plates, equipment tags, valve tags, hanger tags, load buttons, equipment identification or information of any kind.
- 5.5.7 The application method for field-applied coatings may be spray, brush, or roller if environmental requirements are met and in accordance with the paint and coatings manufacturer's recommendations.
- 5.5.8 Supplier is responsible for the proper surface preparation, priming and finish coat for equipment, piping, steel shapes, vessel surfaces and equipment surfaces.
- 5.5.9 Supplier is responsible for determining whether or not the work is for complete coatings or just touch ups on pre-primed or pre-finished items.
- 5.5.10 The supplier finds that coating has been damaged during transportation, assembly, installation, or any other reasons due to handling of the equipment, the supplier shall be responsible for re-coating.
- 5.5.11 The supplier finds that equipment has a suppliers' standard finish coat color that does not match the plant specific color chart the supplier shall be responsible for re- coating.
- 5.5.12 Supplier is responsible for the appropriate surface preparation, priming and finish coat of instrument mounting brackets or instrument stands that are not stainless steel, advanced alloy or galvanized.
- 5.5.13 Supplier shall coat vessel and tank shop weld seams, and shall prime and finish paint field weld seams. The coating width shall be no less than 500 mm wide, centered on the seam.
- 5.5.14 Supplier shall comply with safety instructions as outlined by the material safety data sheets (MSDS) supplied by the paint and coatings manufacturer. This applies to every different compound, material, and solvent supplied.
- 5.5.15 Paints, hardeners, catalysts, solvents and other flammable material supplied by the supplier shall be stored in a safe place and in an area recommended for that type of material. Ignition sources, sparks, flames and welding operations are prohibited in the material storage and working areas.
- 5.5.16 Dry film thickness of each coat shall be measured as described in ASTM D7091. The complete surface shall be inspected visually for skips, holidays, hiding and uniform color.
- 5.5.17 Random thickness measurements shall be taken with a frequency of at least 5 readings per 10 m2. Each measurement shall consist of the average of 3 readings taken within a 25mm radius of the sample point.
- 5.5.18 Instruments used for the measurement of thickness shall be calibrated prior to the start of testing and shall be in accordance with the manufacturer's instructions. The base metal thickness of the calibration standard should not vary more than 15% of the metal in the component being painted.



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5.5.19 Coatings and coating layers that do not meet the minimum thicknesses as set out in this document or by the manufacturer shall be repaired according to the paint and coatings manufacturer's instructions and shall be retested.

5.5.20 Coating requirement for piping below 93 deg C with shop primer

5.5.20.1 Surface preparation

Clean surface in accordance with SSPC-SP 6 commercial blast cleaning. If this is not possible, then hand tool clean to SSPC-SP 2 or power tool clean to SSPC-SP 3.

5.5.20.2 Primer coat

Macropoxy® epoxy mastic 125 +/- 25 microns DFT.

5.5.20.3 Finish coat

- Timing of application – finish coat to be applied within 24 hours of priming.
- Surface Preparation – Remove dirt, oil, grease, and other contaminants.
- Apply one coat of polyurethane enamel topcoat or high solids acrylic polyurethane, at 75 microns DFT. The total dry film thickness should be 200 microns. The maximum dry film thickness shall not exceed 250 microns.

5.5.21 Coating requirement for piping below 93 deg C without shop primer

5.5.21.1 Surface preparation

Clean surface in accordance with SSPC-SP 6 commercial blast cleaning. If this is not possible, then hand tool clean to SSPC-SP 2 or power tool clean to SSPC-SP 3.

5.5.21.2 Primer coat

Macropoxy® epoxy mastic 125 +/- 25 microns DFT.

5.5.21.3 Finish coat

Timing of application – finish coat to be applied within 24 hours of priming.

surface preparation – Remove dirt, oil, grease, and other contaminants.

Apply one coat of polyurethane enamel topcoat or high solids acrylic polyurethane, at 75 microns DFT. The total dry film thickness should be 200 microns. The maximum dry film thickness shall not exceed 250 microns.

5.5.22 Tanks (exterior of clad tanks and vessels only)

5.5.22.1 Surface preparation

Clean surface in accordance with SSPC- SP 6 commercial blast cleaning. If not possible, then hand tool clean to SSPC-SP 2 or power tool clean to SSPC-SP 3.



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5.5.22.2 Prime Coat

Apply one coat of Macropoxy® epoxy mastic 125 +/- 25 microns DFT

5.5.22.3 Finish Coat

Timing of application – finish coat to be applied within 24 hours of priming.

Surface Preparation – Remove dirt, oil, grease, and other contaminants.

Apply one coat of Polyurethane enamel topcoat or acrylic polyurethane, at 75 microns DFT. The total dry film thickness should be 200 microns. The maximum dry film thickness shall not exceed 250 microns.

5.5.23 Color scheme: The color scheme shall be as follows:

EXTERIOR SURFACE COLORS		
Surface	Federal Standard 595C or ANSI Color No.	Color
Equipment	30475	Rawhide
Handrails	13591	Yellow
Pipe Attachments (clamps, etc.)		Match Pipes
Pipe Hangers and Supports		Match Steel

INTERIOR SURFACE COLORS		
Surface	Federal Standard 595C or ANSI Color No.	Color
Pipe Attachments (clamps, etc.)	-----	Match Pipes
Pipe Hangers and Supports	-----	Match Steel



<u>PIPING COLOR CODE</u>			
<u>System</u>	<u>Pipe Design Code</u>	<u>Color</u>	Federal Standard 595C <u>Color No.</u>
Bleed Steam to Htr. #1,2,3,4	EX	Yellow	13591
Bleed Steam to Htr. #6,7,8	EX	Yellow	13591
Drains, from Htr. #1,2,3,4	HD	Brown	10091
Drains, from Htr. #6,7,8	HD	Brown	10091
Vents, Htr. #2,3,4	TV	Gray	16251
Vents, Htr. #6,7,8	TV	Gray	16251
Feedwater Discharge	FW	Orange	12246
Nitrogen	NB	Green	14090

5.6 PIPING

5.6.1 General

- 5.6.1.1 Where called upon to design, fabricate, supply, deliver to site, erect, test and commission piping systems, the Contractor shall install such systems in accordance with the requirements of ASME Boiler and Pressure Vessel Code (B&PVC), ASME B31.1 and ASME B31.3, unless otherwise specified.
- 5.6.1.2 Piping systems shall be designed to have sufficient flexibility to prevent pipe movements from causing failure due to overstress of the pipe material or anchors, leakage at joints or detrimental distortion of connected equipment resulting from excessive thrusts and movements. Flexibility shall be provided by changes of direction in the piping through the use of bends and expansion loops. Swivel, ball joints, corrugated pipe, bellows or flexible metal hose shall not be used to absorb thermal movements.
- 5.6.1.3 Overhead pipe including insulation when applicable shall have a minimum headroom of 2.5 meters above floor level.



High piping points shall have vents and low points in the system shall have drains. Intermediate pockets shall be avoided. The drain pipes shall run to the nearest drain sump or trench in a safe and adequate manner.

5.6.2 Material Selection

The maximum allowable fluid velocities shall be as follows:

SERVICE	VELOCITY
STEAM:	
LP saturated ≤ 200 kPa	35 m/s
LP superheated ≤ 200 kPa	61 m/s
MP saturated ≤ 1400 kPa	51 m/s
MP superheated ≤ 1400 kPa	71 m/s
HP superheated $v \geq 0.0624$	76 m/s
HP superheated $v < 0.0624$	71 m/s
Where v = specific volume, m^3/kg	
WATER:	
General service	3 m/s
HP boiler feedwater	6 m/s
AIR:	
Compressed air (≤ 700 kPa)	23 m/s

5.6.3 Vent and Drain Piping Design Criteria

- 5.6.3.1 Vent and drain piping through design shall be consistent with the piping for the main piping system.
- 5.6.3.2 Vent connections shall be provided at high points in liquid piping and high points in other piping, including steam lines, that will be hydrostatically tested.
- 5.6.3.3 Drain connections shall be provided at non-drainable low points in liquid piping and other piping that will be hydrostatically tested.
- 5.6.3.4 Drain and vent connections shall be provided between the isolation valves for inline equipment such as pumps and strainers if not already included on the equipment.
- 5.6.3.5 Piping systems such as steam systems may have the high point vent valve omitted following hydrostatic testing, with the vent connection plugged by welding a cap/plug in place on the vent valve.
- 5.6.3.6 Vent and drain connections that require frequent operation shall be piped to a suitable drain away from walkways or work areas. Vent or drain connections that normally require operation with hot fluids shall be piped to a safe termination point (drain funnel or floor area discharge) away from walkways or work areas. Other connections shall terminate with the isolation valve.
- 5.6.3.7 Piping high point vents shall be valved and shall be DN 20 minimum size for piping sizes being vented that are equal to or greater than, DN 20. Vent and drain valves shall be provided with a chained cap/plug.



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- 5.6.3.8 Vent and drain valves requiring frequent operation shall be readily accessible from walkways, platforms, or permanent man-ladders. Other less frequently used vents and drains may be accessed via temporary ladders, man lifts or temporary scaffolds. This would include vents required solely for system hydrostatic testing, filling, and, draining and manual drains from the bottom of steam drip pots.
- 5.6.3.9 Unless shown otherwise on the Drawings root connections on horizontal or sloping lines shall not be located below the centerline of the pipe. Root connections for service on steam and condensable vapors or wet gas shall be taken from the top side of the pipe or from any point between the top and the side. Root connections for service on liquids shall be taken from the side or top of the pipe, with the root nipple horizontal. Root connections for service on dry gases shall be taken from the top of the pipe. Double block root valves on high energy systems shall be supported from the header the line is tapping in order to reduce stresses at the connection.
- 5.6.4 Pipe Design Pressure and Temperature
- 5.6.4.1 The design pressure for piping shall be consistent with conditions established for the design of the associated system.
- 5.6.4.2 The design pressure of a piping system generally shall be based on the maximum sustained pressure, which may act on the system during normal or upset operating conditions plus 175 kPa, unless otherwise noted in the specific design parameters for the system. The piping system design pressure values shall be rounded up to the next 100 kPa increment, unless otherwise noted. On systems with pumps, the maximum sustained pressure is generally the pump shutoff head at the maximum possible suction pressure based on cold water.
- 5.6.4.3 Non-Critical Piping
- 5.6.4.3.1 The design temperature for piping shall be consistent with conditions established for the design of the associated system.
- 5.6.4.3.2 The design temperature of a piping system generally shall be based on the maximum sustained temperature, which may act on the system during normal or upset operating conditions plus 6 °C, unless otherwise noted in the specific design parameters for the system. The piping system design temperature values shall be rounded up to the next 5 °C increment, unless otherwise noted.
- 5.6.5 Piping Joints
- 5.6.5.1 General
- 5.6.5.1.1 Joints in carbon steel and alloy steel pipes shall be made by butt welding for pipe sizes DN 65 nominal bore and over, and by socket welding for the smaller sizes.
- 5.6.5.1.2 Joints in the control oil and turbine lube oil piping shall be made by butt welding for all pipe sizes. Socket weld joints in the turbine hydraulic control oil, turbine lube oil and boilerfeed pump and turbine lube oil systems will not be accepted.
- 5.6.5.1.3 Butt welded joints shall be made without the use of backing rings. For pipes conveying steam , feedwater, condensate, oil (control oil, lube oil), and all stainless steel butt welds the root pass weld



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shall be by the tungsten inert gas process, the balance of the weld being completed using the shielded metal arc process. For other services butt joints can be by the shielded metal arc process throughout. Consumable insert rings may be used where considered necessary.

5.6.5.1.4 Electrode, filler wire and consumable insert materials shall be selected to match the mechanical and chemical characteristics of the parent pipe.

5.6.5.1.5 Butt-weld profiles shall be in accordance with ASME B16.25.

5.6.5.1.6 The proximity of adjacent welds shall be no less than 6 times the thickness of the material being welded. In the case of two different thickness of material to be welded, the thicker material shall govern.

5.6.5.2 Flanges

5.6.5.2.1 Flanges shall be in accordance with the details and pressure-temperature ratings specified in ASME B16.5.

5.6.5.2.2 Flanges shall be constructed of materials equivalent to the pipe with which they are used.

5.6.5.2.3 Unless otherwise required, steel flanges DN 65 and larger shall be of the weld neck type and steel flanges DN 50 and smaller shall be of the socket type. Steel flanges shall have raised face flange preparation except when mating with valve or equipment where either material or manufacture results in a flat face flanged connection.

5.6.5.2.4 Carbon steel flanges shall not be used for temperatures exceeding 427° C.

5.6.5.3 Gasket Material

5.6.5.3.1 The jointing material used for flanged joints shall be selected to accommodate thermal cyclic stresses and movements that will occur during all conditions including cyclic operation of the unit.

5.6.5.3.2 Compressed fiber gaskets shall be used with flat face flanges and slip-on raised face flanges. Spiral wound gaskets shall be used with raised face flanges other than slip-on flanges. The use of asbestos is forbidden.

5.6.5.3.3 Compressed fiber gaskets shall be in accordance with ASME B16.21 and materials shall be suitable for the maximum design pressure and the maximum design temperature of the service. Gaskets shall be dimensioned to suit the contact facing. They shall be full faced for flat face flanges and shall extend to the inside edge of the bolt holes on raised face flanges. Gaskets for plain finished surfaces shall be no less than 1.6 mm thick and for serrated surfaces shall be no less than 2.4 mm thick.

5.6.5.3.4 Spiral wound gaskets shall conform to ASME B16.20 and shall be constructed of a continuous stainless steel ribbon wound into a spiral with non-asbestos filler between adjacent coils. The gasket shall be inserted into a steel gage ring whose outside diameter shall fit inside the flange bolts properly positioning the gasket. The gage ring shall serve to limit the compression of the gasket to the proper value. Compressed gasket thickness shall be 3.3 mm ± 0.13 mm.



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5.6.5.3.5 Rubber gasket materials shall be cloth inserted sheet rubber and shall conform to ASME B16.21. Gaskets shall be full face and 1.6 mm thick unless otherwise required.

5.6.5.3.6 Ring joint gaskets shall be octagonal in cross section and shall have dimensions conforming to ASME B16.20. Material shall be suitable for the service conditions encountered and shall be softer than the flange material.

5.6.5.4 Branch Connections

5.6.5.4.1 Branch connections shall be made by attaching the branch pipe directly to the run pipe by welding. If this procedure warrants the use of branch reinforcement as determined from ASME B31.1 then a branch fitting manufactured by a qualified supplier with successful experience shall be used, that shall provide a branch having a bursting strength equal to that of the unpierced run pipe.

5.6.6 General Fabrication Requirements

5.6.6.1 Circumferential butt welds shall not be located in the arc of any bend. Bends shall be smooth, without buckles, and truly circular. Allowable flattening, as defined by the ASME B31.1 Code, shall not be greater than 8 percent of the average measured outside diameter of the pipe before bending.

5.6.6.2 The Contractor shall provide allowance for thinning of the pipe wall, in accordance with its experience, its bending procedure, and the requirements of ASME B31.1, to ensure that the minimum wall thickness after bending is not less than the wall thickness as permitted by ASME B31.1 paragraph 102.4.5(B) utilizing the design conditions specified, the corrosion allowance specified, manufacturing tolerances, and bend thinning as applicable.

5.6.6.3 Pipe bending may be by the hot or cold bending method and to any radius that will result in a bend surface free of cracks or other defects and meet the design requirements for minimum wall thickness.

5.6.6.4 Where sand filled hot bending of pipe is utilized the pipe inside diameter shall be sand filled, tamped, and the pipe ends capped except where the wall thickness prior to bending is sufficient to ensure that no buckling of the bend will result when no interior sand packing is used.

5.6.6.5 Hot bending or other hot forging operations shall not be carried out on piping outside the temperature range of 899°C to 1093°C.

5.6.6.6 After bending, the Contractor shall verify the minimum wall thickness requirement for the pipe. Pipe bend thickness measurements shall be taken along the tension side of the bend arc, beginning at either tangent location and recorded for minimum wall thickness verification.

5.6.6.7 Hanger lugs, connections and structural attachments welded to the piping shall be of the same chemical composition to the piping and shall be in accordance with ASME/ASTM Standards. Such attachments shall be carefully designed to ensure the presence of sharp edged stress raisers is eliminated. Attachments (e.g. welded lugs and ears) for support of piping systems which shall be stress relieved shall be shop welded on fabricated pipe prior to stress relieving.



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- 5.6.6.8 Thermal insulated pipes are to be supported by steel sleeves attached to the pipes. The outside diameter of these sleeves shall be covered by insulation.
- 5.6.6.9 Each fabricated pipe component shall be identified with its piece mark number painted on each end 180° apart. The same number and the location of the pipe to which it refers shall appear on the finalized piping arrangement drawings.
- 5.6.7 General Welding Requirements
- 5.6.7.1 The Contractor shall be responsible for the welding performed by its organization and shall establish its own welding procedures. The Contractor and its subcontractors shall be responsible for the development and qualification of all Welding Procedure Specifications, welders, and/or welding operators required to perform the Work including the supply of all testing materials and filler material required for the qualification of these procedures.
- 5.6.7.2 Welding shall be performed with qualified welding procedures which comply with Section IX of the ASME B&PVC.
- 5.6.7.3 Welders/welding operators shall be qualified in accordance with the test requirements of Section IX of the ASME B&PVC. Welders to be engaged for site work shall pass the welder qualification test at the site. Welder qualification from a previous employer is not acceptable.
- 5.6.7.4 Any welder who fails to meet the requirements of the Code shall not be accepted for a retest within the period of six months.
- 5.6.7.5 When welding with a gas shielded process, the wind velocity in the weld area shall not exceed 5 mph.
- 5.6.7.6 The welding filler metal shall have a chemical composition as similar as possible to the base metals to be welded. The finished weld as deposited, or after post weld heat treatment (PWHT) when required, shall be at least equal to the base metal as to strength, ductility, notch toughness, corrosion-erosion resistance, or other physical or thermal properties.
- 5.6.7.7 Shielded metal arc welding (SMAW), gas-shielded flux-cored arc welding (FCAW), submerged arc welding (SAW), gas metal arc welding (GMAW), or the gas tungsten inert gas welding (GTAW) process shall be employed in the Work. Other welding processes may be used only if specifically accepted by the Engineer/Owner. Requests to utilize other welding processes shall define where and to what extent the Contractor would propose to use the procedure.
- 5.6.7.8 Use Argon gas of purity at least equal to that of commercial welding grade as a purge to the reverse side of all GTAW welds, except for ASME P Numbers 1, 3, and 4 materials. Maintain this inert purge on the root pass and subsequent passes as necessary to prevent oxidation on the reverse side of the weld joint. The argon gas shall have a dew point of minus 40 degrees C.
- 5.6.7.9 Welding filler metal chemistry shall match that of the base material. Similar metallurgical properties, i.e., yield strength equal to or greater than base metal, equal or better corrosion-erosion resistance, and equal or better thermal properties, shall be produced.



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- 5.6.7.10 As-welded surfaces are permitted, provided the surface of the weld/ welds shall be sufficiently free from course ripples, grooves, overlaps, abrupt ridges and valleys to permit the proper interpretation of radiographic and other nondestructive examinations as required by the Code.
- 5.6.7.11 Store welding filler metal and welding flux in their original unopened containers and in such a manner to ensure no moisture accumulation occurs in the weld rod. Storage, handling, and drying of SMAW electrodes and SAW flux shall, as a minimum, be in accordance with the manufacturers' recommendations. In addition, SMAW low-hydrogen type carbon and low alloy steel electrodes shall be stored in ovens at 121°C minimum after the hermetically sealed or vacuum packed container is opened. Bare rod in straight lengths shall be individually flag tagged, stamped, or otherwise identified with the AWS classification or product classification. Each spool of solid or cored wire shall be tagged, labeled, or otherwise identified with the AWS classification or product classification. Any SMAW low-hydrogen type electrodes that have been wet or have damaged coatings shall not be used. Any welding filler metals or fluxes not readily identifiable shall not be used. Reconditioning of electrodes is prohibited.
- 5.6.7.12 When electrodes are removed from the storage ovens they shall be issued in portable ovens to mitigate the possibility of the electrodes being exposed to moisture.
- 5.6.7.13 A maximum inter-pass temperature of 315°C shall not be exceeded when welding carbon steels and low alloy steels. See Appendix 1 for Boiler Proper, Deviation K-31; manufacturer's maximum inter-pass temperature of 427 C is allowed, provided the manufacturer's procedure is qualified with this maximum temperature.
- 5.6.7.14 Shop and Field personnel not qualified and certified as welders or welding operators are prohibited from performing any welding activity on materials designated for permanent or temporary installation by the Contract, such as tack welds or temporary welds.
- 5.6.8 Post Bending Heat Treatment
- 5.6.8.1 A post bending or post forming heat treatment is required on all carbon steel materials with a nominal wall thickness greater than 20 mm unless the bending or forming operations are performed and completed at a temperature of 899°C or greater.
- 5.6.8.2 Ferritic alloy piping with a nominal pipe size of 100 mm and larger or with a nominal wall thickness of 13 mm or greater which has been heated for bending or other forming operations shall receive a tempering heat treatment.
- 5.6.8.3 All stainless steel pipe subject to bending shall be solution heat-treated in accordance with the requirements of the ASTM specification applicable to that pipe material.
- 5.6.8.4 Cold bending and forming of carbon steel having a wall thickness of 20 mm and greater shall receive a stress relieving treatment.
- 5.6.8.5 Cold bending of carbon and ferritic alloy steel pipe in sizes and thicknesses less than those specified above may be carried out without the need for post heat treatment.



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5.6.9 Pre-Heat of Welds

5.6.9.1 Butt weld joints in carbon and alloy steel piping shall be pre-heated to requirements specified in ASME B31.1. The base metal temperature prior to welding shall be at or above the specified minimum temperature in all directions at a distance as specified in ASME B31.1. Preheating shall be applied prior to any welding, cutting, or gouging operations.

5.6.9.2 Preheat treatment shall be performed with electric resistance, induction heating, or air-fuel gas torch heating methods. The use of oxy-fuel heating sources that introduce oxygen gas are prohibited such as gas rosebuds, welding or cutting torches is prohibited. Preheat and interpass temperature shall be monitored and checked by temperature indicating crayons, thermocouples, thermometers, or surface contact pyrometers.

5.6.9.3 Austenitic stainless steel components shall have a maximum inter pass temperature of 177° C. Heat input for welding shall not exceed **2,165 joules per mm (55,000 joules per inch)**. Minimum preheat shall be 10° C.

5.6.9.4 Where preheating above 10° C is required, the interpass temperature shall be maintained at least equal to the preheat temperature.

5.6.10 Post Weld Heat Treatment of Welds

5.6.10.1 Post weld heat treatment of welds shall be in accordance with ASME B31.1.

5.6.10.2 When post weld heat treatment is performed in a furnace or locally, sufficient thermocouples shall be properly attached directly to the materials to accurately indicate the metal temperature uniformity throughout the heating, soak, and cooling cycle. Post weld heat treatment recorders shall be calibrated in accordance with the manufacturer's standard or other suitable standard to ensure the accuracy of the recorded temperatures.

5.6.10.3 Thermocouples and thermocouple wire shall be Type K chromel/alumel. Thermocouple wire may be temporarily attached directly to materials by using the capacitor discharge method of welding. The capacitor discharge method of welding shall be performed in accordance with the requirements of the applicable Code.

5.6.10.4 Shop welds shall be stress relieved in a furnace, by local electric induction coils or by radiant heating coils. Site welds shall be stress relieved locally by means of electric induction or electric radiant heating coils.

5.6.10.5 The proposed post heat treatment procedure including the time temperature chart for piping that is heat treated shall include the heating rates, cooling rates, holding time and holding temperature and shall be submitted to the Employer for the record.

5.6.10.6 Upon completion of post heat treatment of welds, shop and field piping welds shall be further examined by radiography or 100% ultrasonic testing where required by Table 136.4 of ASME B31.1.



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5.6.11 Cleaning

- 5.6.11.1 Upon completion of fabrication and prior to shipping, all scale, weld spatter, sand, oil, dirt, and other foreign matter shall be removed from the inside and outside of piping by a pickling process or an approved method and grade of shot blasting.
- 5.6.11.2 Immediately following the pickling process, the outside of the piping shall be painted with a rust inhibiting paint to protect it from corrosion during shipping and storage and the inside protected from corrosion by an application of an approved rust inhibitor. Piping ends shall be provided with plastic or metal end-caps that are taped on to protect the internal surfaces from corrosion and foreign matter during transportation and site storage.
- 5.6.11.3 Clean all austenitic stainless steel piping, shop and field/job site, with rotary turbine cleaner, using new austenitic stainless steel rotary elements, after which piping shall be blown out with compressed air free of moisture and halides.
- 5.6.11.4 All tools used in fabrication of stainless steel shall be protected in such a way as to prevent contact with steel alloys or free iron. For wire brushing, bristles shall be stainless steel. Brushes shall be identified and controlled. Grinding shall be performed with resin or rubber bonded aluminum oxide or silicon carbide grinding wheels which are identified and controlled for their use on these materials only. Antispatter compounds, marking fluids, marking pens, tape, and other tools shall have a total halogen content of less than 200 parts per million.
- 5.6.11.5 Thoroughly clean all external carbon steel and alloy steel pipe and pipe support surfaces of loose dirt, rust, and mill scale in accordance with the requirements of SSPC SP 6/NACE No. 3, and apply a primer coat(s) of inorganic zinc silicate paint to within 75mm of field weld connections to obtain a total dry film thickness (DFT) of **76.2 micron (3 mils)** minimum. Surface preparation shall be in accordance with the paint manufacturer's recommendation if more stringent than the requirements of SSPC SP6/NACE No. 3. Mix and apply coating in accordance with the requirements of SSPC- PA 1 and the paint manufacturer's recommendations. Omit paint from all areas of field welding, contact surface of field bolted connections, stainless steel, copper, plastics and other corrosion-resisting surfaces, and all nameplates.
- 5.6.11.6 Machined parts shall be covered with a rust inhibiting grease and openings shall be protected and sealed to prevent damage to weld ends and contamination of the pipe bore during handling, shipping and storage.
- 5.6.11.7 Following site erection, water piping system shall be flushed through with clean water to remove rust. The velocity of the flushing water shall be maintained at 60% above the normal operating velocities until no improvement in the cleanliness of the cleaning agent is observable. Air piping shall be blown with compressed air while steam and fuel piping shall be steam blown to remove foreign matters. The Contractor shall submit the details of steam blow to the Employer for the record.



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5.7 Valves

5.7.1 General

5.7.1.1 This section of Specification shall be read in conjunction with other relevant sections to enable a proper application and selection of valves to suit the equipment and system requirements.

5.7.1.2 Valves shall be designed in accordance with the requirements of ASME B16.10, ASME B16.34 and ASME B31.1.

5.7.1.3 Connections DN 65 and larger in nominal size shall be butt welded. Connections DN 50 and smaller in nominal size shall be socket welded. See Appendix 1 for Boiler Proper, Deviation K-7 or for Boiler BOP, Deviation L-7; butt welding of piping for DN 50mm and smaller in nominal size is acceptable. Weld ends shall be in accordance with ASME B16.25 Figures 4, 5B, or 6B for GTAW root pass in piping systems requiring a GTAW root pass.

5.7.1.4 Valves, except otherwise specified, shall be rising stem, outside screw and yoke. Non-rising stem designs may be used where space limitations dictate and compliance with code requirements are mandatory (such as NFPA), in which case a valve position indicator shall be installed.

5.7.1.5 In this Specification, ASME valve ratings have been specified. The Contractor may supply valves in accordance with the ratings specified in other acceptable national standards which have equivalent or superior pressure and temperature ratings at the design conditions.

5.7.1.6 The selected valves shall not require tightening of gland, sealing and connections during unit shutdown and various modes of start-up operations.

5.7.1.7 The Contractor shall design and select the valves with noise level not exceeding 85 dB (A) at a distance of one meter from the valve under operation conditions including start-up, normal and emergency operations.

5.7.1.8 The Contractor shall engage the valve manufacturer's specialist to commission steam turbine bypass control valves, boiler safety valves and feed water flow control valves.

5.7.2 Design Requirements

5.7.2.1 The valves shall be suitable for the maximum design conditions of the system in which they are installed.

5.7.2.2 Valves shall close against full flow and pressure and open against full design pressure.

5.7.2.3 The valves shall be capable of continuous safe and proper operation under the design operating conditions without undue strain, wear, vibration, corrosion, erosion or other operating problems.

5.7.2.4 A valve list, outlining the valve tag numbers, service description, sizes, materials, manufacturer and other pertinent data shall be submitted.

5.7.2.5 Valves shall be installed with the stem in an upright position.



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- 5.7.2.6 Valve catalogues, design calculation, valve characteristic and sectional drawings showing valve components and materials, including description and codes, shall be submitted prior to manufacture.
- 5.7.2.7 Parts, particularly seats and discs, subject to wear, corrosion or other deterioration requiring adjustment, inspection or repair, shall be accessible and capable of reasonably convenient removal when required. Valve internals shall be capable of being removed with the valve body in position.
- 5.7.2.8 ASTM, ASME, ANSI and MSS Standards and Specifications shall be considered as minimum requirements.
- 5.7.2.9 Packing rings shall be used for stem and shaft sealing on all types of valves.
- 5.7.2.10 Isolating valves shall be of bubble-tight and leak-proof design.
- 5.7.2.11 Valves shall have weld ends or flanges to ASME Standards.
- 5.7.2.12 The end connections of valves shall be of same internal diameter as the pipes to which they are connected.
- 5.7.2.13 Alloy steel valve with welded ends shall be supplied with welding ends of compatible material as the associated pipe.
- 5.7.2.14 Valves of similar make, size and type, shall be interchangeable.
- 5.7.2.15 Bolts, nuts and washers for stainless steel flanges shall be stainless steel.
- 5.7.2.16 The selection of valve trim materials shall be based upon their tensile strength, chemical stability and corrosion resistance at operating temperature. Hardness and toughness, coefficient of expansion relative to the valve body and properties of seat and disc facings shall prevent seizing of their surfaces when one slides over the other.
- 5.7.2.17 The seat material shall retain adequate compressive properties at operating temperatures and be immune from chemical change due to temperature. The seat shall also resist oxidation and corrosion to retain a smooth surface essential for tightness.
- 5.7.2.18 Process isolating valves operating at or over 4.0 MPag, shall be arranged in tandem. The outboard valve shall be the sacrificial valve and the inboard valve shall be the positive isolating valve.
- 5.7.2.19 Notwithstanding the above, drain and vent valves operating at or over 4.0 MPag shall also be arranged in tandem, with the inboard and outboard valves as specified above.
- 5.7.2.20 Additional design requirements for valves required for regulation of flow, pressure regulation and pressure relief are included elsewhere in this Specification.
- 5.7.2.21 Check valves shall be suitable for operation in either a horizontal or a vertical position.
- 5.7.2.22 Permanent lifting beams shall be provided for valve internal parts in exceeding 50 kg.
- 5.7.2.23 Isolation valves and bypass valves shall be provided for control valves to facilitate maintenance.



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5.7.3 Valves for High Pressure Service

5.7.3.1 Valves on high pressure service in ratings for ASME Class 600 and higher and in sizes up to but not including DN 65 shall have forged steel bodies provided with socket weld ends.

5.7.3.2 Valves on high pressure service in ratings for ASME Class 600 and higher and in sizes DN 65 and larger shall have steel bodies with butt welded ends to suit specified ratings and materials.

5.7.3.3 Stop valves on high pressure and high temperature service up to but not including DN 65 shall have the following:

- Stellite seat and disc
- Seal welded bonnet, pressure seal or integral bonnet
- Back seating

5.7.3.4 Stop valves on high pressure service DN 65 and over shall have the following:

- Stellite seat and disc
- Pressure seal bonnet
- Graphite pressure seal ring
- Back seating

5.7.3.5 Stop valves for sizes of ASME Class 600 rating shall have pressure seal or flange type bonnet joint.

5.7.3.6 Check valves on high pressure service shall have the following:

- Lift type for sizes up to but not including DN 65
- Tilting disc type for sizes DN 65 and larger
- Stellite seat and disc
- Steel body

5.7.4 Valves for Low Pressure Service

5.7.4.1 General

5.7.4.1.1 Valves on low pressure service in ratings ASME Class 600 and below and sizes up to but not including DN 65 shall have cast steel bodies provided with socket weld ends.

5.7.4.1.2 Valves except those for oil, sea water and demineralized/reserved feed water services on low pressure service in ratings ASME Class 600 and below in sizes DN 65 and larger shall have cast steel bodies and flanged ends.



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5.7.4.1.3 Fuel oil valves shall be cast steel or stainless steel to match the piping system. Fuel oil valves shall generally have socket weld ends for sizes up to but not including DN 65 and butt weld ends for sizes DN 65 and larger.

5.7.4.1.4 Gate valves on low pressure service up to but not including DN 65 shall have the following:

- Repacked under pressure
- Screwed bonnet

5.7.4.1.5 Globe valves on low pressure service up to but not including DN 65 shall have the following:

- Solid plug
- Repacked under pressure
- Screwed bonnet

5.7.4.1.6 Check valves on low pressure service up to but not including DN 65 shall have the following, unless noted otherwise:

- Steel seating disc
- Swing check

5.7.4.1.7 Gate valves on low pressure service DN 65 and larger shall have the following:

- Steel trim
- Rising stem
- Swing check steel disc
- Steel body

5.8 Pressure vessels and heat exchangers

5.8.1 The vessels shall be designed and fabricated in accordance with the ASME Boiler and Pressure Vessel (B&PVC) Section VIII, "Pressure Vessels" and the Local Statutory requirements.

5.8.2 Pressure vessels and heat exchangers shall be manufactured by an approved ASME U-stamp holder and shall be tested at shop to 1.5 times the maximum allowable working pressure (MAWP) at new and cold condition. Pressure retaining materials shall be furnished in accordance with ASME standards. See Appendix 1 for STG, Deviation E-3 ; pressure test for generator hydrogen cooler shall be 1.3 times of maximum allowable working pressure.

5.8.3 2:1 semi-ellipsoidal seamless head shall be used.

5.8.4 A minimum corrosion allowance of 3 mm shall be provided for vessels.

5.8.5 Each vessel shall be a complete unit including nozzles, support legs, drains and instrumentation.



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- 5.8.6 The vessel design requirements for the various services shall be as specified elsewhere in this Specification.
- 5.8.7 Manhole with davit shall be provided to facilitate inspection. Nominal manhole size shall be 500 mm. Small vessels that cannot accommodate a manhole shall be provided with a handhole.
- 5.8.8 Lifting lugs shall be provided for vessels. The vessels shall be supported on saddle or support legs. Support skirt shall not be used except approved by the Employer. Direct welding of non-pressure parts such as lifting lugs, saddle/supports legs to the pressure parts shall not be allowed. Buffer pad plate of similar material as the shell shall be used.
- 5.8.9 Thin-wall horizontal vessels with a large diameter shall be supported near the heads. Long thick-wall horizontal vessels shall be supported where the maximum longitudinal bending stress at the saddles is nearly equal to the stress at the mid span.
- 5.8.10 Reinforcing plates of similar material as the shell shall be provided. 6.4 mm diameter telltale holes shall be provided and to be located on the horizontal centerline, and open to atmosphere.
- 5.8.11 Nozzles shall be of seamless material and shall be of the full penetration weld type.
- 5.8.12 Nipples, nozzles, pipes and tubes welded directly to the pressure vessels shall be arranged normal to the surfaces unless specified otherwise.
- 5.9 Inspection and Testing
- 5.9.1 General
- 5.9.1.1 The purchaser or his agency has right to perform, audit, surveillance and inspection in order to verify the implementation of quality assurance program for the equipment purchased in accordance with the applicable codes and standards, and this specification.
- 5.9.1.2 Tests and inspections not covered by the above requirements shall be performed in accordance with manufacturer's standards after purchaser's acceptance.
- 5.9.1.3 The supplier shall submit the test and inspection report to the purchaser, and the equipment shall not be shipped till the report has accepted by purchaser.
- 5.9.2 Testing
- 5.9.2.1 The supplier shall provide as a part of the Inspection and test plan, a comprehensive list of factory tests for the works.
- 5.9.3 SHOP PIPING
- 5.9.3.1 Shop fabricated piping shall be in accordance with the requirements of the applicable Code the piping is fabricated to. Temperature charts of shop bending, hot forming, preheat prior to welding, post weld and post bending heat treatment operations shall be made and submitted as part of final documentation.



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- 5.9.3.2 Where radiographic inspection is required the radiograph film and associated reader sheets shall be submitted to the Employer as part of the final documentation.
- 5.9.3.3 ASME partial data reports and Certified Mill Test Reports shall be submitted to the Employer as part of the final documentation.
- 5.9.4 Inspection:
- 5.9.4.1 Final inspection shall be performed before the Final Acceptance will be granted.
- 5.9.5 Valves and piping specialties
- 5.9.5.1 Where operational problems are encountered and leaks through seats are suspected, such valves and specialties will be subjected to disassembly and internal inspection. Valve cones, plugs and seats shall be checked for cracks, cavitations, erosion and proper seat contact.



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6 **DRAWING AND DOCUMENTATION REQUIREMENTS**

6.1 Drawings and Documents to be submitted with Proposal

- A. Drawing and document list including a submittal schedule
- B. Dimensional outline drawing, assembly drawing, cross sectional drawing, P&ID diagram indicating terminal points.
- C. Technical specifications
- D. Strength calculation
- E. Thermal design calculations
- F. Sectional drawings showing details of internals including material
- G. Performance curve
- H. Deviation and exception list
- I. Allowable nozzle loading
- J. Standard and code list
- K. Utility consumption list
- L. Equipment datasheet
- M. QA / QC Manual
- N. Experience or reference list
- O. Manufacturer's catalogues and literature to supplement the drawings and illustrate the equipment, instruments, and fittings to be furnished.
- P. Proposed shipping scheme and packing list
- Q. Shop inspection and test plans
- R. Inspection test procedure
- S. Performance test procedure
- T. Cleaning and painting procedure
- U. Description of shop assembly extent and field installation requirement
- V. Subcontractor list
- W. Packing list

6.2 Drawings and documents to be submitted after contract

6.2.1 Drawings and documents below shall be a guideline of drawings and documents to be provided by the Supplier.

- A. General arrangement drawing
- B. Sectional drawing
- C. Foundation drawing with loading data



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- D. Steel structure drawing (if necessary)
- E. Set point list
- F. Strength calculations
- G. Welding procedure
- H. Erection manual
- I. Operation and maintenance manual
- J. Test procedure
- K. Inspection procedure and manufacturing data report
- L. Progress report
- M. Test report
- N. Performance curve
- O. Cleaning and painting procedure
- P. Packing, shipping and storage procedure
- Q. Thermal and hydraulic design calculation
- R. Recommended insulation specification for the Purchaser's use
- S. Miscellaneous design information such as the sizing of vent orifices and the selection basis of the relief valves
- T. As built drawings and technical data sheets

