HRSG (Heat Recovery Steam Generator) Technical Proposal

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Vogt Power International, Inc. proposes to furnish to:

Albanesi Energia S.A.
for the Project:

Ctral. Termoelectrica Cogeneracion Arroyo Seco
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Revision	Issue Date	Author	Section	Description of Change
0	07/07/2017	RDT	All	Initial Release
1	07/13/2017	RDT	All	Extended Scope Options update per meeting with customer.
2	08/07/2017	RDT	All	Design update to D. Extended scope details added.
3	11/15/2017	RDT	All	Update following meeting with Customer
4	11/22/2017	RDT	All	Final Update for Contract
5	12/15/2017	RDT	All	Update per design change to incorporate Sweetwater Condenser.

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1. Scope of Supply

The proposed base equipment supplied by Vogt Power International Inc. (VPI) for this project consists of two (2) identical, fully top-supported, MSG design, dual pressure level without reheat heat recovery steam generators (HRSG) with related auxiliary equipment at two separate sites, for a total of four (4) HRSGs. The HRSG shall consist of the following scope of supply:

1.1. Scope Table

Item	HRSG Scope of Supply Description	Furnished by VPI: X / Option / N/A	Furnished by Purchaser
1.	**Heat Transfer Components and Design**		
1.1	HP Superheater	X	
1.2	HP Evaporator	X	
1.3	HP Economizer	X	
1.4	Reheater	N/A	
1.5	IP Superheater	N/A	
1.6	IP Evaporator	N/A	
1.7	IP Economizer	N/A	
1.8	LP Superheater	N/A	
1.9	LP Evaporator	X	
1.10	LP Economizer	N/A	
1.11	Condensate Preheater (Heat Exchanger)	N/A	
1.12	Module Header Inspection Connections	N/A	
1.13	Bottom Casing Drains	X	
1.14	Ports for Sky Climbers	X	
1.15	Heat Transfer Structural Steel	X	
2.	**Steam Drums and Deaerator**		
2.1	HP Steam Drum with Internals	X	
2.2	IP Steam Drum with Internals	N/A	
2.3	LP Steam Drum with Internals	N/A	
2.4	Shop Hydro of Steam Drums	N/A	
2.5	Integral Deaerator	X	
2.6	Standalone Deaerator	N/A	
2.7	Insulation and Lagging for Steam Drums (Detailed Engineering)	X	
2.8	Insulation and Lagging for Steam Drums (Material)		X
2.9	Insulation and Lagging for Deaerator (Detailed Engineering)	X	

Item	HRSG Scope of Supply Description	Furnished by VPI: X / Option / N/A	Furnished by Purchaser
2.10	Insulation and Lagging for Deaerator (Material)		X
2.11	External Deaeration	N/A	
3.	**Enclosures**	**N/A**	
4.	**Inlet Duct**		
4.1	Gas Turbine Outlet/HRSG Inlet Duct Expansion Joint	X	
4.2	Inlet Duct	X	
4.3	Flow Distribution Grid	X	
4.4	Gas Turbine Outlet Expansion Joint Acoustical Shroud	N/A	
4.5	Inlet Duct Acoustical Shroud	N/A	
4.6	Barring Air Duct	N/A	
5.	**Outlet Stack and Transition Duct**		
5.1	Stack (Carbon Steel) with Bottom Drain	X	
5.2	Tuned Mass Damper	X	
5.3	Outlet Duct between Stack and HRSG	X	
5.4	Outlet Duct and Stack Personnel Protection - At Each Platform and at Grade (Expanded Metal Barriers)	X	
5.5	Stack CEM/EPA Connections	X	
5.6	Continuous Emission Monitoring Equipment (CEM)		X
5.7	Stack Aviation (FAA) Lighting with Cable to Junction Box/Controller	X	
5.8	Stack Silencer	N/A	
5.9	Motor Operated Stack Damper	N/A	
5.10	Outlet Duct to Stack Inlet Expansion Joint	X	
5.11	External insulation for HRSG Outlet Duct and Stack (Up to stack damper elevation)	N/A	
5.12	Internal Insulation for HRSG Outlet Duct	N/A	
6.	**Platforms, Stairs, Ladder, and Handrails**		
6.1	Stairs on **one side** of the HRSG	X	
6.2	Ladders for Access to Access Doors (**one side only**)	X	
6.3	Platform for Main Operating Area (HRSG Top)	X	

Item	HRSG Scope of Supply Description	Furnished by VPI: X / Option / N/A	Furnished by Purchaser
6.4	Platform and Ladder for Top of Steam Drum Access	X	
6.5	Platform and Ladder for Access to the EPA/CEM ports	X	
6.6	Platform and Ladder for Access to Aviation (FAA) Lights	N/A	
6.7	Platform for Access to the Stack Damper	N/A	
6.8	Walkway Between Units and Associated Structural Steel Support (35 meter centerline to centerline of HRSGs)	X	
6.9	Platforms for Access to Duct Burner Runners and Burner Observation Ports	X	
6.10	Ladders for Access to Ductwork and Casing Instrumentation	N/A	
6.11	Platforms and Ladders for Top of Deaerator Access	X	
7.	**Coating and Painting**		
7.1	Outlet Duct and Outlet Stack Sections Internal Surface Coating	X	
7.2	Inlet Duct & Heat Transfer Casing External Surfaces	Finish Paint	
7.3	Steam Drums	Prime Paint	
7.4	Drum Saddles	Prime Paint	
7.5	Platform Grating, Kickplates, and Stair Treads	Galvanize	
7.6	Handrails, Ladders, and Safety Cages	Galvanize	
7.7	Primary Structural Steel	Finish Paint	
7.8	Platform Support Steel	Galvanize	
7.9	Stair Tower Steel	Galvanize	
7.10	Pipe Support Steel	Galvanize	
7.11	Large Bore Piping	Prime Paint	
7.12	Small Bore Piping	N/A	
7.13	Stack Sections External Surface	Finish Paint	
7.14	Finish Painting for Ammonia Control Skid	N/A	
7.15	Finish Painting for Fuel Control Skid	X	
8.	**HRSG Piping**		

Item	HRSG Scope of Supply Description	Furnished by VPI: X / Option / N/A	Furnished by Purchaser
8.1	HP Steam Piping	X	
8.2	HP Attemperator Piping	X	
8.3	Hot Reheater Steam Piping	N/A	
8.4	Cold Reheater Steam Piping	N/A	
8.5	Reheater Attemperator Piping	N/A	
8.6	IP Steam Piping	N/A	
8.7	IP Steam Outlet to Cold Reheater Piping	N/A	
8.8	LP Steam Piping	N/A	
8.9	HP Feedwater Inlet Piping	X	
8.10	HP Feedwater Outlet Piping	X	
8.11	IP Feedwater Inlet Piping	N/A	
8.12	IP Feedwater Outlet Piping	N/A	
8.13	LP Feedwater Inlet Piping	N/A	
8.14	LP Feedwater Outlet Piping	N/A	
8.15	Condensate Preheater Inlet Piping	N/A	
8.16	Condensate Preheater Outlet Piping	N/A	
8.17	Recirculation Inlet / Outlet Piping	N/A	
8.18	Heat Exchanger Condensate Inlet Piping (Connection only)	N/A	
8.19	Heat Exchanger Feedwater Inlet Piping (From Deaerator / Storage Tank)	N/A	
8.20	Heat Exchanger Condensate Outlet Piping (To Deaerator / Storage Tank)	N/A	
8.21	Heat Exchanger Feedwater Outlet Piping	N/A	
8.22	Heat Exchanger Inlet Piping (from HRSG module)	N/A	
8.23	Heat Exchanger Outlet Piping (To HRSG module)	N/A	
8.24	Heat Exchanger Bypass Piping	N/A	
8.25	HRSG Interconnecting Piping	X	
8.26	Vent Piping	X	
8.27	Drain Piping	X	
8.28	HP Pump Suction Piping	X	
8.29	FW Pump to HP Feedwater Inlet Piping	X	
8.30	Economizer Extraction Piping	X	
8.31	Chemical Feed Piping	X	
8.32	Steam Sampling System Piping	X	
8.33	Boiler Feed Water Pump Recirculation Piping	X	

Item	HRSG Scope of Supply Description	Furnished by VPI: X / Option / N/A	Furnished by Purchaser
8.34	HP Economizer Bypass Piping	X	
8.35	LP Economizer Bypass Piping	N/A	
8.36	Condensate Preheater Bypass Piping	N/A	
8.37	Pegging Water Piping	N/A	
8.38	Pegging Steam Piping	X	
8.39	Nitrogen Purge Piping (Single Terminal Point at Grade)	X	
8.40	Pipe Supports for ALL HRSG Vendor Supplied Piping (primed or manufacturer's standard)	X	
8.41	Insulation and Lagging for External Piping and Valves (Detailed Engineering)	X	
8.42	Insulation and Lagging for External Piping and Valves (Material)		X
8.43	Internal Sandblast / Grit Blast (SSPC-SP6) Major Piping Spools (For Piping Spools larger than 6" nominal diameter)	N/A	
8.44	Casing Drain Piping to Single Terminal Point	N/A	
9.	**Valves**		
9.1	Steam Outlet Stop Valves (HP)		X
9.2	Steam Outlet Non-Return Valves (HP)	X	
9.3	Steam Outlet Non-Return Valves (IP)	N/A	
9.4	Feedwater Inlet Valves, i.e. Stop & Check (HP)	X	
9.5	Feedwater Regulating Valve	N/A	
9.6	Feedwater Control Valves (HP)	X	
9.7	Attemperator Control Valves - Interstage (HP)	X	
9.8	Attemperator Control Valves - Final Stage (HP)	N/A	
9.9	HP Steam Turbine Bypass Station (HP steam to Cold Reheat)	N/A	
9.10	HRH Steam Turbine Bypass Station	N/A	
9.11	IP Steam Turbine Bypass Station	N/A	
9.12	LP Steam Turbine Bypass Station	N/A	
9.13	HP Steam Start Up Valve (Sized for 50% flow)	X	
9.14	RH Steam Start Up Valve	N/A	
9.15	IP Steam Start Up Valve	N/A	
9.16	LP Steam Start Up Valve	N/A	

Item	HRSG Scope of Supply Description	Furnished by VPI: X / Option / N/A	Furnished by Purchaser
9.17	Start-Up Vent Valve Silencers with Piping from Valve to Silencer	X	
9.18	Start-Up Vent Silencer Support Steel	X	
9.19	IP Outlet back pressure control valve	N/A	
10.	**Instrumentation (Scope per VPI P&IDs)**		
10.1	Pressure Gauges	X	
10.2	Local Temperature Indicators	X	
10.3	Water/Steam Temperature Elements	X	
10.4	Exhaust Gas Thermocouples	X	
10.5	Heating Surface Thermocouples	X	
10.6	Test Thermowells	X	
10.7	Steam Drum Water Gauge Glasses	X	
10.8	Steam Drum Electronic Water Level Indicators	X	
10.9	Steam Sample Nozzles	X	
10.10	Instrumentation Blowdown Valves	X	
10.11	Instrumentation Tubing	X	
10.12	Tube Skin Tes (First row of tubes downstream of burner)	X	
11.	**Control and Control Elements (Scope per VPI P&IDs)**		
11.1	Temperature Transmitters	N/A	
11.2	Pressure Transmitters	X	
11.3	Drum Level Transmitters	X	
11.4	Flow Transmitters	X	
11.5	Steam Flow Nozzles (HP)	X	
11.6	Feedwater Flow Nozzles (HP)	X	
11.7	Attemperator Flow Nozzles - Interstage (HP)	N/A	
11.8	Attemperator Flow Nozzles - Final Stage (HP)	N/A	
11.9	Blank Spools for Steam Flow Elements for Steam Blow	N/A	
11.10	Stack Flow Meter	N/A	
11.11	HP Superheater Attemperator - Interstage	X	
11.12	HP Superheater Attemperator - Final Stage	N/A	
11.13	Reheater Attemperator - Interstage	N/A	
11.14	Reheater Attemperator - Final Stage	N/A	

Item	HRSG Scope of Supply Description	Furnished by VPI: X / Option / N/A	Furnished by Purchaser
12.	**SRV and Silencer Systems**		
12.1	Spring Loaded Safety Valves	X	
12.2	Electromatic Safety Valves (ERV)	N	
12.3	SV Vent Stack and Drip Pan Elbows with Supports	N	
12.4	SV Silencers with Inlet Piping	X	
12.5	SV Silencer Supports	X	
13.	**CO Catalyst System**	**N/A**	
14.	**SCR Catalyst System**	**N/A**	
15.	**Duct Burner System**		
15.1	Duct Burner - Natural Gas	X	
15.2	View Ports (**One Side**)	X	
15.3	Burner Outlet Duct and Insulation System	X	
15.4	**Local** Control Panel	X	
15.5	Fuel Control Skid	X	
15.6	Burner Management System	X	
15.7	Fuel Delivery System to Burner Skid	X	
15.8	Fuel Pressure Reduction Station to (30 bar to 2 bar)	X	
15.9	Piping from Fuel Control Skid to Burner (Skid Located Within 35 ft. of Duct Burner)	X	
15.10	Automatic Duct Burner Runner Individual Isolation Valves	X	
15.11	Scanner Cooling Air Blower - **2 x 100%**	X	
15.12	Motor Starter for Scanner Cooling air blowers		X
15.13	Augmenting Air Fans - **2 x 100%**	N/A	
15.14	Single Flame Scanner per Runner	X	
15.15	Pilot Igniters for Each Burner Runner	X	
15.16	Control Logic Diagrams	X	
15.17	**System A** type design to meet NFPA Purge Credit Requirement	X	
15.18	Fuel flow meter	X	
15.19	Duct Burner designed to SIL 3 Rating	X	
15.20	SIL3 Documentation	N/A	

Item	HRSG Scope of Supply Description	Furnished by VPI: X / Option / N/A	Furnished by Purchaser
16.	**Exhaust Bypass System**		
16.1	Spool for Future Bypass Damper	N/A	
16.2	Single-Blade Diverter Damper	X	
16.3	Seal Air Skid	X	
16.4	Hydraulic Skid	X	
16.5	Bypass Stack	X	
16.6	Bypass Stack Expansion Joint	X	
16.7	Bypass Damper Inlet Expansion Joint	X	
16.8	Bypass Damper Outlet to HRSG Expansion Joint	X	
16.9	Bypass Stack Support Steel	X	
16.10	Bypass Stack Silencer	X	
16.11	Inlet Duct to Diverter Damper	X	
16.12	Blanking Plate (one per unit)	N/A	
16.13	Guillotine Damper	X	
16.14	Bypass Stack CEM / EPA Connections	X	
16.15	Bypass Stack Continuous Emissions Monitoring (CEM) Equipment		X
16.16	Bypass Stack FAA Lighting with cable to Junction Box/Controller	X	
16.17	Platform and Ladder for Access to the EPA / CEM Ports and FAA Lights	X	
17.	**Blowdown System**		
17.1	Blowdown Tank (located **in a pit**)	X	
17.2	HP Flash Tank	X	
17.3	Secondary Flash Tank	N/A	
17.4	Flash Tank to DA Piping	X	
17.5	Insulation and Lagging for Blowdown Tank and Flash Tank (Basic Engineering)	X	
17.6	Insulation and Lagging for Blowdown Tank and Flash Tank (Material)	X	
17.7	Piping between Tank and Sewer		X
17.8	Tank Personnel Protection (Expanded Metal Barrier)	X	
17.9	Blowdown Piping from HRSG to Flash Tank	X	
17.10	Piping from HRSG drains to Blowdown Tank	X	

Item	HRSG Scope of Supply Description	Furnished by VPI: X / Option / N/A	Furnished by Purchaser
17.11	Blowdown Piping from the HRSG to the Blowdown Tank	X	
17.12	Cascading Blowdown Piping	N/A	
17.13	Blowdown Tank Silencer	X	
17.14	Blowdown Tank Vent Stack	X	
18.	**Boiler Feed System**		
18.1	HP Feedwater Pumps - 2 **x 100%**	X	
18.2	Blowdown Tank Drain Pumps - 2 x 100%	X	
18.3	Condensate Pump		X
19.	**Feedwater Temperature Control System**		
19.1	Recirculation Pumps	N/A	
19.2	Motor Starter for Recirculation Pump	N/A	
19.3	Heat Exchanger (**Plate & Frame**)	X	
20.	**Sweetwater Condenser**		
20.1	Sweetwater Condenser	X	
20.2	HRSG and Sweetwater Condenser Interconnecting Piping	X	
20.3	Platforms and Ladders for Access to Sweetwater Condenser, as required	X	
20.4	Sweetwater Condenser External Insulation and Lagging (Basic Engineering)	X	
20.5	Sweetwater Condenser External Insulation and Lagging (Material)		X
20.6	Personnel Protection	X	
21.	**Electrical Equipment (Designed to IEC Requirements)**		
21.1	Equipment Grounding System - Grounding Lugs Only	X	
21.2	Electrical Power Outlets for Maintenance		X
21.3	Electric Power Receptacles for Welding Machines		X
21.4	Lightning Protection System		X
21.5	Area Lighting	X	
21.6	Instrumentation and Control Cabling (Armored Cable)	X	
21.7	Power Cabling (Motor Operated Valves and HRSG Lighting)	X	
21.8	Cable Trays and Conduit	X	

Item	HRSG Scope of Supply Description	Furnished by VPI: X / Option / N/A	Furnished by Purchaser
21.9	Heat Tracing	N/A	
21.10	Power Distribution Panel (HRSG Lighting)	X	
21.11	Motor Control Center	N/A	
21.12	Junction Boxes	X	
21.13	Motor Starters (Integral to Motor Operators Only)	X	
21.14	Electrical Scope Design (Routing and Material Specifications)	X	
22.	**Miscellaneous**		
22.1	Nitrogen Bottles		X
22.2	Davit Arm	N/A	
22.3	Hoist with Davit Arm	N/A	
22.4	Jib Crane	N/A	
22.5	Steam Sample System	X	
22.6	Chemical Dosing System	X	
22.7	Freeze Protection of Instruments and Instrument Tubing (Basic Engineering)	N/A	
22.8	Freeze Protection of Instruments and Instrument Tubing (Material)	N/A	
22.9	Instrument Enclosures (No Heating)	X	
22.10	Sparging Steam Connections including valves	N/A	
22.11	Computer Flow Model Test	N/A	
22.12	Start-Up Spare Parts (Refer to VPI Commercial Proposal for details)	X	
22.13	Special Tools (Refer to VPI Technical Proposal Installation and Erection section)	X	
22.14	Frames for Shipping and Erection	N/A	
22.15	Training Manuals	X	
22.16	O & M Manuals	X	
22.17	Life Cycle Analysis **(Start Up Procedure)**	X	
22.18	Life Assessment Report	N/A	
22.19	PE Stamp	N/A	
22.20	Extended Warranty	N/A	
22.21	Tube Vibration Report	N/A	
22.22	Small Bore Isometric Drawings	N/A	

Item	HRSG Scope of Supply Description	Furnished by VPI: X / Option / N/A	Furnished by Purchaser
22.23	Elevator	X	
22.24	Soot Blowers	N/A	
22.25	External Insulation - Design Only (VPI to Provide BOM)	X	
22.26	External Insulation - Supply, Supports, Installataion. For Drums, Deaerator, and Piping Only.		X
22.27	2 Year Spare Parts	X	
23.	**Constructability**		
23.1	Box Main Steel Bolted Connections	N/A	
23.2	Ductwork Main Steel Bolted Connections	X	
23.3	Platform Bolted Connections	X	
23.4	Lifting Lugs for Ductwork Panels	X	
23.5	Shop Installed Lifting Lugs for Boxes (Top Only)	N/A	
23.6	Shop Fabricated Small Bore Piping	N/A	
23.7	Shop Installed Large Bore Valves per P&ID	N/A	
23.8	Shop Installed Small Bore Valves (Manual only)	N/A	
23.9	Shop Installed Base Plates for Ductwork	X	
23.10	Shop Installed Base Plates for Stair Tower	N/A	
23.11	Shop Installed Base Plates for Main Columns	N/A	
23.12	Platforms in Preassembled Sections with Grating Attached	X	
23.13	Handrail Sections with Toe Plate Attached	X	
23.14	Stair Stringers Shop Assembled with Stair Treads	X	
23.15	Short Side of Stair Tower Shop Assembled	N/A	
23.16	Control Valve Shop Installed Hydro Kits	N/A	
23.17	Individually Packaged Pipe Supports	X	
23.18	Protective Metal Covers for Bellows	X	
23.19	Stack Bottom Portion in 180º Sections	N/A	
23.20	SCR Frame "**X**" Pre-assembled sections	N/A	
23.21	SCR Frame Ability to Field Assemble at Grade for Single Lift	N/A	
23.22	CO Frame "**X**" Pre-assembled sections	N/A	
23.23	CO Frame Ability to Field Assemble at Grade for Single Lift	N/A	
23.24	Shop Install of Attic and Basement Panels	X	
23.25	Single Lift for Stm Silencer Support Steel & Piping Assemblies	X	

Item	HRSG Scope of Supply Description	Furnished by VPI: X / Option / N/A	Furnished by Purchaser
23.26	Stainless Steel tubing for SRV & Silencer Drains	N/A	
23.27	Structural Bolts with **DTI Washers / Tension Control Bolts** (Slip Critical Connections Only)	N/A	
23.28	Interconnecting Piping Cut to Length & Beveled (Except Risers & Downcomers)	X	
23.29	Piping Thermowells Shop Welded into LB Piping	X	
24.	**Start-Up and Construction**		
24.1	Erection: HRSG, SCR, Burner, Ducting, and Stack		X
24.2	Commissioning: HRSG, SCR, and Burner		X
24.3	Assembly, Setting, Alignment, and Grouting of Equipment		X
24.4	Foundations Labor		X
24.5	Civil Work		X
24.6	Foundation Base Plates	X	
24.7	Foundation Anchor Bolts	X	
24.8	Foundation Anchor Bolt Design: Location, Diameter, Projection, and Recommended Material	X	
24.9	Field Erection & Commissioning Consumables		X
24.10	Field Erection & Commissioning Utilities		X
24.11	Field Erection Direct Labor		X
24.12	Field Erection Supervision		X
24.13	Construction Advisor	X	
24.14	Commissioning Direct Labor		X
24.15	Commissioning Supervision		X
24.16	Start-up / Commissioning Advisor	X	
24.17	Operator Training	X	
24.18	Hydrostatic Test Direct Labor		X
24.19	Blow-out Supervision		X
24.20	Performance Test Advisor	X	

1.2. Purchaser Supplied Items

1.2.1. Chemical cleaning of the boiler after erection.

1.2.2. All necessary control, field instruments, etc. required to complete the system not supplied with the boiler.

1.2.3. All electrical wiring, conduit, cable trays, etc. required to tie in the system, except what is explicitly included in VPI's electrical scope. All wiring shall be to the instruments.

1.2.4. All piping required to complete the installation outside the scope of the boiler.

1.2.5. All motor starters and disconnects for all motors including power wiring to motors.

1.2.6. Feedwater treatment system.

1.2.7. Plant and equipment lighting.

1.2.8. All other items required to make the HRSG operational but not included in the HRSG Scope.

1.3. Terminal Point Connections

Terminal point connections are as described below. Vertical location refers to distance above grade unless otherwise stated. Horizontal location refers to distance from HRSG casing unless otherwise stated.

Item	Description	Location		Notes
		Vertical (meters)	Horizontal (meters)	
1.	**Exhaust Gas** Horizontal flow direction			
1.1	Inlet Flange of HRSG Inlet Duct	TBD	-	Vertical location from the combustion turbine centerline
1.2	Main Stack Outlet	32	-	
1.3	Stack Drain Valve Outlet	1	-	
1.4	Casing Drains	At cap		
1.5	Emissions Monitoring Ports and Test Connections	Flanged Connections		In the ductwork and stack
1.6	Test Connections	Pipe caps		In the inlet duct, casing, and stack
2.	**Feedwater** Left Side of the HRSG in direction of the gas flow			
2.1	HP Feedwater Stop Valve Inlet	N/A	N/A	Same side as the boiler feedwater pumps
2.2	HP Feedwater Pump Suction Line	N/A	N/A	Same side as the boiler feedwater pumps

Item	Description	Location		Notes
		Vertical (meters)	Horizontal (meters)	
2.3	HP Feedwater Pump Recirculating Piping	N/A	N/A	Same side as the boiler feedwater pumps
2.4	HP Feedwater Pump Minimum Flow Lines	N/A	N/A	Same side as the boiler feedwater pumps
2.5	Condensate Stop Valve Inlet	1	3	
3.	**Steam** Left side of the HRSG in direction of the gas flow			
3.1	HP Main Steam Outlet	6	1	
4.	**Vents and Drains**			
4.1	Economizer Vent Valves Outlet Piping	Economizer modules vent in to drum.		
4.2	Miscellaneous vents	1 m Above platform or on inlet ductwork	-	For second valve terminal point. First valve close connected to source.
4.3	Superheater Vent Valve Outlet Piping	3 m Above main deck platform	-	Connected to the silencer
4.4	Safety Valve Outlet Piping	3 m Above main deck platform	-	Connected to the silencer
4.5	Heat Transfer Surface Drains.	N/A	N/A	For second valve terminal point. First valve close connected to source. Economizers may have a single root valve with a common second valve at the collection header.
4.6	Drum Mounted Instrumentation Drains Common Drain (open funnel)	1	3	Drum mounted instrumentation drain valves shall be close coupled at the drum and collected into a 4” drain header
4.7	Maintenance Drains	1	3	All maintenance drains shall be collected into a 4” drain header and routed to grade level.

Item	Description	Location		Notes
		Vertical (meters)	Horizontal (meters)	
5.	**Blowdown (in a pit)**			
5.1	Blowdown Tank Cooling Water Pipe	-	-	Close to blowdown tank
5.2	Blowdown Tank Outlet Pipe	-	0.5 m From blowdown tank	
5.3	Blowdown Tank Vent Pipe	3 m Above main deck platform		
6.	**Pneumatic**			
6.1	Off skid individual actuator and instrument terminals	On actuator or instrument		
7.	**Electrical**			
7.1	Electronic Steam Drums Level Gauges	On Control Unit		
7.2	Fuel gas skid junction boxes or local installed BMS	On skid far side and / or BMS		
7.3	Burner header/frame junction box(s) terminals to off-skid destinations	TBD		
7.4	BMS panel to off-skid destinations	2	-	
7.5	Burner scanner cooling air fan motor(s) terminals	On motor		
7.6	FAA lighting	At CEMS		
8.	**Miscellaneous**			
8.1	Steam Drum Nitrogen Blanketing	Single N2 Terminal Point at Grade		

Item	Description	Location		Notes
		Vertical (meters)	Horizontal (meters)	
8.2	Main Fuel Gas Shut Off	On fuel gas skid		
8.3	Burner Fuel Gas Skid	-	7.5	

2. Major Component Description

This section is included to briefly describe the HRSG and the components within the HRSG. It is not intended to replace the scope of supply section of this proposal.

2.1. Pressure Parts and Thermal Design

2.1.1. Heating Surface Concept

All heating surfaces will be constructed of module “harps” consisting of finned tubes welded to a top and bottom header with one to three rows per harp. The harps are designed for single pass flow on the gas side and single or multi-pass flow on the waterside. Multiple return bends (crossovers) connect the harps.

For multiple-width HRSGs, sets of module harps will be placed side-by-side in order to minimize gas-side pressure drop. Baffling will be installed around the tube banks in an effort to eliminate gas bypassing the heat transfer sections.

Fluid will be fed to each set for parallel flow stream and will be combined into a manifold header at the outlet. Module harps will be equipped with low point drains for a “fully drainable” design. The inlet and outlet piping will be selected based on steam design pressure and design temperature.

For the evaporator, the drum water is fed to the bottom header through the downcomers, low feeder header, and feeder pipes. The steam/water mixture produced in each module is piped into the steam drum by the riser pipes. The downcomers, feeder header, feeder pipes, and riser pipes are all designed to ensure proper circulation in each module.

The economizer is designed so that the final pass is upward towards the drum. Therefore, with this feature any steam bubbles generated will be removed to the drum. In addition, VPI’s design incorporates vent valves on each economizer harp so that any steam generated in the economizer during start up can be removed through the vent valves.

For heat transfer surface and module harp design information, including overall surface areas, and total number of tubes for each section, see the HRSG Information section of this proposal.

2.1.2. Interconnecting Piping

All interconnecting piping between the HRSG modules will be supplied. All piping will be provided with the required supports. Most large bore piping within a box will be shop installed. Connections from box to box will be installed in the field.

2.1.3. Valves

There is no industry standard on the definition of "full-port", “standard”, or “reduced port” valve configuration. The specific design of the full-port or standard-port valve is left to the discretion of each vendor. VPI will furnish all valves with the vendors’ standard port design. Full-port valves will be furnished only if required by the process conditions.

2.1.4. Steam Drums

The steam drums will be of fusion welded construction and made from SA-516 Grade 70 or SA-299 plate materials. In general, drumheads will be hemispherical for drums with a design pressure greater than 1000 psig and elliptical for drums with a design pressure less than 1000 psig. Each head will have a forged steel hinged elliptical manway, 14” x 18, with bolts, arches, and two (2) sets of gaskets (one spare).

The steam drums will be grit blasted and furnished with nozzle / stub connections for all evaporator riser pipes, saturated steam outlet pipes and water pipe (downcomer/pump suction) connections. The riser pipes in the lower pressure systems will be fabricated from SA-213 P-11 or P-22 material to prevent the erosion/corrosion phenomenon prone to low pressure steam-water mixture in areas where changes in direction occur.

2.1.5. Integral Deaerator

The deaerator reduces the oxygen content of the boiler feedwater. The steam heats the feedwater to the saturation temperature resulting in the release of oxygen and other dissolved gases from the water, lowering the oxygen content. A portion of the steam/oxygen mixture is then vented to remove the oxygen. It is designed to reduce the oxygen content of the feedwater to 7 ppb.

The deaerator will be mounted atop the LP steam drum. The deaerator will receive the required deaeration steam directly from the LP drum through interconnecting piping. The internals of the deaerator will be of the drip tray configuration with spray nozzles. All internals will be factory installed.

2.1.6. ~~External Heat Exchanger~~ (No Longer Applicable)

~~The external heat exchanger will heat the boiler feedwater before it enters the deaerator for more efficient operation. The heat exchanger shall be heated by the deaerator outlet/pump suction line. It shall also be possible to completely bypass the external heat exchanger should higher temperature feedwater be required in the economizers directly downstream of the external heat exchanger.~~

2.1.7. Spraywater Attemperator

Spray attemperators (desuperheaters) will be utilized as required to control the final steam temperature. The steam temperature is controlled by spraying boiler feedwater at a lower temperature into the superheated steam. An interstage spray attemperator will be used for the high-pressure superheater and reheater. The attemperators will consist of a spray nozzle with either an integral or a separate control valve.

The attemperation piping of sufficient mixing length will be furnished, and will be designed with an internal sleeve downstream of the spray nozzle to protect against thermal shock. The thermal sleeve will be designed with metal sufficient for the design temperature of the attemperation device.

2.1.8. Feedwater Temperature Control System

The feedwater temperature control system is designed per the scope of supply and the P&IDs. The system will control feedwater inlet temperature to accommodate acid/water dew point concerns in the LP economizer. The system may be applied in one of two methods: ~~(1) recirculation system~~ or ~~(2) external heat exchanger.~~

~~The recirculation system includes a recirculation pump skid. Water from the LP economizer outlet is pumped to the main feedwater header inlet piping, where it is mixed with cooler incoming feedwater. Downstream of the mixing point, a thermocouple measures the water temperature, which is then fed back to a temperature controller (by others). The flow rate is controlled to maintain the LP economizer inlet temperature at the specified temperature by a control valve located in the pump discharge piping.~~

~~The external heat exchanger includes a plate and shell external heat exchanger located between heating surface modules. Feedwater enters the heat exchanger cold side prior to entering the LP economizer. Hot water from a specified location between LP economizer heating surface modules heats up the cold feedwater to maintain the LP economizer inlet temperature above the required minimum inlet temperature.~~

2.1.9. Blowdown System

The blowdown system includes a vertical blowdown tank and piping. The blowdown tank is primarily used as a steam/water separator for boiler blowdowns and blowoff lines. The blowdown system is provided in accordance with the latest revision of the National Board of Boiler and Pressure Vessel Inspectors (NBBI) *A Guide for Blowoff Vessels*, *NB-27*. Blowdown and blowoff piping should be arranged to avoid traps, additional drains and routed to the blowdown tank.

Each HRSG will have a vertical blowdown tank. The tank will be sized to accept the intermittent and continuous blowdowns from all HRSG pressure levels at any given time. The intermittent blowdown rates are as defined in the National Board Code. Each continuous blowdown capacity is based on a maximum flow rate of 5% of generated steam. Only HRSG drain piping is considered for sizing and not steam or water piping outside VPI's scope. ~~The NBBI rules are for steady state,~~

~~normal operation with no considerations for start-up/shut down transients.~~ VPI blowdown tank is designed for steady state, startup and shutdown operation.

The standard blowdown tank MAWP is based on a minimum of 50 psi limit as specified by NBBI. The expected maximum operating pressure is 3 to 5 psig with a generous sized vent to atmosphere, per NBBI rules. The vent should be extended at least 15 feet into the air, or whatever is safe per OSHA standards. With the maximum pressure in the tank, water can drain by gravity from the tank to any other low point tank or disposal area providing the effluent water temperature is at a temperature no greater than 140°F (60°C). Instrumentation for the blowdown tank is per NBBI rules.

2.1.10. Corrosion Allowance

VPI does not recommend the use of additional corrosion allowances on HRSG components. Based on the Purchaser's specification for this project, the following corrosion allowances have been included.

Equipment	Corrosion Allowance (in)
Drums	None
Tubes	None
Headers	None
Stack	1/16
Ductwork (internal)	None
Piping	None

2.2. Mechanical Design and Non-Pressure Parts

2.2.1. Ductwork and casing

VPI will design and furnish the gas inlet duct and boiler casing as shown on the General Arrangement Drawings. These shall be designed with the objective of preventing flow detachment from the duct wall and providing the most economical pressure loss. The design will be based upon the gas turbine profile provided by the Buyer. If the Buyer does not provide a profile, a typical profile will be used based upon the past experience of VPI.

The duct and casing will be fabricated from carbon steel plate, and reinforced with structural steel members. The structural members are seal welded to the casing to eliminate corrosion that may occur behind the structural members. When rolled shapes are used for structural steel members, butyl rubber caulk will be shop applied prior to painting to seal the continuity plate joints located in the k zone where welding is not permitted by code.

The duct will contain a number of access doors, test connections, and drain connections arranged as shown on the General Arrangement Drawings included with this proposal.

The inlet duct, burner duct, catalyst duct, and module casing will be provided with shop installed internal insulation and liner panels as described herein. The ductwork will be shipped in “donuts”, “c-sections”, or “flat panels” based on final shipping clearances or fabrication locations.

Internal insulation will be designed to provide an acceptable average casing surface temperature per OSHA requirements. Selected, small, localized areas can be expected to exceed the design skin temperature requirement. These areas would include casing test or instrumentation connections, support attachment points for flow distribution devices, and similar areas. The VPI design will minimize on a practical basis the skin temperature excursion. The insulation and liner panel retaining studs are attached to the inside casing using a stud weld gun or via hand welding.

Unless stated otherwise in this proposal, the stud spacing for critical and transitional flow duct areas shall by 7-1/2” staggered pitch. Critical and transitional flow duct areas are defined as ducting areas with exhaust gas average velocity greater than 82 ft/second. All other remaining HRSG duct areas will have a 22” square pitch stud spacing.

Access doors included in the ductwork and HRSG box design are 18” x 24” on the top and sides.

2.2.2. Platform, Ladders and Stairways

VPI will design and furnish a system of galvanized platforms, grating, ladders and stairways as shown on the General Arrangement Drawing. The platforms will be of the open grate type with pipe handrails. The ladders will be equipped with safety cages, and all platforms, ladders, and stairways will comply with OSHA Regulations. Weld clips for platforms will be field installed to ensure proper fit-up.

2.2.3. Self-supporting Outlet Stack

VPI will furnish a freestanding circular outlet stack, terminating at the height shown on the General Arrangement Drawing. The stack will be fabricated from Carbon Steel with exterior seal welds. The stack will be equipped with an access opening, drain, connecting ductwork with expansion joint, required EPA test connections, and access platforms and ladders.

2.2.4. Shop Applied Paint

VPI will sandblast and prime paint all ductwork and casing with one coat of inorganic zinc primer, rated for 700°F (370°C). Major Field weld joints will be masked off and provided unpainted or will be painted with a compatible zinc rich, weldable primer, 0.5 to 1.0 mils DFT. When masking is used, all masking material shall be removed prior to welding. Installer, prior to welding minor welds, shall remove the primer. Sandblast and coatings for the supplied equipment are specified below. Machined surfaces will be coated with a rust-preventive coating. In addition, VPI recommends that all finish coatings be compatible with the zinc rich primer and be of a temperature rating of 500°F (260°C) for the best final installation.

Equipment	Sandblast	Coating
Inlet Duct and Heat Transfer Casing*	SSPC-SP6	Finish Paint
Insulated Steam Drums*	SSPC-SP6	1 Coat Primer (2 – 3 mils)
Drum Saddles	SSPC-SP6	1 Coat Primer (2 – 3 mils)
Platform Grating, Stairs and Kickplates	SSPC-SP6	Galvanized
Ladders and Handrails	SSPC-SP6	Galvanized
Platform Support Steel	SSPC-SP6	Galvanized
Miscellaneous Support Steel	SSPC-SP6	Galvanized
Large Bore Piping*	SSPC-SP6	1 Coat Primer (2 – 3 mils)
* External Only		

2.2.5. Duct Burners

VPI proposes to furnish a duct burner system as manufactured by a supplier per our subcontractor vendor list. The burner runners are manufactured using manifold pipes that are mounted horizontally across the duct. The flame stabilizers and burner elements are bolted to the burner runners. Scanner(s) will be supplied to prove burner flame. In between the burner runners, and also mounted horizontally are baffle runners to direct the combustion turbine exhaust flow across the burner elements. The runners will be supported by vertically oriented supports spaced evenly across the duct. The burner and baffle runners will be mounted to the HRSG casing by mounting plates that will be packed with ceramic fiber insulation covered with a stainless steel. The carbon steel outer surfaces of the burner runner's mounting plate will be prepared to SSPC-SP-6 or 10 and painted with inorganic zinc primer. The elements, flow baffles, and supports shall be mounted by others in a duct section with clear inside dimensions as shown on the proposal general arrangement drawings. View ports

will also be mounted in the casing as shown on the proposal general arrangement drawings.

The main fuel gas and pilot gas valve trains are factory-assembled and mounted on the burner skid. The natural gas supply is assumed to be at a pressure of approximately 30 psig, if a pressure-reducing valve is not included in the VPI scope of supply. The fuel trains are pre-wired to a ~~NEMA 4~~ or 4X junction box mounted on the skid.

The BMS system will be designated for a ~~NEMA 4~~ or 4X electrical enclosure equipped to meet the NEC Hazardous electrical classification of Unclassified. The system will be operable from either the local control panel or the DCS.

The scanner cooling air blowers will be factory-assembled and mounted on the blower skid. The blowers are pre-wired to a ~~NEMA 4~~ or 4X junction box mounted on the skid.

2.2.6. Steam Sampling System

The water Sampling System shall consist of a measurement rack assembly suitable for indoor installation.

The sampling system shall be capable of obtaining continuous samples from the process locations and measurement for the values given below. It shall also be capable of accessing grab samples from each of the process locations for additional lab analysis.

The sample rack shall consist of but not be limited to the following:

- Wet Section Construction (Sample Conditioning Section)
- Dry Section Construction (Electronic Section)
- Sample Sink
- Sample Inlet Bulkhead Connectors (Customer Connection)
- Sample Inlet Valves (Located on Panel Front)
- High Pressure Sample Blowdown Valves
- High Pressure/Temperature Sample Blow down Header
- Primary and Secondary Sample Coolers
- Primary Sample Cooler Cooling Water Inlet and Outlet Valves
- Primary Sample Cooler Cooling Water Thermal pressure Relief Valves
- Primary Sample Cooler Cooling Water Supply and Return Piping
- Sample T-Filters
- High Pressure Sample Reducing Elements
- Low Pressure Reducing Valve
- Sample Pressure Relief Valves
- Thermal High Sample Temperature Shutoff Valve
- Sample Pressure Indicators, Temperature Indicators and Back Pressure Valves
- Analyzer and Total Sample Rotameters

- Measurement Monitors fitted with Hart Protocol on the 4-20mA signal
- PH, Specific Conductivity, Cation Conductivity, Dissolved Oxygen and Silica Sensors and Analyzers,
- All necessary rack electrical and instrumentation wiring and termination equipment for customer connection

Other equipment for the sampling system shall include:

- 20'L x 8' W x 9'6" H Shelter (Modified Shipping Container)
- Tubing between the HRSG and the Sampling Skid
- Closed Circuit Chiller

All Sample, Cooling Water, Electrical and Signal connections shall be via suitable interface connections.

2.2.7. Chemical Dosing System

The Chemical Dosing System shall be an outdoor mounted skid system for the dosing of Ammonia and Phosphate into the HRSG process.
The system shall contain but not be limited to:

Ammonia Dosing System

- Ammonia Transfer Pump
- Ammonia Transfer Pump Suction and Discharge Piping
- Ammonia Feed Tank
- Ammonia Vent Seal Pot
- Ammonia Feed Tank Agitator
- Ammonia Feed Pumps
- Ammonia Feed Pump Suction and Discharge Piping
- Ammonia System Control Panel
- Ammonia System Mounting Skid, Approx. 9'L x 4'W x 7'8"H

Phosphate Dosing System

- Phosphate Transfer Pump
- Phosphate Transfer Pump Suction and Discharge Piping
- Phosphate Feed Tank
- Phosphate Vent Seal Pot
- Phosphate Feed Tank Agitator
- Phosphate Feed Pumps
- Phosphate Feed Pump Suction and Discharge Piping
- Phosphate System Control Panel
- Phosphate System Mounting Skid, Approx. 9'L x 4'W x 7'8"H

All Dosing, Electrical and Signal connections shall be via suitable interface connections.

2.2.8. Electrical Equipment

VPI provide the following electrical scope.

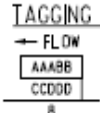
- HRSG instrumentation junction boxes located on the HRSG as preferred by VPI to combine instrument wiring as required.
- HRSG instrumentation wiring including conduit and/or cables trays from the HRSG instrumentation or VPI supply junction boxes to a (DCS Panel / Junction box located near grade on the HRSG (To be provided by others).
- HRSG Power distribution panel(s) located near grade for the HRSG lighting and motor operated valves.
- HRSG lighting for the HRSG main operating platform and ladders and stairs as shown on the Vogt GA. Emergency lighting is not included.
- HRSG power wiring including conduit and/or cable trays from the HRSG lighting and motor operated valves to the power distribution panel(s) located on the HRSG near grade.

Electrical equipment will not be included for the pump scope. Please refer to the attached Electrical Interface Diagram for more information.

2.2.9. Tagging

Tagging shall be per the below KKS system.

TAGGING INFO.:



P]P]NG DES[GNAT]ON FLAG.
PO]NT]NG]N FLOW D[RECT]ON
– SYSTEM CODE
– L]NE CODE
– L]NE S]ZE
– VP]]NTERNAL SPEC
(HT=HEAT TRAC[NG)

VALVE ——— AAA BB CC DDD
INSTRUMENT ——— AAA BB CC DDD
EQU]PMENT ——— AAA BB CC DDD
TERM]NAL PO[NT — AAA BB CCDDD

AAA - SYSTEM ID

EKT = FUEL GAS HEATER EXTRACT]ON
HAA = LP FEED HEAT[NG SURFACE
HAC = ECONOM]ZER SYSTEM
HAD = DRUM / EVAPORATOR SYSTEM
HAH = SUPERHEATER SYSTEM
HAJ = REHEAT SYSTEM
HAN = DRA]N AND VENT SYSTEM
HBK = DUCTWORK (EXHAUST GAS S]DE OF HRSG)
HHA = BURNER P]P]NG
HNE = HRSG EXHAUST STACK
HSG = AIG P]P]NG
LAB = FEEDWATER
LAE = HP ATTEMPERATOR (DESUPERHEATER)
LAF = RH ATTEMPERATOR (DESUPERHEATER)
LBA = MA]N STEAM P[P]NG
LBB = HOT REHEAT
LBC = COLD REHEAT
LBG = AUX]L]ARY STEAM P]P]NG
LBH = BLOWDOWN TANK/DRA]N P]P]NG
LCA = MA]N CONDENSATE P]P]NG
LFN = CHEM]CAL DOS[NG SYSTEM
QUA = FEEDWATER SAMPL[NG SYSTEM
QUB = STEAM SAMPL[NG SYSTEM
QUC = CONDENSATE SAMPL]NG SYSTEM
QUH = STEAM GENERAT[NG SAMPL]NG SYSTEM

X = PRESS. CLASS IDENTIFIER (FLANGE RATING)

A = 4500#
B = 2500#
C = 1500#
D = 900#
E = 600#
G = 300#
H = 150#
X = NO CLASS REQU]RED (NON PRESSURE PART)

Y = MATERIAL TYPE IDENTIFIER

A = SA-335 P91
B = SA-335 P22
C = SA-335 P11
D = SA-106 GR.B
E = SA-106 GR.C
G = A-312 TYPE 316 SS
H = A-312 TYPE 316H SS
J = A-312 TYPE 304 SS
K = A-312 TYPE 304H SS
L = SA-790 S31803
M = SA-53 WELDED
N = AP] 5L GR.B

Z = CODE CLASS IDENTIFIER

K = ASME SECT]ON [(SECT]ON] ADM]N]STRAT]VE & TECHN]CAL JUR]SD]CT]ON - BO]LER PROPER)
H = ASME SECT]ON [(SECT]ON] ADM]N]STRAT]VE JUR]SD]CT]ON, ASME B31.1 TECHN]CAL JUR]SD]CT]ON - BO]LER EXTERNAL)
D = ASME B31.1
M = SECT]ON 8
T = ASME B31.3
X = NON-CODE

BB - SUB-SYSTEM ID

00 = FLUE GAS
01 = RH/HP ATT. SPRAYWATER TAP
10 = HP SYSTEM / FLUE GAS SYSTEM
11 = HP ATTEMPERATOR SPRAY
15 = HP ATTEMPERATOR STEAM
20 = HP MA]N STEAM DRA]NS
30 = CONDENSATE
40 = HOT REHEAT, CONDENSATE OUTLET
50 =]P SYSTEM
60 =]P FEEDWATER / ECONOM]ZER
80 = LP SYSTEM
90 = LP FEEDWATER

CC - ITEM TYPE CODE

AA = VALVES
AB = EXPANS]ON JO]NT
AC = ATTEMPERATOR HEAT TRANSFER SURFACES
AP = PUMPS
AT = STRA]NER / SEPARATOR
BB = DRUM / CONDENSATE POTS
BP = FLOW REST]CTOR
BR = L]NES
BS = S]LENCERS
BU = MODULE BOX / DUCTWORK
CF = FLOW DEV]CES
CG = POS[T]ON MEASUREMENT
CL = LEVEL DEV]CES
CP = PRESSURE DEV]CES
CQ = FLAME DETECTORS, QUAL]TY MEASUR]NG DEV]CES
CT = TEMPERATURE DEV]CES
CY = V[BRAT]ON DEV]CES
DG = POS[T]ON CONTROL S]GNAL
DH = LOCAL / REMOTE
GB = JUNCT]ON BOXES
GR = D]STRIBUT]ON GR]D
KC = HEAT EXCHANGER
MS = MODULE HARPS
SK = OUTLET STACK
TP = TERM]NAL PO]NT

DDD - ITEM NUMBERING

FOR 'AA':
001-100 = VALVES, GENERAL
101-190 = CONTROL VALVES / DAMPERS
191-199 = SAFETY VALVES
301-399 =]NSTRUMENTS
401-499 = DRA]NS
501-599 = VENT
601-699 = SAMPL[NG & DOS]NG
701-799 = NOT USED
801-899 = NOT USED
901-999 = NOT USED

FOR 'BR':
001-190 = P]P]NG (GENERALLY)
191-199 = SAFETY L]NES
201-300 = NOT USED
301-399 =]NSTRUMENTS
401-499 = DRA]NS
501-599 = VENTS
601-699 = SAMPL[NG & PROPORT]ON[NG
701-799 =]NTERNAL]NSTRUMENT L]NES
801-899 = NOT USED
901-999 = NOT USED

FOR 'C*':
001-100 = ANALOG S]GNAL
101-199 = B]NARY S]GNAL
201-299 = TEST]NG
301-399 = NOT USED
401-499 = ACCEPTANCE TEST
501-599 = LOCAL MEASUR]NG
601-699 = NOT USED
701-799 = BLOCKED
801-899 = SAFETY SYSTEM
901-999 = GROUPED MEASUR]NG C]RCU]TS

FUNCTION CODE

BE = QUAL]TY ELEMENT (FLAME SCANNER)
COP = CONDENSATE POT
FE = FLOW ELEMENT
FO = FLOW OR]F]CE
FT = FLOW TRANSM]TTER
FY = POSIT]ON CONTROLLER (FLOW)
GI = L]M]T SW]TCH, CLOSED
GIAZ = L]M]T SW]TCH, OPEN, ALARM
GIZ = L]M]T SW]TCH, PROTECT]ON
GS = POSIT]ON TRANSM]TTER
GSA = POS]T]ON SW]TCH, CLOSED
GSB = POS]T]ON SW]TCH, OPEN
GSC = TORQUE SW]TCH, CLOSED
GSD = TORQUE SW]TCH, OPEN
HS = HAND SW]TCH
J = JOGGING
JB = JUNCT]ON BOX
L = LOCK]NG
LG = LEVEL GAUGE
LI = LEVEL]ND]CATOR
LS = LEVEL SW]TCH
LT = LEVEL TRANSM]TTER
LY = POSIT]ON CONTROLLER (LEVEL)
LYT = DENS]TY COMP. LEVEL TRANSM]TTER
PDT = PRESSURE D]FFERENT]AL TRANSM]TTER
PI = PRESSURE GAUGE
PT = PRESSURE TRANSM]TTER
PY = POSIT]ON CONTROLLER (PRESSURE)
QI = QUAL]TY]ND]CATOR
RLI = REMOTE LEVEL]ND]CATOR
TE = TEMPERATURE ELEMENT
TI = TEMPERATURE]ND]CATOR
TT = TEMPERATURE TRANSM]TTER
TW = THERMOWELL
TY = POSIT]ON CONTROLLER (TEMPERATURE)
VT = V]BRAT]ON TRANSM]TTER
ZY = POSIT]ON COMMAND, STOP
ZYC = POS]T]ON COMMAND, CLOSED
ZYO = POS]T]ON COMMAND, OPEN

2.3. Fabrication

2.3.1. Codes and Standards

The equipment supplied will be designed, manufactured, tested, and will be in accordance with the approved applicable addendum of the following codes and standards or their international equivalent:

ASME Boiler and Pressure Vessel Code, Section I, Power Boilers
ASME Boiler and Pressure Vessel Code, Section VIII, IX
ASME Code for Pressure Piping, B31.1, Power Piping
American National Standards Institute (ANSI)
American Society for Testing and Materials (ASTM)
Environmental Protection Agency (EPA)
Institute of Electrical and Electronic Engineers (IEEE)
American Iron and Steel Institute, AISI
National Electrical Manufacturers Association (NEMA)
National Fire Protection Association (NFPA)
Occupational Safety & Health Act (OSHA)
Scientific Apparatus Manufacturers Association (SAMA)
Instrument Society of America (ISA)
Boiler Water Requirements and Associated Steam Purity for Commercial Boilers, American Boiler Manufacturers Association (ABMA)
HRSG Performance Testing (ANSI/ASME PTC 4.4)
Society for Protective Coatings (SSPC)
National Electric Code (NEC)
American Welding Society (AWS)
American Institute of Steel Construction (AISC)
American Society of Civil Engineers (ASCE)
International Building Code (IBC) 2012

2.3.2. World-Wide Sourcing of Components and Labor

The basis for this proposal is for all the engineering, materials, and labor associated with this contract to be procured from any place in the world. VPI has extensive experience with pressure parts and steelwork fabrication in different parts of the world, and has a long list of proven suppliers.

Workshops issued with an order for the fabrication of pressure parts are audited before these orders are issued, and must adhere to rigorous quality plans and standards. VPI has a number of standard contracts with various approved workshops in the world. During fabrication, members of the VPI subcontracting department are present. This ensures the quality of the products and fabrication is in accordance with the time schedule.

2.3.3. Inspection and Shop Certificates

The Purchaser has the right to inspect the boiler and parts thereof during fabrication to insure that all materials are in accordance with the contract, and to assure that proper fabrication procedures are used.

A Manufacturer's ASME Code Data Sheet will be furnished for the heat recovery system generator. For domestic projects, all Section I and Section VIII vessels will be stamped with a NBBI number as required by the ASME and local codes. Only international projects where the contract requires registration with the National Board will a NBBI number be stamped on the HRSG.

A fabrication schedule will be submitted by the Project Manager (with the monthly progress report) to permit the Purchaser to select suitable items for inspection and will give at least one week's notice before factory tests are conducted.

Equipment	Factory Testing
Harp Assembly	Non-ASME stamp hydrostatic test of each module harp
Steam Drums	100% Volumetric Examination of Longitudinal & Circumferential welds per ASME Section I
Downcomers	100% Volumetric Examination of Circumferential welds per ASME Section I
Butt Welds	10% random radiography of all butt welds (Alloy)
Butt Welds	10% random radiography of all butt welds (Carbon Steel)

2.4. Piping Interface Information

2.4.1. Large Bore Piping Fit Up

VPI has included in our scope of work the supply of all large bore piping spools cut and prepped for welding in the exact length needed based upon VPI's drawings. VPI will only accept back charges on the fit up of these spools if:

(1) The spool was incorrectly fabricated per VPI drawings or
(2) It can be shown that VPI drawings were in error.

Due to fabrication and erection tolerance, there will be multiple field welds that will require field fit up even though the majority of large bore piping spools are cut and prepped for exact length. The intent is to minimize the amount of field fit up; however, some field fit-up may be required.

VPI has also included pup pieces of the various piping spools to compensate for small fit up differences. Some large bore piping spools such as evaporator risers and downcomers are cut and prepped for welding on one end and additional length of three (3) inches for field fit-up on the other end. This additional length must be cut to fit and prepped for welding to connecting pipe.

All small bore piping (2" IPS and smaller) shall be provided in random lengths for field installation depending on final construction requirements.

If piping is not installed properly as per VPI drawings, then the Buyer assumes risk of fit up.

VPI would extend an offer to the customer and/or their representative to a face to face review with VPI of the pipe routings. This review would be prior to the start of the preparation of spool drawings. The meeting would be a line by line review of the spools with VPI and customer agreeing upon where each field weld would be and where exact length piping would be supplied. It would also be suggested by the Seller that where long runs of piping are found one (1) spool in that long run be left long for easy fit up field.

2.4.2. Customer Interface Piping

VPI standard practice for interfacing VPI piping with Purchaser piping is as follows:

VPI/Purchaser piping interface points (terminal points) are preliminarily established via the P&IDs and General Arrangement Drawings contained in this offer. Actual interface details will be finalized during the execution of the project.

VPI generates stress analysis models for critical steam and feedwater piping systems. These models extend beyond the physical VPI/Purchaser interface points to include Purchaser piping and pipe supports to the first anchor point on the Purchaser's pipe rack. These anchor points should be within 100 ft (30 m) of the interface points. In some cases, small bore piping will be anchored against movement near the interface point. Note that this anchor will most likely be on the HRSG, and the HRSG does move with thermal, wind & seismic loads. Some small bore piping interface points will require coordination due to unavoidable movement. VPI cannot accept large thermal movement forced into our scope of piping from the balance of plant piping. As such, forces and moments applied to the structural steel and piping, as reactions from Purchaser piping shall be submitted for VPI approval.

The Purchaser shall provide routing and piping support data (isometrics, material, support details and thermal movements) between the interface points and their anchor points to support VPI's analysis. If the Purchaser wishes to perform their own analysis of VPI piping to a fixed point on the HRSG, VPI will accommodate this by providing data as noted above. VPI uses Algor/Pipe-Plus and/or Coade/Caesar software for all pipe stress analysis.

The maximum allowable forces and moments in the piping at the interface points shall be determined based on the stress limits in the current edition of the ASME Boiler Code. Maximum forces and moments that can be allowed by VPI at the header / nozzle interface are provided in the table below.

A steam hammer pipe stress analysis is assumed to be by others after pipe routing and supports are located. Additional supports arising from this analysis are to be placed in Balance of Plant Piping.

Nozzle Size (IPS)	Max Force in One Direction	Max Resultant Force $\sqrt{F_x^2 + F_y^2 + F_z^2}$	Max Resultant Moment $\sqrt{M_x^2 + M_y^2 + M_z^2}$
Inch	lbF	lbF	ft-lb
4	600	800	2000
6	900	1200	5300
8	1200	1600	10500
10	1500	2000	18600
12	1800	2400	27300
14	2100	2800	33200
16	2400	3200	43800
18	2700	3600	55900
20	3000	4000	69400
22	3300	4400	72400
24	3600	4800	102400
26	3900	5200	122500
28	4200	5600	143000
30	4500	6000	165000

3. HRSG Performance

Refer to the attachment stated below for the HRSG performance details for VPI's proposed design including capacity guarantees, steam purity guarantees, emissions guarantees, and HRSG noise guarantees, as applicable to the HRSG design.

Please refer to the latest revision: "P7525_HRSG Performance and Guarantees_Rev03"

4. Preliminary Exceptions and Clarifications

Refer to the attachment stated below for a list of the Specifications reviewed by VPI, and their respective exceptions and clarifications. VPI reserves the right to add additional comments to be discussed prior to award and/or contract date.

Please refer to the latest revision: "P7525_VPI Technical Exceptions and Clarifications_Rev02"

5. HRSG Information

5.1. Pressure Parts

Refer to the attachment stated below for the heating surface details of VPI's proposed design.

Please refer to the latest revision: "P7525G_VPI Heating Surface Data_Rev02"

5.2. Insulation

The insulation schedule shown below will result in an average outer casing skin temperature of 140°F (60°C) with an ambient temperature of 80°F (27°C) and wind velocity of 1.6 ft/sec (0.5 m/s).

Ductwork Section		Outside Casing		Insulation		Liner
Section	Location	Material	Thickness (mm)	Material	Thickness (mm)	Material
Inlet Duct critical Area Transition	Walls	6	CS	AES	111	Typ 4xx
	Roof	6	CS	AES	111	Typ 4xx
	Floor	6	CS	AES	156	Typ 4xx
Remaining Inlet Duct	Walls	6	CS	AES	111	Typ 4xx
	Roof	6	CS	AES	111	Typ 4xx
	Floor	6	CS	AES	156	Typ 4xx
Burner Duct	Walls	6	CS	AES	200	Typ 30x
	Roof	6	CS	AES	200	Typ 30x
	Floor	6	CS	AES	311	Typ 30x
Box 1	Walls	6	CS	AES	178	Typ 30x
	Roof	6	CS	AES	178	Typ 30x
	Floor	6	CS	AES	244	Typ 30x
Box 2	Walls	6	CS	AES	44	CS
	Roof	6	CS	AES	44	CS
	Floor	6	CS	AES	67	CS

Note: Due to world-wide sourcing of materials, the metric equivalents may be less than the English dimensions shown above.

5.3. Drums

Drums	Inside Diameter (mm)	Seam-Seam (m)	Shell Thickness (mm)	Material	Hold Up Time NWL – LLC (min.)
HP	1,676	3.35	57	SA-516 Gr70	2
LP (DA Storage Tank)	2,896	3.96	38	SA-516 Gr70	15

6. Shipping Information

6.1. Receiving & Off-loading

6.1.1. Guidelines

Equipment to be installed will be loaded, shipped, unloaded, handled, and stored, as defined in the quotation letter. Any such moving and storage will be executed by others and per VPI guidelines.

6.1.2. Receiving by Erection Contractor

Every effort shall be made to accurately identify, receive, and document materials and equipment. All material shortages and/or damages must be identified and reported to VPI by the Erection Contractor within two (2) working days of the identification of the same.

6.1.3. Responsibility

The Erection Contractor will be responsible for all equipment received by them for installation, until it has been accepted by the Owner per contract.

6.1.4. Registration

The Erection Contractor will keep written records of all equipment and material received by them with performance of regular inspections and maintenance as appropriate during storage. These records shall be made available to VPI upon request.

6.2. Inspection Upon Arrival

Upon arrival at the agreed delivery point, a thorough visual inspection shall be performed by the Purchaser to assure no shipping damage to the equipment has occurred and to verify receipt of equipment. Reports of any such damage shall be made in writing by the Purchaser to VPI within a two (2) day working period to assure proper methods are used to remedy problems.

Pressure parts should be checked for material integrity. Connections on the module harps, steam drums, and major pipe spools should be properly capped. Steam drum internals should be checked for integrity. Ductwork and casing panels should be checked for structural integrity. Their internal insulation should not be exposed, and should be properly wrapped in plastic or plywood shipping material.

Shipping containers should be checked for structural integrity. Any damage to the outside of a shipping container (or any item) should be properly documented and brought to the immediate attention of the VPI Project Manager and 7the party responsible for overseas freight. Upon unpacking, individual items should be visually inspected for damage due to improper packing or shipment.

6.3. Preliminary Shipping Information

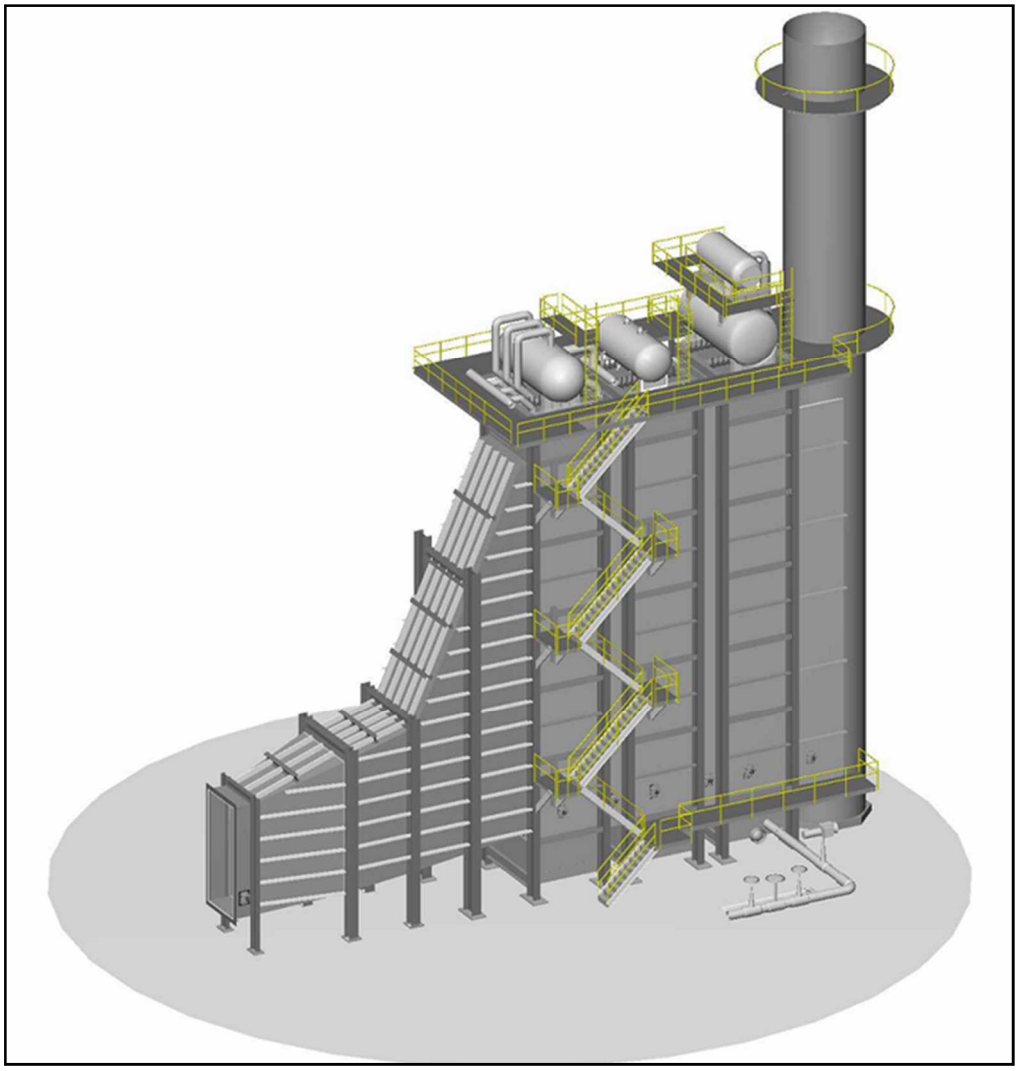
Refer to the attachment stated below for the shipping information for VPI's proposed design including component descriptions, weights, and dimensions.

Please refer to the latest revision: "P7525G_VPI Shipping Information_Rev02"

7. Installation Information – MSG Design

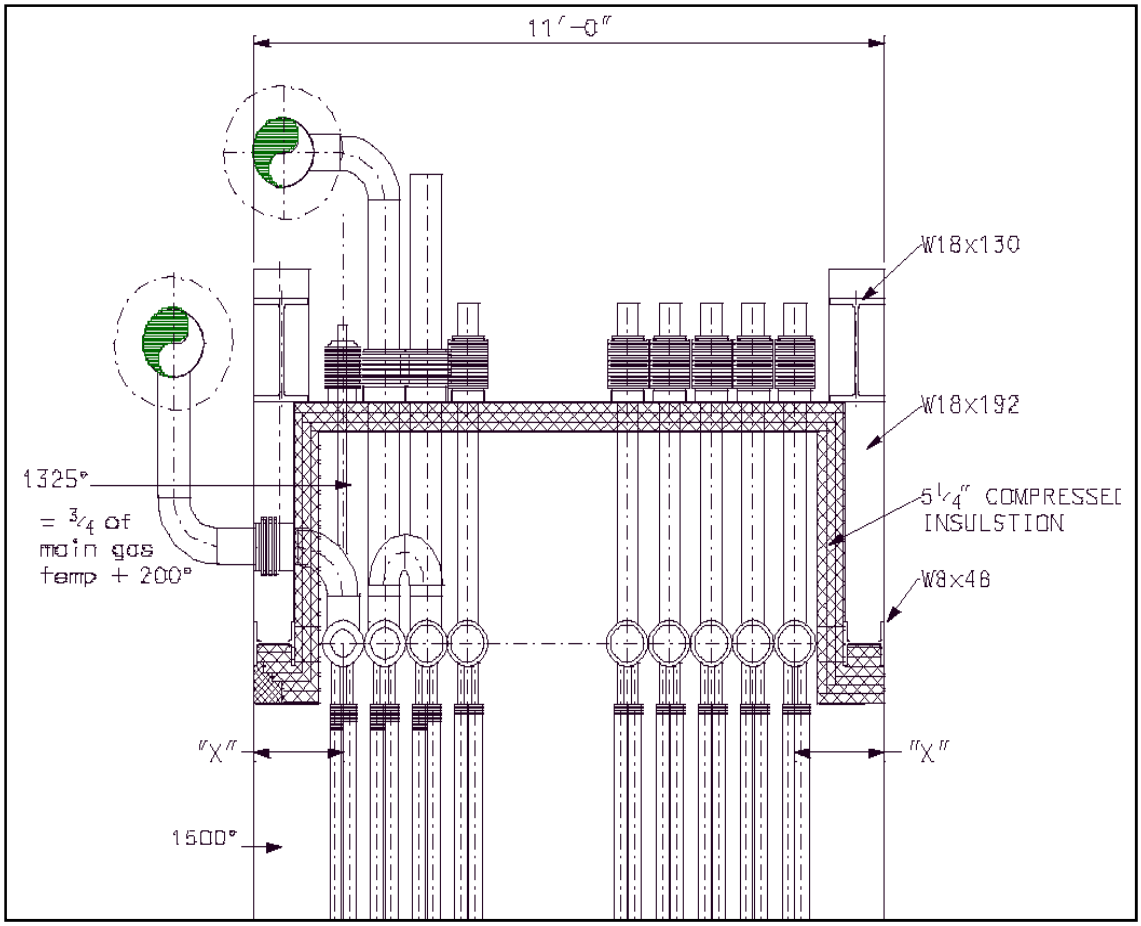
This section is included to briefly describe the HRSG and the components within the HRSG. It is not intended to replace the scope of supply section of this proposal.

VPI offers its well proven MSG Design HRSG. This design has been supplied to many customers over many years

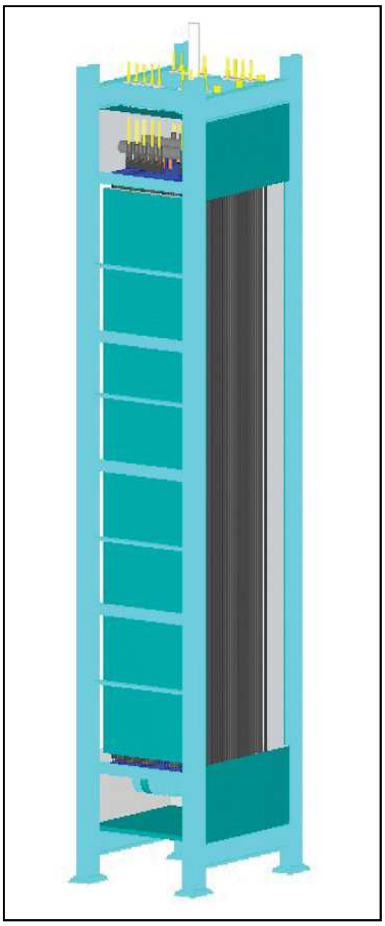


The specifics of this design are:

- All top-supported heating surfaces, with all fin tubes installed between top and bottom headers.
- Large access space above the top headers and below the bottom headers for maintenance and inspections.
- Access space inside the larger boxes for cleaning and inspection purposes.



The MSG design features an extremely high level of pre-fabrication, reducing on-site construction hours. The pressure parts of the HRSGs are assembled in self-supporting module boxes which include fin tubes, headers, casing, structural steel and interconnecting piping within the boxes. Piping connections to other boxes and drums are brought to the outside of the box. After setting the box, there is no inside pressure part work required.

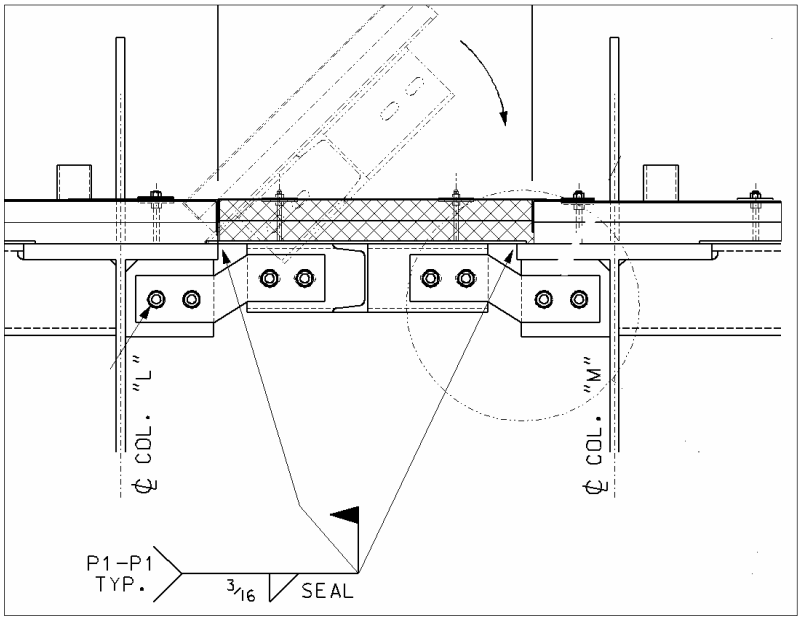


Small panels are installed between the boxes, preventing any requirement for inside seal welding and, in the cold end of the HRSG, for field installation of internal insulation and liner. All welds can be approached from the outside using 'sky climbers'.

Intermediate side panels

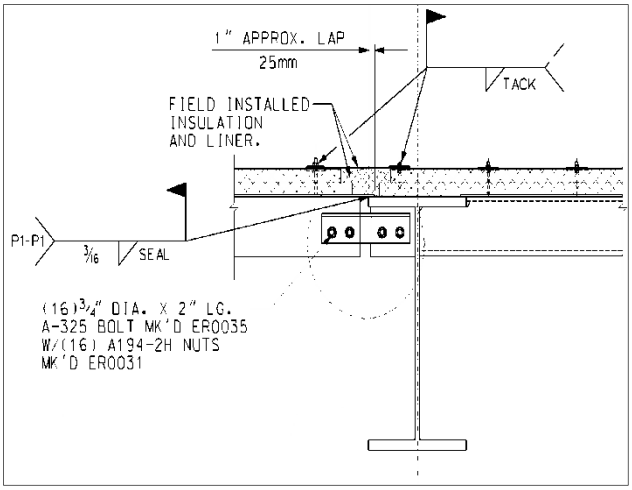
In areas where these panels are installed there is usually no requirement to go inside the gas path to install insulation and liner panels between the boxes. When the intermediate panels are installed, the insulation and liner panels are compressed to form a tight fitting surface without the heat leaks.

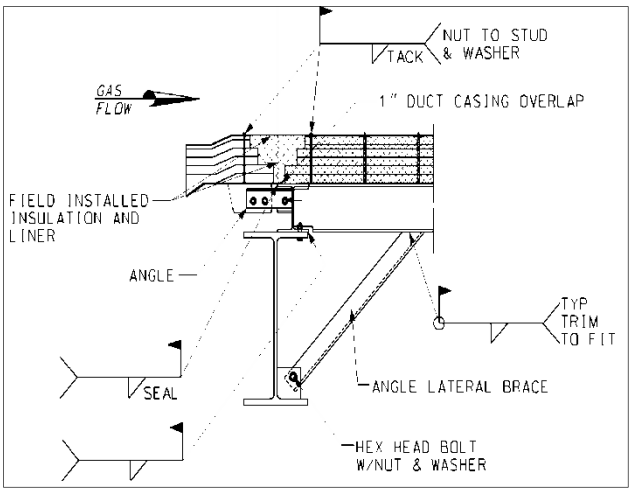
(Temporary) bolting provisions are available on the intermediate panels for ease of installation. After the bolts are tightened, the crane can be released and the seal weld can be made as manpower becomes available.



7.1. Field Installation of Internal Insulation

In the inlet duct, between the inlet duct and first box, and between the burner duct (If required) and usually the second box insulation and liner is installed in the field. The temperatures of the flue gas in this area require a thicker and completely tight pack of insulation so that this can only be done after the seal welds are completed.





7.2. Drum with Nozzles and Drum Saddles

VPI supplies the drums with all nozzles welded in place, welds prepared for connection to the piping. Also, the saddles will be installed so that the drum can be lifted immediately upon delivery.

7.3. Prefabrication of Stairs, Walkways, Ladders and Platforms

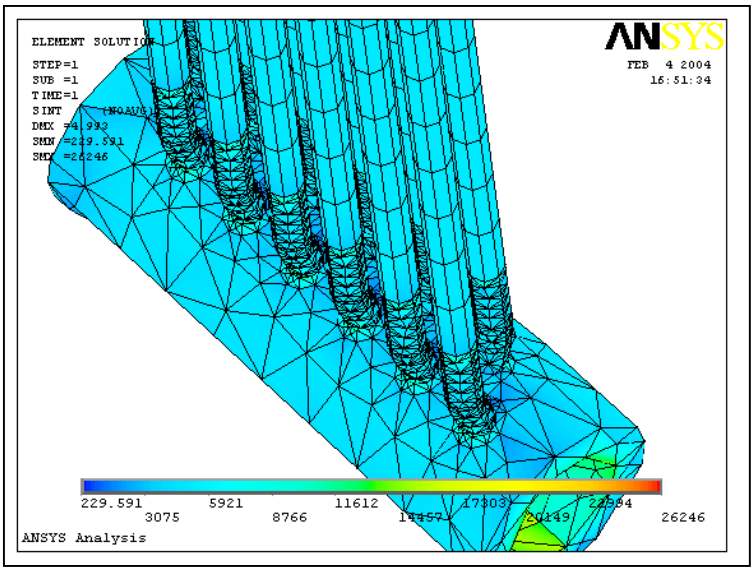
Stairs, walkways, ladders and platforms are supplied in standard containers. Within this constraint, pre-assembly has been completed to the maximum extent possible. Assembly on the site will all be bolted, with the exception of the clips on the support steel, which are welded to the casing and the steel of the HRSG. Grating and toe-plates will be mounted on the frames; handrails are fully assembled to be bolted onto the frame. Stair steps are preassembled into stringers. It should be noted that platforms are completely assembled in the factory to insure proper fit-up.

7.4. Other options to further reduce field work

In some cases when transport dimensions allow, we can offer the supply of the stack in complete cans, and we can arrange for larger than panel sizes. Cost of these options can be provided on request and will vary significantly dependent upon the location of the job site and transport possibilities.

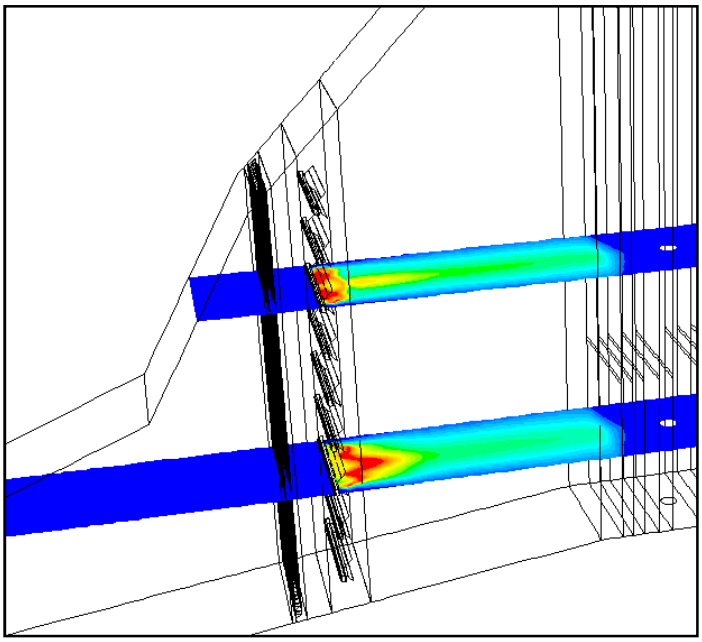
7.5. Selection of tube to header connection

VPI has conducted extensive studies to assess the effect of frequent starts and stops and has assessed the effect of different tube to header welds. Depending on the application, pressures, temperatures and locations in the HRSG, and the cycling requirements, VPI selects the optimal tube to header connection.



7.6. CFD Analysis of Flue gas flow through HRSG

As part of the engineering activities, computer flow modeling is done on every design to verify and establish optimal inlet duct configuration, burner locations, baffling and distribution grids. This assures properly functioning catalysts and protection of the heating surface against flame impingement and overheating.



8. List of Attachments

No.	File Name	Revision	Description	Notes
1	P7525_HRSG Performance and Guarantees.pdf	3	HRSG Design Performance Basis and Capacity Guarantees, Emissions Guarantees, and Noise Guarantees	
2	P7525G_VPI Predicted Performance.pdf	1	HRSG Design Predicted Performance	
3	P7525_VPI Technical Exceptions and Clarifications.xls	2	VPI Technical Exceptions and Clarifications to Customer Specifications	
4	P7525G_VPI Heating Surface Data.xls	0	Details of Heating Surface for VPI's HRSG Design	
5	P7525G_VPI Shipping Information.pdf	0	Shipping information with component description, weight and dimension.	
6	7525G-GAPR-0001.pdf	0	Proposed General Arrangement drawing – Right side view	
7	7525G-GAPR-0002.pdf	0	Proposed General Arrangement drawing – Plan view	
8	7525G-GAPR-0003.pdf	0	Proposed General Arrangement drawing – Left side view	
9	7525G-ICPR-0001.pdf	0	P&ID Legend and General notes	
10	7525G-ICPR-0002.pdf	0	Flue Gas P&ID	
11	7525G-ICPR-0003.pdf	0	HP Superheater P&ID	
12	7525G-ICPR-0004.pdf	0	HP Economizer & Evaporator P&ID	
13	7525G-ICPR-0005.pdf	0	External Deaerator P&ID	
14	7525G-ICPR-0006.pdf	0	Blowdown Tank P&ID	
15	7525G-ICPR-0007.pdf	0	Flash Tank P&ID	
16	7525G-ICPR-0008.pdf	0	Burner P&ID	

No.	File Name	Revision	Description	Notes
17	7525G-ICPR-0009.pdf	0	Sampling Skid P&ID	
18	7525G-ICPR-0010.pdf	0	Chemical Dosing System P&ID	
19	7525G-ICPR-0011.pdf	0	Electrical Interface Diagram	
20	7528G-ICPR-0012.pdf	0	Sweetwater Condenser P&ID	