

TECHNICAL SPECIFICATION FOR HYDROCARBON VAPOR RECOVERY SYSTEMS

INTRODUCTION

Hydrocarbon vapor recovery systems are the result of environmental laws initiated with the enactment of the Clean Air Act of 1970 in the USA, and the formation of the EPA to enforce the Act. Many countries throughout the world have adopted this law, or variations thereof, to minimize local air pollution. This law mandates the removal of hydrocarbon from air/vapor streams otherwise entering the atmosphere from any source. Various technologies were initially developed and applied to satisfy this law, but within a few years the activated carbon short-cycle pressure swing adsorption/absorption (aka AdAb) system proved technically and economically superior. From the early 1970s through 1995 all AdAb systems used liquid ring vacuum pumps for the carbon regeneration. These pumps, and their associated equipment, and the limited use of process control automation, proved to be untenable, causing excessive maintenance, and resulting in malfunctioning or inoperative systems in too many cases. In 1995 Symex introduced the first “dry” AdAb System using a dry-screw vacuum pump. Within a few years SYMEX Americas introduced the first fully automated dry AdAb, using the proven and reliable Busch Cobra dry-screw vacuum pump and a comprehensive process control automation system and software. This advancement revolutionized the AdAb process. It is known today as DRYVac™, and DRYVac™ has become the global “Standard of the Industry”. The following is SYMEX Americas’ general specification for the DRYVac™ Vapor Recovery System (VRS).

1.0 General Vendor VRS Scope Of Supply

1.1 The VRS offered shall include system design and engineering specific to the conditions of this application. The engineering shall begin with the determination of actual loading profile of this facility and the sizing of and confirmation of pressure drop in vapor collection piping system from the furthest loading position to the VRS site and VRS inlet. From this the engineering effort will generate a P&ID and PDF which document the VRS size, model number, the order and size of each of the components, and the flows through all interconnecting lines. The design engineering will produce mechanical and electrical specification documentation item by item for each and every item comprising the VRS. The selected vendor will undertake procurement of component raw materials, fabrication in accordance with the most current standards, inspection at works, assembly, pre-testing at works, painting, functional testing of the PLC system operating and HMI system and all annunciation and operational software, supervision of erection, commissioning and start-up of Vapor Recovery System. The vendor shall provide a Performance Test of complete Vapor Recovery System (VRS) at site. This test shall be conducted in accordance with standard practices and shall prove the function of the VRS

consistent with the emissions specifications, data sheets, local standards, all drawings, and shall be consistent with the client's original emissions and performance requirements.

The Vendor shall suggest and offer a proven package for Vapor Recovery System. Vendor's scope shall include all equipment, items, piping, structures, electrical, instrumentation and controls etc. as required according to the proposed scheme, within the system battery limit. Vendor shall furnish complete details of their supply in the bid.

- 1.2 The VRS supplied shall be supplied as a complete system, including all required auxiliary equipment, skidded and assembled where possible, and suitable efficient and satisfactory operation and maintenance as a whole for the purpose intended. In order to provide for normal maintenance, all components and subcomponents shall be designed and installed in such a manner as they are removable/replaceable without the disassembly or removal of other adjacent components. Vendor shall be responsible for furnishing all documentation, operating and maintenance manuals, mechanical, electrical, instrumentation, structural supports, piping, wiring, pressure vessels, software, controls, PC/PLC operational manuals, VRS training materials/presentation, and other interconnecting and safety items as may be required to make the system complete.
- 1.3 All equipment and materials supplied shall be consistent with the following data and these general specifications.
- 1.4 The VRS shall be completely installed by the successful vendor. Installation shall be in strict accordance with sound engineering principles, industry accepted fabrication methods, and consistent with industry-wide construction practices. No act or omission on the part of the Vendor shall absolve Vendor of the responsibility to comply fully with these specifications.
- 1.5 All materials supplied under this specification shall be new, shall be provided with a performance guarantee and all OEM warranties, and shall be adequate for the proposed service per this specification. Proper consideration shall be given to their function with regard to corrosion, chemical and other processes, fire hazards, and erosion due to the design and/or the medium being handled.
- 1.6 All process flows, vessel and line sizes shall be clearly stated herein and shall be shown on the vendor's PFD which shall serve as the referee document for the proper sizing of each item supplied.
- 1.7 The Vendor's scope of supply shall include, One (1) skid mounted Activated carbon adsorption Vapor Recovery System, complete with but not be limited to the following:
 - Vapor collection piping design, complete with blower (and installed spare) if/as necessary, to move hydrocarbon vapors from the source to the VRS.
 - Two ASME Code designed and stamped. Carbon bed adsorber vessels with adsorbents proven not to overheat.
 - Busch Cobra DRY Vacuum pumps with electric motor driver, each powered by a variable frequency drive (VFD), and one installed spare pump and VFD as a standby.
 - One (1) packed column absorber with at least four theoretical trays, with engineered hydraulic inlet absorbent distributor, demister guaranteed to prevent absorbent

- carryover, concentrically enlarged sump designed to prevent overflow, and complete with sump level transmitter and dedicated HH and LL shutdowns level devices.
- Absorbent naphtha supply and return pumps with electric motor drive. Return pump complete with VFD. System shall be complete with one installed spare supply pump and motor, one installed spare return pump and motor with VFD.
 - Stack analyzer for measuring the stack emission level
 - Ground Level Concentration analyzer. The analyzer shall be suitable for the ambient conditions specified in the bid documents.
 - Inlet analyzer, temperature transmitter, and flow meter shall be provided for the inlet vapor.
 - Special tools and tackles for operation and maintenance (to be included in Lump sum price & a list to be furnished with offer).
 - Commissioning spares for the Vapor Recovery system.
 - Consumable spares for 06 months operation (to be included in lump sum price). Vendor to furnish the list of commissioning spares along with offer.
 - Instrumentation mandatory spares (to be included in the lump sum price.)
 - Operation and Maintenance Spares, for two year's smooth and trouble-free operation of offered VRU system. Vendor shall furnish an itemized price list along with offer. Vendor shall specify / include the operation and maintenance spares required for the offered Centrifugal pump & Vacuum pump in the two years operation and maintenance spares list.
 - Vendor shall ensure
 - First fill of lubricants, oil, grease etc.
 - First fill of all adsorbents.
 - All piping inside the Vapor recovery system shall be to vendor's scope. Battery limit of VRU system shall have flanged connection with isolation valves to match with the outside B/L piping.
 - Any additional item or feature required during detail engineering for the completeness and trouble-free performance of the system shall be deemed to be included in the Vendor's scope without any cost and time implication to owner, as long as the system performance requirements within the battery limits of the system are kept unchanged.

1.8 The vendor scope of project-related services is as follows:

- Process design engineering
- Detailed mechanical and electrical design engineering
- Documentation for all design engineering and components
- Procurement of equipment and materials
- Preparation and submission of all drawings and specification sheets for approval by Purchaser or his agent
- Fabrication and assembly at works
- Surface preparation, protective coating, and painting as per attached painting specifications
- Inspection and testing
- Transport to site
- Supervision of erection
- Commissioning of Vapor Recovery System
- Start-up of the VRS under normal terminal conditions
- Performance test of the complete system at site
- Training for clients' operating personnel provided at site following commissioning and start-up.

- One full day of classroom and one full day of on-site training for owner's operating personnel including PLC and HMI functions.
- The cost for the same to be included in the VRU cost.

2.0 Site Specific Data

2.1 Actual site and climate conditions influence the VRS design. As such each condition shall be identified below. The site conditions determine many of the requirements and specifications for the many components of this VR system. Therefore, each shall be identified specific to this application as considered by the vendor for vendor's offer, as follows:

Owner name..... _____

Owner's full address _____

Name of location _____

Full address of location _____

Owner's inquiry number _____

Inquiry due date..... _____

Owner contact person _____

Contact person contact phone/fax numbers..... _____

Product storage temperatures:

Maximum summer °F _____

Minimum winter °F/°C _____

Ambient Temperature (max) °F _____

Ambient Temperature (min) °F _____

Site elevation (above sea level) _____

Wind speed (maximum) _____ to _____

Maximum Rainfall (30 day period and annually) _____ to _____

Relative humidity (max) _____

Area classification _____

Gas zone _____

Electrical supply _____ VAC, _____ -phase, _____ Hz

Terminal open hours, per day _____

Available pressure at inlet, inches of water _____ to _____

Products loaded: _____

Gasoline max RVP (assumed)

Summer psi ... _____

Winter psi _____

VRS Design life (min) _____

Materials of construction –vessels _____

Materials of construction –piping _____

Sound level _____

Truck capacity average in gallons (assumed) _____

HC vapor concentration range % Vol. _____ to _____

Design HC inlet vapor concentration % Vol. (max)..... _____

Required emission Limit in outlet mg/liter _____

2.2 Site Specific Utilities: Electrical power will be supplied at the Battery Limit (B.L.) of vapor recovery system. The utilities required and consumption to be specified by the

vendor. The following are the utilities that will be supplied by the owner at the B.L. of vapor recovery system.

Sr. No.	Utility	Pressure (Kg/cm ² g)			Temperature (°C)		
		Min.	Norm.	Max.	Mech. Design	Normal	Design
1	Inst. Air						
2	Plant Air						
3	Nitrogen						
4	Service Water						
5	C. W. Supply						
6	C. W. Return						

Electrical Power Utilities Available

No.	Voltage	Phases	Amps of Service	Outage, % of Total	Hertz

2.3 The vendor will provide the following start-up requirements:

Description	Pressure (Kg/cm ² G)		Temperature (°C)	
	Operating	Design	Operating	Design
Product to VRS (Initial Fill)				
Product from VRS to Product tank				

3.0 Seismic Information

The seismic/earthquake factor or zone used as the basis for vendor's offer shall be specified. All civil and mechanical designs and structural facilities shall be based on this data, and shall be specified by the vendor, as follows:

3.1 Earthquake rating/zone

4.0 VRS Equipment Supply Specification

4.1 The system supplied is known generically as a "Dry Vapor Recovery System". The process description is an "automated, self-managing, dry, short cycle, AdAb, activated carbon based, hydrocarbon vapor recovery system" similar in layout to Annexure II. All pressure vessels shall be designed in strict accordance with the ASME Code, Section VIII, Division 1, and all designed for 15+ PSIG MAWP shall be ASME Code stamped. All nozzles 1" and larger shall be ANSI 150 RF flanges consistent with ANSI standards. All nozzles smaller than 1" shall be full couplings rated at 3000# or greater, or the equivalent Threadolet/Weldolet.

General Specification: Each VRS is complete with at least:

Two (2) each activated carbon adsorption vessels suitable for full vacuum

- One (1) each absorption contactor vessel with hydraulic distributor, stainless steel packing, and liquids sump with anti-vortex outlet
- One (1) or more Dry-Screw vacuum pumps with jacket and vapor cooling, designed for foundation mounting to prevent vibration transfer to carbon beds
- One (1) supply gasoline pump with mechanical seal and designed for 20% over-pressure
- One (1) return gasoline pump with mechanical seal and designed for 20% over-pressure
- One (1) lot of interconnecting piping per ANSI B-31.3 and 16.5
- One (1) industrial PLC with SIL rating of 1 or higher
- One (1) HMI with 24" or larger color LCD screen
- One (1) lot of specialty instruments, valves, and controls
- One (1) automation hardware system
- One (1) automation software system

Specific Specifications: The vendor shall identify the specifics of each of the above in offer, as follows:

ASME Code Designed Carbon Vessels: The carbon vessels shall be designed and fabricated in accord with vendor-conducted ASME Code calculations conforming to the latest edition of Section VIII, Division 1. The Code calcs shall be transmitted to the owner for information. The civil engineering shall include the bed support and leg beams. The bed support shall be 1" X 3" bar grate suitable to comply with the dead weight of wet carbon. The carbon shall be supported above the bar grate on two layers of replaceable stainless steel mesh. Each carbon vessel shall have at least three 6" carbon fill nozzles in the top head, one ANSI flanged relief valve connection for an included fire-rated relief valve, one 24" manway above and near the bottom head seam with a blind and davit, three temperature indicator connections, and appropriately sized ANSI flanged inlet and outlet. Flow diffusers shall cover both the inlet and outlet openings.

- Number to be supplied _____
- Diameter _____
- Seam-to-seam shell height _____
- Head type _____
- Design working pressure _____
- ASME Code Design Generated (Yes/No) _____
- ASME Code Calcs Provided to Owner (Yes/No) _____
- ASME Code Stamped (Yes/No) _____
- Designed for full vacuum (Yes/No) _____
- MAWP _____
- Shell: grade of steel _____
- Thickness w/o corrosion allowance _____
- Corrosion allowance _____
- Heads: grade of steel _____
- Thickness w/o corrosion allowance _____
- Corrosion allowance _____
- Base type (Skirt/Legs) _____
- Foundation contact area/load _____ / _____
- Total number of vessel fittings _____
- Service designation and size _____
- Service designation and size _____

Service designation and size _____
 Service designation and size _____
 Service designation and size _____
 Service designation and size _____
 Service designation and size _____
 Service designation and size _____
 Carbon supplier/manufacturer/processor _____
 Carbon brand name _____
 Base carbon material (Wood, Coal, Other) _____
 Carbon particle size _____ X _____
 Carbon density _____
 Total weight of carbon to be supplied for this project _____

Absorber Vessel: The absorber vessel shall be designed for at least 14.9 psig MAWP per the latest edition of the ASME Code, Section VIII, Division 1, and at least 90% contact efficiency. This vessel may be a single piece or two piece vessels. If it is a two-piece vessel, the two pieces shall be joined by an ANSI RF flange. The Absorber section shall have an engineered inlet absorbent distributor designed to provide uniform distribution of the sorbent liquid. It shall be a randomly packed column which shall be designed with a minimum of four (4) theoretical trays. This section shall include a removable demister, a RF flanged relief valve connection sized for the fire case and included, a rich-vapor ANSI flanged outlet nozzle extended into the vessel and up to very near the top of the inside, and a bar grate and screen support for the IMPT or equal random packing. The absorber sump section shall be tall enough to provide for adequate NPSH for the absorbent return pump. It shall have level control and hi/lo shutdown connection, a pressure gauge connection, a coolant gasoline return ANSI flanged connection, a bottom drain, an anti-vortex ANSI RF flanged pump suction connection near the bottom, and an ANSI RF flanged vapor inlet.

Number to be supplied _____
 Absorber Section
 Diameter _____
 Seam-to-seam shell height _____
 Head type _____
 Design working pressure _____
 Designed for full vacuum (Yes/No) _____
 MAWP _____
 Shell: grade of steel _____
 Thickness w/o corrosion allowance _____
 Corrosion allowance _____
 Heads: grade of steel _____
 Thickness w/o corrosion allowance _____
 Corrosion allowance _____
 Demister type _____
 Diameter _____
 Depth _____
 Material of construction _____
 Relief valve size _____ X _____
 Type _____
 Manufacturer _____

Sump Section

Diameter _____
 Seam-to-seam shell height _____
 Head type _____
 Design working pressure _____
 Designed for full vacuum (Yes/No) _____
 MAWP _____
 Shell: grade of steel _____
 Thickness w/o corrosion allowance _____
 Corrosion allowance _____
 Heads: grade of steel _____
 Thickness w/o corrosion allowance _____
 Corrosion allowance _____
 Base type (Skirt/Legs) _____
 Foundation contact area/load _____
 Total weight of vessel dry _____
 Total weight of vessel wet _____
 Total weight of vessel flooded _____
 Total number of vessel fittings _____
 Service designation and size _____
 Service designation and size _____
 Service designation and size _____
 Service designation and size _____
 Service designation and size _____
 Service designation and size _____
 Service designation and size _____
 Service designation and size _____
 Total weight of vessel dry _____
 Total weight of vessel wet _____
 Total weight of vessel flooded _____

Dry Vacuum Pump(s): The vacuum pumps shall be dry screw type equal or similar to the Busch Cobra series pumps, designed and suitable for at least 15,000 of continuous service run-time hours, with internal cooling jackets and final stage coolant injection port. The vacuum pump shall be base mounted and coupled to an explosion proof motor of suitable size and rated for VFD operation (inductance duty), complete with Woods coupling or equal with one (1) coupling guard per pump. The motor shall be fitted with an internal heat switch which shall be tied to the PLC to alert the owner's operations staff in the event of a heat-up. The pump and motor shall be Laser aligned by the vendor after installation at the site and before start-up. The motor shall be fitted with an internal high-temperature switch tied to the PLC. The base shall be secured to the VRS foundation to prevent the transmission of vibration back to the carbon beds through the interconnecting piping. At least one bellows-type expansion joint shall be supplied for the inlet side of the pump. The vendor shall provide for thrust blocks or other pipe supports for the discharge piping, each of which shall be designed to prevent vibration. The suction of each pump shall be fitted with a cone strainer with 1/32"/0.8mm screen captured between two RF ANSI flanges and located for ease of R&R. Both vapor and jacket coolant flows shall be monitored by flow indicating transmitters. The flows shall be adjustable. The vapor coolant flow shall be stopped during all periods of pump-off time, and shall be reinitiated during period of pump-on times. This flow shall be

managed by two (2) solenoid valves, each with a discrete open/closed signal from the PLC. Each pump shall be fitted with a RPM monitor tied to the PLC.

Manufacturer _____
 Model number _____
 Motor HP rating _____
 50/60Hz _____
 3 Phase (Yes/No) _____
 Suitable for VFD control (Yes/No) _____
 Capacity @ full speed _____
 Weight _____
 Mounting method _____
 Maximum Torr rating _____
 Hours between overhauls _____
 Jacket coolant flow rate _____
 Vapor coolant flow rate _____
 Vibration detection included (Yes/No) _____
 VFD Model and Size _____ and _____
 Maximum current draw _____
 Design turndown _____
 Minimum turning RPM _____
 Coupling model number _____
 Brand _____
 Model number _____
 Coupling guard included (Yes/No) _____
 Inlet connection size _____
 Outlet connection size _____
 Vapor coolant meter type/size _____ / _____
 Jacket coolant meter type/size _____ / _____

Supply Pump: The supply pump shall be complete with suitable explosion proof motor fitted on a base to the pump via a Woods coupling (or equal). The motor shall be fitted with an internal high-heat switch tied to the PLC. It shall be sized to move the absorbent from the owner's absorbent storage to the VRS site. It shall be shipped lose for installation at close proximity to the client's day tank by others. It shall include, as a minimum:

Manufacturer _____
 Model number _____
 Design capacity at full rpm _____ @ _____
 Mechanical seal (Yes/No) _____
 Motor Type/Class _____
 Motor size and HP rating _____ and _____
 Motor temperature switch included (Yes/No) _____
 Motor VFD rated (Yes/No) _____
 Coupling model number _____
 Coupling guard included (Yes/No) _____
 Base model number _____
 Dimension to suction centerline _____

Return Pump: The return pump shall be complete with suitable explosion proof motor fitted on a base to the pump via a Woods coupling (or equal). The motor shall be fitted with an internal high-heat switch tied to the PLC. It shall be sized to move absorbent form the VRS to the owner's day tank. It shall include, as a minimum:

Manufacturer _____
 Model number _____
 Design capacity at full rpm _____ @ _____
 Mechanical seal (Yes/No) _____
 Motor temperature switch included (Yes/No) _____
 Motor Type/Class _____
 Motor VFD rated (Yes/No) _____
 Coupling model number _____
 Coupling guard included (Yes/No) _____
 Motor size and HP rating _____ and _____
 Base model number _____
 Dimension to suction centerline _____

Vapor Inlet/Outlet Piping: The owner shall provide the vendor with a dimensional isometric drawing of an acceptable and owner approved vapor collection pipe route from the fuels loading facility to the VRS site so the vendor can determine the minimum vapor pipe sizes to prevent overpressure at the owner's loading rack. Additionally, the owner shall provide the vendor with an acceptable and approved dimensional isometric drawing of the supply and return gasoline pipe routing so the vendor can size the supply and return pumps. All piping shall be designed per the ANSI B31.3 and 16.5 for flows well below turbulent flow velocities, and large enough to minimize the flowing pressure drop. The vendor will provide the following based on the owner's drawings.

Vapor Pipe Size(s) _____
 Schedule _____
 Working Pressure _____
 Seamless (Yes/No) _____
 Grade _____

 Supply Gasoline Pipe Size(s) _____
 Schedule _____
 Working Pressure _____
 Seamless (Yes/No) _____
 Grade _____

 Return Gasoline Pipe Size(s) _____
 Schedule _____
 Working Pressure _____
 Seamless (Yes/No) _____
 Grade _____

Vapor Inlet/Outlet Switching Valves: All vapor switching valves shall be high performance, bubble tight, lug-type butterfly valves with replaceable Viton o-ring cushioned Teflon seats, Viton seals, and electric or pneumatic motor operators. The liquid gasoline circulation valves shall also be MOVs, however these two valves MUST

use fail closed operators, without fail or exception. Vendor shall list vapor and gasoline valve specifics below.

Brand _____

Type _____

Model Number, Size, and Torque:

- Vapor valves _____
- Vacuum valves _____
- Gasoline circulation line valves _____

Valves are bubble tight, high performance (Yes/No) _____

Valves are "lug-type" (Yes/No) _____

All valve actuators shall be RCS electrically operated of suitable torque to completely seat and unseat the valve each is joined with in any temperature or ambient condition. Each actuator shall be supplied with one coupling kit for joining it properly with its respective valve. Each actuator shall be supplied with on-off limit switches indicating the open and closed positions with one pair of installed spare switches

Brand offered _____

Type and size of valve actuators (list all)

- _____
- _____
- _____
- _____
- _____
- _____

Maximum torque of each actuator (list for each size valve)

- _____
- _____
- _____
- _____

Operating current _____

Maximum operating amperage _____

- SIL rating _____
- NEMA rating _____

Maximum design pressure drop across each carbon bed loaded with vendor's activated carbon and ready for service _____

Source(s) of Vapors _____

5.0 Loading Profile

The actual products loaded and the actual loading scenario are different in every terminal and often different every hour of every day in the same terminal. Nevertheless, the loading profile is a critical component of VRS sizing. The client provides the terminal loading information below, which may or may not be indicative of the actual conditions. Therefore, it is necessary for the vendor to document the loading profile used in the preparation of the vendor's proposal.

Client's Loading Data is as Flows:

- Listing of all products loaded
 - _____

- _____
- _____
- _____
- _____
- _____
- _____
- o Number of total loading positions _____
- o Listing of loading arms per position _____
- o Number of total product loading pumps _____
- o Capacity of each loading pump _____

Client’s Loading Profile

- o Maximum liters of total product loaded instantaneously _____
- o Maximum liters of gasoline loaded instantaneously _____
- o Maximum total product loaded in all positions in 15 minutes _____
- o Maximum total product loaded in all positions in 60 minutes _____
- o Maximum total product loaded in all positions in 4 HOURS _____
- o Maximum total product loaded in all positions in 24 HOURS _____
- o Maximum total product loaded in all positions in 30 days _____
- o Maximum total product loaded in all positions in 1 year _____

Vendor’s Loading Profile (used to prepare vendor’s proposal)

- o Maximum liters of total product loaded instantaneously _____
- o Maximum liters of gasoline loaded instantaneously _____
- o Maximum total product loaded in all positions in 15 minutes _____
- o Maximum total product loaded in all positions in 60 minutes _____
- o Maximum total product loaded in all positions in 4 HOURS _____
- o Maximum total product loaded in all positions in 24 HOURS _____
- o Maximum total product loaded in all positions in 30 days _____
- o Maximum total product loaded in all positions in 1 year _____
- o Vendor’s Design Maximum Ambient Temperature _____
- o Vendor’s Design Minimum Ambient Temperature _____
- o Vendor’s design VRS operating conditions _____
- o Absorbent Maximum Operating Temperature _____
- o Absorbent Maximum Vapor Pressure _____
- o VRS Design Pressure/Vacuum Levels _____/_____
- o Design Maximum Operating Temperature _____
- o Inlet Maximum HC Concentration - % _____
- o Inlet Minimum HC Concentration - % _____
- o Residual Naphtha/MS in Vent Vapor after Vapor Recovery _____mg/L
- o Guaranteed VOC Reduction from VRS _____mg/L on a 1 hour averaged basis
- o Guaranteed VOC Reduction from VRS _____mg/L on a 6 hour averaged basis

6.0 Instrumentation

All necessary instrumentation, safety interlock & analyzer for measuring inlet and exit Gas concentration for smooth and safe functioning of the system is considered under the vendor’s scope of supply. The instrumentation selected by each vendor is critical to the

operational reliability, efficiency, maintenance, and life of the overall system. Therefore it is necessary for the vendor to use only devices considered to be standards of the industry, suitably rated, tested, and certified. The same holds for the automation system as well.

Instrumentation Requirements: All instruments shall be UL/Cenelec approved for a Class1, Division 2 environment, or equal.

- The inlet vapor flow shall be measured at all times. The flow meter shall be a vortex shedding type with no moving parts and shall be rated for the service it is in. It shall be calibrated to span the flow of vapor for this application from no flow to the maximum flow with a 20% overage so it will measure unusually high instantaneous flows. It shall be rated for Class1, Division 2 service, and shall be locally indicating. It shall be an insert-type, manufactured for ease of removal from the inlet vapor piping without having to shut the vapor flow off for instrument extraction. The instrument shall be shielded from all external “noise”, and shall generate a 4-20ma linear output consistent with the overall flow rate.
- The inlet vapor stream shall be sampled and the sample shall be fed to an inlet vapor hydrocarbon analyzer to determine the inlet hydrocarbon concentration at all times. This analyzer shall be in constant communication with the PLC/HMI. The sample shall be collected from a probe reaching into the center of the pipe being sampled to assure uniformity of sampling.
- The inlet vapor temperature shall be measured at all times. The temperature element used shall be of the RTD type, and shall generate a linear output signal consistent with the temperature being measured.
- The inlet vapor temperature and pressure shall be indicated locally and/or to the PLC at all times.
- The inlet “supply” gasoline flow shall be measured at all times using a FIT communicating with the PLC/HMI.
- The exiting “return” gasoline flow shall be measured at all times using a FIT communicating with the PLC/HMI.
- The inlet “jacket coolant” gasoline flow to each vacuum pump shall be measured at all times using a FIT communicating with the PLC/HMI.
- The inlet “vapor coolant” gasoline flow shall be measured at all times using a FIT communicating with the PLC/HMI.
- The jacket coolant gasoline temperature shall be measured leaving each vacuum pump with a TE which communicates constantly with the PLC//HMI.
- The supply gasoline temperature shall be measured as it enters the VRS upstream of the Absorber Column with a TE which communicates constantly with the PLC//HMI.
- The return gasoline temperature shall be measured as it exits the VRS downstream of the Absorber Column with a TE which communicates constantly with the PLC//HMI.
- The discharge vapor temperature shall be measured constantly as the vapor leaves the final pump stage of each vacuum pump with a TE which communicates constantly with the PLC//HMI.
- The true rotating speed of each vacuum pump shall be measured constantly and shall communicate with the PLC/HMI.
- All motors shall have motor heat switches which shall be monitored by the PLC constantly, and which will shut down any motor that overheats immediately.
- The

the torque requirements of the valves by at least 50%. Each automatic valve shall include:

- Four micro-switches. Two shall indicate the full open and full closed positions of the valve, and two shall be used as installed spares.
- Each automatic valve actuator shall be fitted with a brake for precise stopping of the valve at its open and close positions.
- Each actuator shall be rated for Class 1, Division 2 service, or better.\
- Each automatic valve shall communicate with the PLC/HMI constantly.
- The system shall be also fitted with dedicated solenoid valves suitable for Class 1, Division 2 service, and rated for the appropriate pressure or vacuum consistent with the application of each. Each solenoid valve shall be normally closed.
- The gasoline supply and return lines shall be fitted with two fail closed bubble tight, high performance butterfly valves with RCS Sur49 spring closed electric actuators, or equal.

○ **Vendor Shall List All Instruments to be Supplied Below:**

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

○ **Manual Vapor and Liquid Valve Requirements:** All manual valves shall be bubble tight, high performance full-open ball and fine hand-wheel adjustment globe valves. Each shall be manufactured from either cast steel or stainless steel, and shall be specified or pressure and materials of construction consistent with the service into which each is placed. Only Viton and Teflon elastomers may be supplied.

- Valves smaller than 2" may be NPT threaded.
- Valves 2" and larger shall be ANSI RF flanged consistent with Class 150 as a minimum.

○ **Vendor Shall List All Instruments to be Supplied Below:**

- _____
- _____

- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
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- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

- All instruments shall be UL/Cenelec approved for a Class1, Division 2 environment or equal.

7.0 General Information

7.1 Vapor Composition: The owner shall provide a proper analysis of the vapor composition to be processed by vendor’s vapor recovery system. This analysis shall be in typical chromatographic analysis results format, stating the weight or volume percent of each component to at least the nearest tenth of one percent. All sulfur and olefin compounds shall be included.

- See Product Analysis - Annexure I

7.2 Additional Site Specific General Information: The owner of a refinery/ terminal/loading/unloading gantry/marine loading/jetty operation shall provide the following information.

Type of Transport _____

Type of Filling _____

Rail Wagon Capacity _____

Road Tanker Capacity _____

Barge Capacity _____

Tanker Capacity _____

Max. Number of Points of product loaded at a time

- Rail _____

- Road _____

Duration of Loading (from entry into the loading spot to departure from the loading spot)

Maximum No. of Hours Loading /Day

- Rail Loading (1 Full Rake): _____

- Road Tanker: _____

Distance from Rail Loading Gantry to VRS Site: _____

Distance from ROAD Tanker Loading Site to VRS Site: _____

Distance from most-used Day Tank to VRS Site: _____

8.0 Process Design Drawing Required With Vendor's Proposal

8.1 The vendor shall supply, as a minimum, the following drawing documents with the proposal:

- P&IDS for Legend – Annexure ____
- P&ID for rail gantry – Annexure ____
- P&ID for road gantry – Annexure ____
- P&ID for VRS Interconnection P&ID – Annexure ____
- Overall Plot plan – Annexure ____
- PFD for each item checked above

9.0 General Notes to Vendors

9.1 The System should be able to handle loading rates to a minimum & maximum as mentioned below:

Road Tanker Loading

- Min Hourly Flow Rate m³/hr: ____
- Min Daily Flow m³: ____
- Min 15 Minute Flow m³: ____
- Min one hour Flow m³: ____
- Maximum Meter Flow m³: ____
- Maximum 15 Minute Flow Rate m³: ____
- Maximum Hourly Flow Rate m³: ____
- Maximum 4 Hour Flow Rate m³: ____
- Maximum DAILY Flow Rate m³: ____
- Hours of Operation /Day
- Number of Days Operated/Week

Rail Loading

- Min Hourly Flow Rate m³/hr: ____
- Min Daily Flow m³: ____
- Min 15 Minute Flow m³: ____
- Min one hour Flow m³: ____
- Maximum Meter Flow m³: ____
- Maximum 15 Minute Flow Rate m³: ____
- Maximum Hourly Flow Rate m³: ____
- Maximum 4 Hour Flow Rate m³: ____
- Maximum DAILY Flow Rate m³: ____
- Hours of Operation/Day
- Number of Days Operated/Week

9.2 Vapor collection line from loading gantry shall be installed up to the battery limit of the Vapor Recovery System by the client. Vendor will check the client's piping arrangement and make recommendations for re-routing, re-sizing, drip legs, etc, to

provide for optimal vapor flow to VRS. Vendor to also provide recommendations for fire prevention, flame, deflagration, or detonation protection, safety interlock systems, over pressure protection, vacuum for client's vapor collection system and for Vendor's VRS.

- 9.3 Absorbent product liquid shall be supplied by the Owner at the VRS battery limit in the quantity and pressure specified by the Vendor. The pumps required for absorbent circulation shall be entirely in Vendor's scope of supply.
- 9.4 Recovered product liquid shall be routed to product Day Tank.
- 9.5 Vendor shall determine the need for vapor movers (blowers) in the vapor collection system and shall recommend suitable vapor movers to safely move the hydrocarbon vapors from loading gantries to the VRS. Blowers to be optional depending upon the pressure drop created by line size and number of bends.
- 9.6 Vendor shall supply ONLY Busch Cobra DRY vacuum pumps and shall include all required vacuum pump accessories.
- 9.7 All rotating equipments (Blowers, Pumps, Vacuum Pump, and Compressor) shall be provided with an installed spare in the standby condition.
- 9.8 Vendor to provide variable frequency drives on all motors designed to control the capacity of the vapor recovery system. The regeneration of the VRS shall be optimized based on the mass of hydrocarbon of the inlet stream, and the concentration of hydrocarbons in the outlet stream.
- 9.9 A hard piped by-pass for around the Vapor Recovery System directly to stack shall be offered as an option.
- 9.10 Appropriate PCV, PSV, and depressurization devices for over pressure protection device shall be provided by vendor.
- 9.11 Appropriate device for under pressure protection system like VRV shall be provided by vendor in vapor recovery system.
- 9.12 Vendor to provide Flow, Temperature, and HC concentration measurement and transmitter devices for inlet stream which shall be used by Vendor's software to calculate mass flow and determine frequency and intensity of regeneration.
- 9.13 Vendor to provide HC analyzer to monitor the outlet concentration in the vapor vent outlet of the VRU. Vendor's software to provide for alarm and shutdown conditions based on the output of this instrument, and for immediate regeneration when the appropriate HC level is reached.
- 9.14 All elastomers and mechanical seal shall be suitable for Naptha/MS/Ethanol/BTEX services.
- 9.15 Vendor to provide suitable control and safety interlock for safe and smooth operation of the system. All instrument signals from package shall be routed to Vendor's HMI which shall be located in the Marketing Control Room after start-up.

- 9.16 Vendor to annunciate and report all safety interlocks with respect to the VRS and PLC logic on the Vendor's HMI.
- 9.17 The vendor is required to provide four (4) hard copies and one software copy of the Operating and Maintenance manual for the VRS. Also the vendor is required to provide ten (10) copies of a Monitoring manual for the HMI. This manual shall instruct the Owner's operations staff in the full capabilities and use of the HMI.
- 9.18 The vendor is required to demonstrate operating the VRS during start-up when loading operation is being carried out.
- 9.19 The vendor is also responsible to commission the VRS and fine tune all controls such that it operates smoothly. Vendor is to rectify any defect or replace the defective equipment as required if the need arises within 24 months from the date of commissioning at no cost to the Owner.
- 9.20 The vendor is to conduct the performance test for the vapor recovery system and prove the recovery as stipulated in the process data during the start-up process. The VRS shall be designed to continuously indicate the true instantaneous emissions on the HMI based on the inlet mass flow. The vendor shall specify the procedure of the performance test and submit it to the owner for approval 60 days prior to the planned performance test.

10.0 Codes and Standards

10.1 The design, fabrication, supply and testing shall conform to codes and standards listed below and all other Codes and Standards specified elsewhere in Enquiry document. Vendor may also base his design on other international standards subject to approval of owner. Only latest editions as on the date of issue of enquiry shall always be referred to. The following codes, standards, and recommended practice shall govern.

- Pressure Vessels : ASME Sec. VIII Div. I, ASME Sec. IX
- Shell & Tube Heat Exchanger : TEMA, ASME Sec., VIII Div. I
- Air Cooled Exchanger : ASME Sec. VIII Div. I, API 661
- Piping : ASME B 31.3
- Centrifugal Pumps : ANSI ASME B 73.1
- Other international standards may also be acceptable subject to their being equivalent or superior with prior approval of purchaser.
- For provisions not covered by the above codes and standards, applicable industry standards and good engineering practices and norms shall govern.

11.0 Special Requirements

- 11.1 Vendor shall supply their overall plot plan area with the bid.
- 11.2 Vendor shall declare in his offer that blowers upstream are required or not. If blowers are required, vendor shall furnish calculations for blowers upstream of VRU.

- 11.3 Vendor shall furnish blower data sheet, performance curves and drawings of pumps. Duly filled –in data sheet in manufacturer’s standard format for the blower along with offer.
- 11.4 The Blowers shall be sourced from the regular & well proven supplier of the vendor. The vendor shall submit general reference list of the proposed blower models along with their past track records in VRS. The experience record shall contain the similar type blower had been used in which project for the same service fluid, year of supply, client name, type of Vapor recovery system, etc.
- 11.5 Vendor shall furnish proven Past Track Record (PTR) for the activated carbon bed Vapor Recovery System. PTR shall include client name, project name, year of commissioning, guaranteed emission level, etc.

12.0 Inspection & Testing

- 12.1 All equipment shall be shop tested as per the applicable codes and standards. Vendor shall submit his QAP for review by client after order.
- 12.2 The owner or its representative may at the owner’s option, witness any or all the tests. However, such inspections shall be regarded as check-up and in no way absolve the Vendor of his responsibility, nor delay the project.

13.0 PERFORMANCE GUARANTEE

- 13.1 All equipment and components shall be guaranteed by the Vendor against any defective material, design, and/or workmanship for the period specified in the commercial document.
- 13.2 After installation and commissioning at site, the system shall be tested for overall performance as per procedures mutually agreed upon. Vendor shall, at his own cost, arrange all instruments and controls required for testing at site.
- 13.3 Vendor shall demonstrate the following parameters at site during performance test:
- 13.4 Emission level meets the bid requirements
- 13.5 Document the recovered volumes per unit volume loaded

14.0 Spare Parts

- 14.1 Vendor shall submit recommended list of spare parts with itemized prices for first two years' of operation of the equipment with bid. Proper coding and referencing of spare parts shall be done so that later identification with appropriate equipment will be facilitated. Total cost of spares shall be included in lump-sum price of the system.
- 14.2 Vendor shall also submit a list of commissioning spares with quantity. Total cost of commissioning spares shall be included in lump-sum price of the system.
- 14.3 Vendor shall also guarantee that commissioning spares, if required over and above the commissioning spares included in the order shall be made available without any cost and time implication to the owner. If, for any reason during commissioning, Vendor needs to utilize spares from list of 2 years normal operational spares, he will replenish the same free of cost duly delivered at site including all freights, insurance, taxes, and duties.
- 14.4 Mandatory spares shall be supplied per Instrumentation specifications and their price to be included in the lump sum price of the system.

15.0 Special Tools And Tackles

- 15.1 The Vendor shall provide a set of new, unused special tools and tackles required for operation and maintenance of the Vapor Recovery system. Price above shall also be included in the basic cost of the package.

16.0 Shop And Field Painting

- 16.1 Surface preparation shall be to NACE SP10 specifications with protection and painting based on "Normal corrosive" environment.

17.0 Conflict

- 17.1 In case of conflict in the MR documents, the following order of precedence shall prevail:
- Process specification
 - P&ID
 - Job specifications
 - Codes and Standards
 - Vendor's engineering standards.

18.0 Exclusions

- 18.1 Civil work.
18.2 All work outside the battery limit.
18.3 Supply of utilities.

19.0 Software

- 19.1 Vendor shall develop VRS operating software to 1) optimize the VRS operation to reduce energy consumption while maintaining the emissions at or below the target level, and 2) regenerate only on an as-needed basis using the absorbed mass of hydrocarbons as the primary regeneration trigger, and emission level as the over-riding trigger.
- 19.2 Vendor's operating software shall automatically control the amount of purge air fed to each carbon bed using a dedicated valve and flow control device. Purge air shall be allowed to enter each carbon vessel at the conclusion of each regeneration cycle. The PLC logic shall determine the amount of purge air entering in each cycle based on the mass of hydrocarbons loaded onto the carbon in the previous bed loading cycle so that the operators need not make any manual adjustments for the life of the system.
- 19.3 Vendors operating software and controls system shall automatically control the re-pressure air system with a dedicated flow control valve and flow control device such that the operators need not make any manual adjustments for the life of the system.
- 19.4 In order to prove the energy efficiency of the vendors VRS, vendors operating software shall calculate the mass of hydrocarbons adsorbed, compare it with the adsorption capacity of the carbon supplied, and trigger regeneration only when

- the adsorbed mass reaches a preset fraction based on the maximum possible adsorbed hydrocarbons.
- 19.5 Vendor's operating software shall make a permanent record of the actual volume of VRS recovered gasoline and store this data in units of recovered liters daily, weekly, monthly, annually, and since start-up.
 - 19.6 Vendor's operating software and controls system shall be designed to monitor the travel and position of each vapor flow and liquid flow valve in the VRS and to alarm or shutdown in the event of any malfunction. Vendor shall identify for the owner which malfunctions are alarms and which are shutdowns. Vendors HMI shall annunciate each according this schedule.
 - 19.7 Vendor's operating software and controls systems shall be developed to monitor, control, and optimize the absorber pressure during each individual regeneration cycle by varying the absorber pressure to optimize the adsorption efficiency and minimize the hydrocarbon loading on the in-service adsorbing carbon.
 - 19.8 Vendor's operating software shall be written to allow for 1) logical progressive normal shutdowns, 2) immediate emergency shutdowns (ESDs), 3) automatic start-up or re-start after all alarms/shutdowns are reset. Each shall be recorded on discrete HMI logs which shall stay active in real time for at least 33 days.
 - 19.9 Vendor's software shall be designed to operate the supply and return pumps in both the automatic and manual modes operating via HOA switches. The position of these switches shall be annunciated on Vendor's HMI graphics.
 - 19.10 Vendor's operating software shall monitor all temperature transmitters continuously, and shall alarm and/or shutdown the VRS upon published alarm and shutdown temperature values. These values shall be annunciated on Vendor's HMI graphics.
 - 19.11 Vendor's software shall monitor all motors and pumps for proper and safe operating conditions. Each shall be annunciated on Vendor's HMI graphics.
 - 19.12 Vendor's operating software shall monitor the HOA status of each motor. Each shall be annunciated on Vendor's HMI graphics.
 - 19.13 Vendor's operating software and controls system shall measure and monitor the supply and return liquid flow rates and temperatures, and the vapor inlet flow rate and temperature at all times. All such values shall be annunciated on Vendor's HMI graphics.
 - 19.14 Vendor's operating software package shall be fully functional with or without the HMI system in operation.
 - 19.15 Vendor's HMI software and graphics package shall provide for an overview (Main) screen that continuously reports all real-time flows, temperatures, pressures/vacuum levels, pumping speeds, loading status lane-by-lane, liquid levels, emissions, loading rates, and recovered product volumes at all times. All such values shall be annunciated on Vendor's HMI graphics.
 - 19.16 Vendor's HMI software and graphics package shall include dedicated HMI separate trend line and separate data screens for real time and historical alarms, historical and real time shutdowns, historical and real time emissions, real time emissions levels, real time vacuum pump operating parameters including RPM, coolant flow and temperatures to jacket and vapor, and vapor discharge temperature.
 - 19.17 Original site specific adjustable set-up information so the site personnel with proper security clearance can make operating parameter adjustments to fine tune the system over time.
 - 19.18 A layered security-enabled log-in status record graphic panel.

- 19.19 Vendor's HMI and PLC shall be configured with a 24/7 high-speed DSL link to the internet for secured and continuous off-site monitoring.
- 19.20 Owner shall provide a continuous DSL connection suitable for remote monitoring 24/7.
- 19.21 Vendor's shall include off-site monitoring of the in-service system for a minimum of 24 months after start-up at no additional cost to the owner, and shall include an option to renew the monitoring service thereafter.

20.0 Owner's Scope Of Supply

- 20.1 Owner shall be responsible for the supply of the following items and services.
- 20.2 Soil loading study of the job site plot area.
- 20.3 Reinforced concrete foundation, including all calculations.
- 20.4 Concrete foundation for Supply Pumps.
- 20.5 Concrete foundation for the Control Cabin in a VRS nearby and unclassified area.
- 20.6 Vapor inlet pipeline connected to the DRYVac™ VRS.
- 20.7 Steel Gasoline Supply and Return pipelines to the DRYVAC™ VRS from terminal day tank storage.
- 20.8 Grounding points or grid for connection to the DRYVac™ VRS.
- 20.9 Conduit and wiring between DRYVac™ VRS pumps, vacuum pump motors, junction boxes and Control Cabin.
- 20.10 Power supply and all liaison cables to the gasoline Supply Pumps.
- 20.11 Power supply and all terminal electrical inputs to the DRYVac™ VRS Controls Cabin.
- 20.12 Modifications as required in the existing Terminal Control Room for the installation of the DRYVac™ VRS PC/HMI Monitoring System.
- 20.13 Supply and connection of communication cable between the Controls Cabin and the Terminal Control Room.
- 20.14 Conduits for cables from the loading racks for lane-by-lane loading signals back to the VRS.
- 20.15 Supply and connection of all communication cables between the VRS Cabinets and the PC visualization system installed in the Terminal Main Control Room.
- 20.16 Dedicated network connection with access for high-speed remote monitoring.
- 20.17 Firefighting equipment in the area of the VRS.
- 20.18 Supply pump installation and communication conduit and suitable electrical service and wiring to the Controls Cabin.
- 20.19 Knockout Tank and Sump pump installation with start-stop communication conduit and wiring to the Controls Cabin.
- 20.20 Gasoline absorbent circulation pipelines with all fittings, valves instruments, and controls between normally used Terminal Day Tank and the VRS site.
- 20.21 Adequate overall electrical service to operate this DRYVac™ VRS (please specify available voltage, number of phases, hertz and amperage).
- 20.22 Basic design and installation of vapor collection piping from the source to the VRS.
 - o Note: Vendor to advise on safety (flame, deflagration, and/or detonation arrestors, drip legs and low point condensate collection sumps, end of line liquid knockout/collection drum, vapor movers if/as necessary, etc.) and review Owner's design for pressure drop considerations at no cost to Owner.
- 20.23 Installation workforce and equipment for installation of above.

20.24 All fees, taxes, duties, local fees and other costs.

21.0 Warranty

21.1 Vendor shall warrant the system to be free of defects and workmanship for a period not less than 24 months from delivery or 18 months after start-up, whichever shall occur first.

21.2 Vendor shall warrant all components of the system for the full period of the warranty period stated above, and shall replace and component found to be defective during that period at no cost to the Owner.

21.3 Vendor shall warrant the performance of the VRS during the period stated above so long as it is used for the purpose intended. In the event the unit does not meet the performance guaranteed emissions level of ____ mg/L on a six hour averaged basis, Vendor take whatever actions are necessary at Vendor's expense to correct the situation, and if unable to do so, the following penalties shall prevail:

- Up to 5 mg/L overage = 2% of purchase price
- 6 mg/l up to 10 mg/L overage = 5% of purchase price
- 11 mg/L to 15 mg/L overage = 10% of purchase price
- >15 mg/L overage = 25% of purchase price

ANNEXURE – I

VAPOR PROPERTIES	PRODUCT
SPECIFIC GRAVITY	
SULPHUR, ppmw	
OLEFINS vol%	
PARAFFINS vol%	
AROMATICS	
RVP, kPa	

VAPOR PROPERTIES	PRODUCT
SPECIFIC GRAVITY	
SULPHUR, ppmw	
OLEFINS vol%	
PARAFFINS vol%	
AROMATICS	
RVP, kPa	

VAPOR PROPERTIES	PRODUCT
SPECIFIC GRAVITY	
SULPHUR, ppmw	
OLEFINS vol%	
PARAFFINS vol%	
AROMATICS	
RVP, kPa	

ANNEXURE – II

