

**CORROSION EVALUATION**

**LVP-HX-00001  
Catalytic Oxidizer Heat Recovery Exchanger**

**Contents of this document are Dangerous Waste Permit affecting**

**Results**

**Materials Considered:**

Materials Considered (UNS No.)	Acceptable Materials
Type 304L (S30403)	
Type 316L (S31603)	
Type 347 (S34700)	X
AL-6XN® 6% Mo alloy (N08367)	
Hastelloy® C-22® (N06022)	

**Recommended Material Types:**

Structural support: Type 347 stainless steel  
 Hot side plates: Type 347 stainless steel  
 Cold-side components and enclosure: Type 347 stainless steel

**Minimum Corrosion Allowance: 0.010 inch (structural steel in contact with offgas)  
 No corrosion allowance required for heat transfer surface**

**Inputs and References**

- Operating temperature, cold-side (°F) (norm/max): 169/189 (in); 370/412 (out) (24590-LAW-M4E-LOP-00009)
- Operating temperature, hot-side (°F) (norm/max): 624/680 (out); 724/792 (in) (24590-LAW-M4E-LOP-00009)
- Corrosion allowance (in contact with offgas, excluding heat transfer surfaces): 0.010 inch (24590-WTP-SRD-ESH-01-001-02)
- Corrosion allowance (heat transfer surfaces): 0.00 inch (24590-WTP-GPG-M-047)
- Location: room L-0304F; out cell (24590-LAW-P1-P01T-00005)
- Operating conditions are as stated in the applicable section of *WTP Process Corrosion Data - Volume 4* (24590-WTP-RPT-PR-04-0001-04)

**Assumptions and Supporting Justification (refer to Section 19—References)**

- Operating conditions presented on the Process Corrosion Datasheet (PCDS) are conservative with respect to corrosion.<sup>7</sup>

**Operating Restrictions**

- Develop a procedure for decontamination.
- Develop procedure to control lay-up and storage (mitigation of condensation in accordance with *Manual - Operation, Maintenance And Installation Instructions For LAW Thermal Catalytic Oxidizer / Reducer (TCO) And Ammonia Dilution Skid*, 24590-CD-POC-MBT0-00007-05-00004); including both before plant is operational and during inactive periods during plant operation.
- Procedures are to be reviewed and accepted by MET prior to use.

Concurrence J. Davis  
Operations

3	06/25/15	To expand material selection information and references to address ORP and Ecology comments.	DLAdler	APRangus	RBDavis	TERwin
2	12/16/14	Complete re-write; no rev bars shown New format Incorporate revised PCDS Revise Ops Restrictions Update references Add AEA notice	DLAdler	JRDivine Tom Esquivel	RBDavis	TERwin
1	7/18/12	Incorporate revised PCDS Update design temp/pressure Include AEA notice Minor format and editorial changes	DLAdler	RBDavis	NA	DJWilsey
0	3/19/08	Initial Issue	DLAdler	JRDivine	RBDavis	SWVail
<b>REV</b>	<b>DATE</b>	<b>REASON FOR REVISION</b>	<b>ORIGINATE</b>	<b>CHECK</b>	<b>REVIEW</b>	<b>APPROVE</b>

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This bound document contains a total of 15 sheets.

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### Corrosion/Erosion Detailed Discussion

The heat recovery exchanger raises the offgas temperature from LVP-ADBR-00001A/B, using the hot offgas from the catalyst beds (LVP-SCR-00001).

#### 1 General/Uniform Corrosion Analysis

##### a Background

General corrosion or uniform corrosion is corrosion that is distributed more-or-less uniformly over the surface of a material without appreciable localization. This leads to relatively uniform thinning on sheet and plate materials and general thinning on one side or the other (or both) for pipe and tubing. It is recognized by a roughening of the surface and usually by the presence of corrosion products. The mechanism of the attack typically is an electrochemical process that takes place at the surface of the material. Differences in composition or orientation between small areas on the metal surface create micro-anodes and cathodes that facilitate the corrosion process.

##### b Component-Specific Discussion

Offgas corrosion, like atmospheric corrosion, depends on the development of corrosion cells or electrochemical cells consisting of the base metal, corrosion products, deposition products, anode, cathode, electrolyte, and current path. Stainless steels also have the added influence of the protective passive film. Because the corrosion process is electrochemical, an electrolyte must be present on the surface for corrosion to occur. In the absence of moisture, corrosion will not take place. As an example, where temperatures are less than freezing, corrosion is minor because the ice is not a good conductor; or when the relative humidity is low, the water condensation is negligible and corrosion is negligible. Offgas corrosion is also influenced by the deposition of particulates, dust, and thin monolayers of gas constituents. The physically adsorbed molecules on the surface (HCl, HNO<sub>3</sub>, and H<sub>2</sub>SO<sub>4</sub>) will form an acid droplet from the deliquescence of water molecules. Moisture is needed to activate the corrosion process, typically a relative humidity of 60% to 80% is necessary to support corrosion; below this range corrosion does not occur. The relative humidity range for corrosion is discussed in Coburn (1978), Dean and Lee (1986), Dean and Rhea (1980), Schweitzer (1988), and in the *ASM Metals Handbook, Volume 13*. Normal operating conditions for the components of the thermal catalytic oxidizer (TCO) skid are dry, and relative humidity is very low (0.04% relative humidity, as shown in the PCDS). The anticipated dry-air conditions are not conducive to general corrosion and none is expected. Further, operating restrictions are in place to ensure that dry-air conditions are maintained.

The stabilized austenitic Type 347 stainless steel is considered suitable for the offgas conditions. The Type 347 austenitic stainless steel is an enhancement over that of a Type 300 stainless steel. The corrosion rates are a product of the alloy chemistry, and the only difference between Type 347 and Type 304L is the increase in carbon content that improves the high temperature properties. The carbon increase is offset with niobium and tantalum alloyed to decrease the tendency for carbide precipitation during fabrication and welding. Type 347 alloy has improved oxidation resistance and high temperature properties and is a good choice for the TCO components. Type 347 was selected for the following reasons: improved thermal properties, readily available in most product forms, standard stainless steel fabrication practice (tools and processes), and lower cost per pound than the higher nickel or duplex alloys (*High-Temperature Characteristics of Stainless Steels*, NIDI Publication No. 9004).

The recuperative heat exchanger is operated at elevated temperatures; oxidation is considered as part of this corrosion evaluation. The recommended alloy for the elevated temperature sections is Type 347 stainless steel. The higher carbon content and the addition of niobium to prevent sensitization act to improve the oxidation resistance.

The skid base frame is not considered as a material in contact with the offgas. If structural materials are not welded to the pressure boundary of the heat exchanger, they are outside the scope of this corrosion evaluation.

#### 2 Pitting Corrosion Analysis

Pitting is localized corrosion of a metal surface that is confined to a point or small area and that takes the form of cavities. Pitting corrosion will only be a concern if sufficient moisture is present. The heat exchanger normally operates at temperatures above the dew point of the dry offgas, and therefore sufficient moisture is not present to act as an electrolyte for corrosion processes to proceed. It is assumed that there will be no condensation in the unit.

Justification for this position is that corrosion will not proceed without an electrolyte present.

#### 3 Crevice Corrosion Analysis

Crevice corrosion is a form of localized corrosion of a metal or alloy surface at, or immediately adjacent to, an area that is shielded from full exposure to the environment because of close proximity of the metal or alloy to the surface of another material or an adjacent surface of the same metal or alloy. Crevice corrosion is similar to pitting in mechanism. Crevice corrosion will only be a concern if sufficient moisture is present. The offgas humidity is controlled so that there will be no condensation.

Justification for this position begins with the understanding that this is an air handling unit operating at elevated temperatures, above the dew point. Corrosion will not take place or initiate when no electrolyte is present.

#### 4 Stress Corrosion Cracking Analysis

Stress corrosion cracking (SCC) is the cracking of a material produced by the combined action of corrosion and sustained tensile stress (residual or applied). In addition, sensitization of the grain boundaries is prevented with the materials recommended. Either an "L" grade, low carbon, stainless steel or a niobium-stabilized stainless steel is specified to negate sensitization from becoming a

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corrosion issue. It is assumed that there will be no condensation in the unit; therefore, the recuperative heat exchanger will not undergo stress corrosion cracking because insufficient moisture will be present.

This position is justified because of the temperature of the gas during operation will be greater than the dew point. Corrosion will not take place or initiate when no electrolyte is present.

### 5 End Grain Corrosion Analysis

End grain corrosion is preferential aqueous corrosion that occurs along the worked direction of wrought stainless steels exposed to highly oxidizing acid conditions. End grain corrosion typically is not a major concern, it propagates along the rolling direction of the plate, not necessarily through the cross sectional thickness. In addition, end grain corrosion is exclusive to metallic product forms with exposed end grains from shearing or mechanical cutting. The heat exchanger design uses cooling channels and does not expose the pressure boundary cut ends to offgas. Also, end grain corrosion will not take place in the component because of the absence of sufficient moisture.

End grain corrosion is not expected to occur in the recuperative heat exchanger because the temperature of the gas will be greater than the dew point of the gas therefore corrosion will not occur in the absence of an electrolyte.

### 6 Weld Corrosion Analysis

The welds used in the fabrication will follow the WTP specifications and standards for quality workmanship. The materials selected for this fabrication are compatible with the weld filler metals and ASME/AWS practice. Using the welding practices specified for the project there should not be gross micro-segregation, precipitation of secondary phases, formation of unmixed zones, or volatilization of the alloying elements that could lead to localized corrosion of the weld.

This position is justified because the operating temperature and dry air conditions will not corrode because of the lack of the electrolyte for corrosion.

### 7 Microbiologically Influenced Corrosion Analysis

Microbiologically influenced corrosion (MIC) refers to corrosion affected by the presence or activity, or both, of microorganisms.

Typically, with the exception of cooling water systems and stagnant water, MIC is not observed in operating systems.

The recuperative heat exchanger will operate at elevated temperatures and the offgas is dry. In this system, the stated operating conditions are not suitable for microbial growth.

### 8 Fatigue/Corrosion Fatigue Analysis

Corrosion-fatigue is the result of the combined action of cyclic stresses and a corrosive environment. The fatigue process is thought to cause rupture of the protective passive film, upon which stainless steel can actively corrode in the localized area of the film rupture. The corrosive environment may also act to reduce the stress necessary for film rupture. The result is that a metal exposed to a corrosive environment and cyclic mechanical load may initiate cracking at conditions at stress levels less than the endurance limit for the material.

The recuperative heat exchanger is not cyclically operated; offgas flow is constant, steady and dry. Thermal cycles and therefore thermal stress is also low and associated with the start-up and shut down of the offgas system. Corrosion fatigue will not be observed in the recuperative heat exchanger (24590-LAW-MVC-LVP-00004, LVP-SKID-00002, LAW Thermal Catalytic Oxidizer / Reducer, Stress Analysis with ANSYS).

The conclusion that corrosion fatigue will not be a problem is based on the low mechanical and thermal cycling, as well as the lack of an electrolyte for corrosion.

### 9 Vapor Phase Corrosion Analysis

Vapor phase corrosion considers the gas and vapor constituents that form acidic condensate and the alloy corrosion resistance. The aggressive constituents are HCl, HF, and HNO<sub>3</sub>; however these are present in low concentrations in the gas. The formation of acidic condensate requires moisture condensing on the surface and mixing with the adsorbed surface constituents to produce an aggressive environment. Condensation on the surface is not likely during normal operation.

Vapor phase corrosion will not occur in the recuperative heat exchanger conditions because the operation conditions for this component preclude the presence of sufficient moisture and concentrations of acid gas forming components.

### 10 Erosion Analysis

Erosion is the progressive loss of material from a surface resulting from mechanical interaction between a particle and that surface. Solid particle erosion can occur in air, steam, and water fluid systems. The WTP waste is a slurry consisting of water, waste oxide particles, and / or precipitated salts. When the fluid propels the solid particles at a sufficient velocity and the particle mass is sufficient, the surface can be damaged by the combined effect of millions of individual erosion "scars". Prior to reaching the recuperative heat exchanger the offgas passes through a high efficiency particulate filter (HEPA) and therefore should be free of particulates.

The solids content and gas velocity are sufficiently low that erosion is not a concern.

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### 11 Galling of Moving Surfaces Analysis

Galling is a form of wear caused by a combination of friction and adhesion between moving surfaces. Under high compressive forces and movement, the friction temperatures cold-weld the two surfaces together at the surface asperities. As the adhesively bonded surface moves some of the bonded material breaks away. Microscopic examination of the galled surface shows some material stuck or even friction welded to the adjacent surface, while the softer of the two surfaces appears gouged with balled-up or torn lumps of material stuck to its surface.

Galling is most commonly found in metal surfaces that are in sliding contact with each other. It is especially common where there is inadequate lubrication between the surfaces. Softer metals will generally be more prone to galling; austenitic stainless steel is relatively soft and ductile and is known to gall easily. Martensitic stainless steel or precipitation hardened stainless steel or nitrogen strengthened austenitic stainless steels have higher surface hardness and therefore are resistant to galling.

The recuperative heat exchanger does not have any moving surfaces.

### 12 Fretting/Wear Analysis

Fretting corrosion refers to corrosion damage caused by a slight oscillatory slip between two surfaces. Similar to galling but a much smaller movement, the corrosion products and metal debris break off and act as an abrasive between the surfaces, classic 3-body wear problem. This damage is induced under load and repeated relative surface motion, as induced for example by vibration. Pits or grooves and oxide debris characterize this damage, typically found in machinery, bolted assemblies and ball or roller bearings. Contact surfaces exposed to vibration during transportation are exposed to the risk of fretting corrosion.

The recuperative heat exchanger does not have moving parts and design precludes the use of tube support plates that would normally become a fretting corrosion problem in tube-and-shell heat exchangers. Fretting corrosion is not expected in this component.

### 13 Galvanic Corrosion Analysis

Galvanic corrosion is an electrochemical process in which one metal corrodes preferentially to another when both metals are in electrical contact, in the presence of an electrolyte. Dissimilar metals and alloys have different electrode potentials, and when two are in contact in an electrolyte, one metal acts as anode and the other as cathode. The electropotential difference between the dissimilar metals is the driving force for an accelerated attack. The potential difference for more than 200 mV is needed for sufficient driving force to make a difference. Galvanic compatibility is one of the attributes used to select the WTP alloys. Austenitic stainless steels in contact with other austenitic stainless steels do not have sufficient electropotential difference to significantly influence the metal loss.

The recuperative heat exchanger plates, frame, and support materials are all fabricated from Type 347 stainless steel. In addition, the gas is dry and contains insufficient moisture to act as an electrolyte. Galvanic corrosion is not expected to be a corrosion issue under these conditions.

### 14 Cavitation Analysis

Cavitation corrosion is defined as another synergistic process, the combined influence of mechanical disruption of the metal surface and the corrosion of the active metal. Cavitation occurs when the local fluid pressure drops below the vapor pressure of the fluid resulting in a liquid vapor interface or bubbles to form. Their collapse on the metal surface has sufficient energy to rupture the oxide film and depending on alloy, may be capable of removing metal. The fluid chemistry and alloy define corrosion characteristics of the oxide film; where localization of the cavitation produces a condition where the bubble collapse rate is greater than the ability to passivate, the normally passive alloy can experience accelerated loss. This is most likely to occur in pumps, valves (flow control), orifices, ejectors/eductors, and nozzles.

Cavitation is not expected in an offgas system

### 15 Creep Analysis

Creep is defined as a time-dependent deformation at elevated temperature and constant stress, creep is a thermally activated process. The temperature at which creep begins depends on the alloy composition. Creep failures and stress rupture failures follow the same mechanism and are influenced by similar variables like temperature. Stress rupture is defined as bi-axial creep restricted to pipe like geometries. Creep is found in components subjected to heat for long periods and the creep rate generally increases as the temperature nears the melting point. The creep temperature is different for each alloy, the Nickel Development Institute has cataloged the creep properties of Type 304, Type 316, and Type 347 austenitic stainless steels (*High-Temperature Characteristics of Stainless Steels*). The material creep properties at 1000 °F indicate a difference of several hundred degrees over the maximum recuperative heat exchanger at 792 °F.

The maximum operating temperature for the recuperative heat exchanger is less than the creep temperature, creep will not occur.

### 16 Inadvertent Addition of Nitric Acid

Addition of nitric acid to the offgas is not a plausible scenario.

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### 17 Conclusion and Justification

The conclusion of this evaluation is that LVP-HX-00001 can be fabricated from Type 347 stainless steel and that Type 347 stainless steel is capable of providing 40 years of service. Providing the reported dry-air conditions are maintained, Type 347 stainless steel is expected to be resistant to uniform and localized corrosion. The probable uniform corrosion is negligible; a minimum allowance of 0.010 inch for surfaces in contact with the offgas (except heat transfer surfaces) is recommended for conservatism. No corrosion allowance is recommended for the heat transfer surfaces. Conditions in the heat exchanger do not promote erosion so no erosion allowance is necessary.

### 18 Margin

Per 24590-WTP-SRD-ESH-01-001-02, Appendix H "When erosion and corrosion effects can be shown to be negligible or entirely absent, a design corrosion allowance need not be specified." In the reported dry-air conditions, there is no electrolyte. If there is no electrolyte, there can be no corrosion. The system is designed with a uniform corrosion allowance of 0.010 inch based on the range of inputs, system knowledge, and engineering judgment/experience. The service conditions used for materials selection have been described above and result in negligible uniform loss. The specified minimum corrosion allowance exceeds the minimum required corrosion allowance which provides margin. The uniform corrosion design margin for the operating conditions is sufficient to expect a 40 year operating life and is justified in the referenced calculation.

Localized erosion of this component is not expected. Prior to reaching the recuperative heat exchanger, the offgas passes through a high efficiency particulate filter (HEPA) and, therefore, should be free of particulates. The solids content and gas velocity are sufficiently low that localized erosion is not a concern. Since localized erosion effects are not present, additional localized corrosion protection is not required.

This component contains no fluids or electrolyte to promote localized corrosion. As shown in the PCDS summary table (page 8, below), the unit operates at high temperatures and low humidity (0.04% at the outlet) and is described in the PCDS. While not quantifiable, the largest contributor to the total localized corrosion design margin is the absence of sufficient moisture to form a corrosive electrolyte. During inactive periods of plant operations and prior to initial plant startup, layup and storage procedures will monitor and control condensation.

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### 19 References

1. 24590-CD-POC-MBT0-00007-05-00004, *Manual - Operation, Maintenance and Installation Instructions For LAW Thermal Catalytic Oxidizer / Reducer (TCO) And Ammonia Dilution Skid.*
2. 24590-LAW-3YD-LOP-00001, *System Description For The Law Primary Offgas (LOP) And Secondary Offgas/Vessel Vent (LVP) Systems.*
3. 24590-LAW-M4C-LOP-00001, *LAW Melter Offgas System Design Basis Flowsheets with ECCN 24590-LAW-M4E-LOP-00009.*
4. 24590-LAW-MVC-LVP-00004, *LVP-SKID-00002, LAW Thermal Catalytic Oxidizer / Reducer, Stress Analysis with ANSYS.*
5. 24590-LAW-P1-P01T-00005, *LAW Vitrification Building General Arrangement Plan at El. 48 Feet - 0 Inches.*
6. 24590-WTP-GPG-M-047, *Preparation of Corrosion Evaluations.*
7. 24590-WTP-RPT-PR-04-0001-04, *WTP Process Corrosion Data-Volume 4.*
8. 24590-WTP-SRD-ESH-01-001-02, *Safety Requirements Document Volume II.*
9. ASM Metals Handbook, Volume 13, *Corrosion.* 1987. ASM International, Materials Park, OH.
10. Coburn SK. 1978. *Atmospheric Factors Affecting the Corrosion of Engineering Metals - STP 646.* ASTM International, West Conshohocken, PA.
11. Dean SW and Lee TS. 1986. *Degradation of Metals in the Atmosphere - STP 965.* ASTM International, West Conshohocken, PA.
12. Dean SW and Rhea EC. 1980. *Atmospheric Corrosion of Metals - STP 767.* ASTM International, West Conshohocken, PA.
13. NIDI. *High-Temperature Characteristics of Stainless Steels,* Publication No. 9004, Nickel Development Institute. Toronto, Ontario, Canada.
14. Schweitzer PA. 1989. *Corrosion and Corrosion Protection Handbook.* Marcel Dekker, Inc., New York, NY.

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### Additional Reading

- 24590-LAW-MKD-LVP-00012, *Mechanical Data Sheet for 24590-LAW-MX-LVP-SKID-00002 24590-LAW-MX-LVP-00003 - LAW Catalytic Oxidizer / Reducer.*

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## PROCESS CORROSION DATA SHEET (extract)

Component(s) (Name/ID #) Catalytic Oxidizer Heat Recovery Exchanger (LVP-HX-00001)Facility LAWIn Black Cell? NO

		Stream ID LVP14
Chemicals	Unit	Gaseous
CO2	ppmV	22330
HCl	ppmV	7
HF	ppmV	4
NH3	ppmV	237
NO	ppmV	35
NO2	ppmV	0
SO2	ppmV	7
SO3(s)	mg/m <sup>3</sup>	2
RH	%	0.04
Suspended Solids	wt%	0
Temperature	°F	792

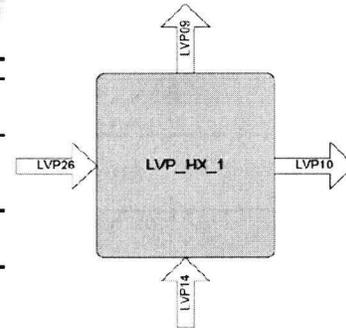
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Figure C- 25 LVP-HX-00001 Gaseous PCDS

Vessel : LVP\_HX\_1

Properties	Stream ID			
	LVP26	LVP14	LVP09	LVP10
Suspended Solids [wt %]	0	0	0	0
Total Salts [wt %]	0.00	0.00	0.00	0.00
Sodium Molarity [M]	n/a	n/a	n/a	n/a
Relative Humidity [%]	13.02	0.04	1.25	0.06
pH	n/a	n/a	n/a	n/a
Anti-Foam Agent [ppm]	0	0	0	0
TOC [kg/h]	2.70E-03	1.35E-04	1.35E-04	2.70E-03
Pressure [bar]	0.92	0.90	0.90	0.92
Temperature [C]	87.22	422.22	211.11	360.00
Temperature [F]	189.00	792.00	412.00	680.00
Water Flow Rate [kg/hr]	303.79	319.15	319.15	303.79
Total Aqueous Flow Rate [kg/hr]	303.79	319.15	319.15	303.79
Total Flow Rate [kg/hr]	5.19E+03	6.20E+03	6.20E+03	5.19E+03
User Note	VIT VAPOR Activated Carbon Adsorber Discharge	VIT VAPOR Primary NOx SCR Discharge	VIT VAPOR Caustic Scrubber Inlet	VIT VAPOR Energy Recovery Heat Exchanger Cold Offgas Discharge
<b>GASEOUS [ppmV or mg/m<sup>3</sup>]</b>				
Ar	8206	8401	8401	8206
CH3I	0	0	0	0
Cl2	0	0	0	0
CO	431	18	18	431
CO2	26053	22330	22338	26053
F2	0	0	0	0
H2	0	0	0	0
HCl	9	7	7	9
HCN	0	0	0	0
HF	5	4	4	5
I2	0	0	0	0
N2	699668	711673	711673	699668
NaCl(s)	0	0	0	0
NaCN(s)	0	0	0	0
NaF(s)	0	0	0	0
NaI(s)	0	0	0	0
NH3	22	237	1925	22
NO	2111	35	1714	2111
NO2	10	0	8	10
O2	188778	190901	191317	188778
P2O5(s)	0	0	0	0
PO2	0	0	0	0
SO2	10	7	7	10
SO3(s)	0	2	2	0



Note: Concentrations for constituents representing particulates (as denoted by suffix "(s)" in their name) are reported in units of mg/m3; all others are reported in units of ppmV

**GENERAL NOTE FOR USE OF PCDS:**

- The information provided by the PCDS report is intended solely for use in support of the vessel material selection process and Corrosion Evaluations. The inputs, assumptions, and computational/engineering models used in generating the results presented herein are specific to this effort. Use of the information presented herein for any other purpose will require separate consideration and analysis to support justification of its use for the desired, alternative purpose.
- The process descriptions in this report cover routine process operations and non-routine (infrequent) process operations, when such exist, that could impact corrosion or erosion of process equipment.
- The process descriptions provided in this report are for general information and reflective of the corrosion engineer's analysis for transparency, the information is current only at the time this document is issued. These process descriptions should not be referenced for design.

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## 6.6.1 Description of Vessel/Equipment

The LAW Secondary Offgas/Vessel Vent Process (LVP) System is designed to treat the offgas from the LAW Primary Offgas Process (LOP) System and the LAW Facility vessel vents. The purpose of the LVP System is to remove almost all remaining particulates, miscellaneous acid gases, nitrogen oxides, VOCs, and mercury from the LAW Facility offgas that have not been removed by the LOP system.

Figure 10 is a sketch of the input and output arrangement of streams for all equipment within the LVP System. Streams that are not primary routes (infrequent transfers) are represented with dashed lines.

Figure 10a LVP System Sketch

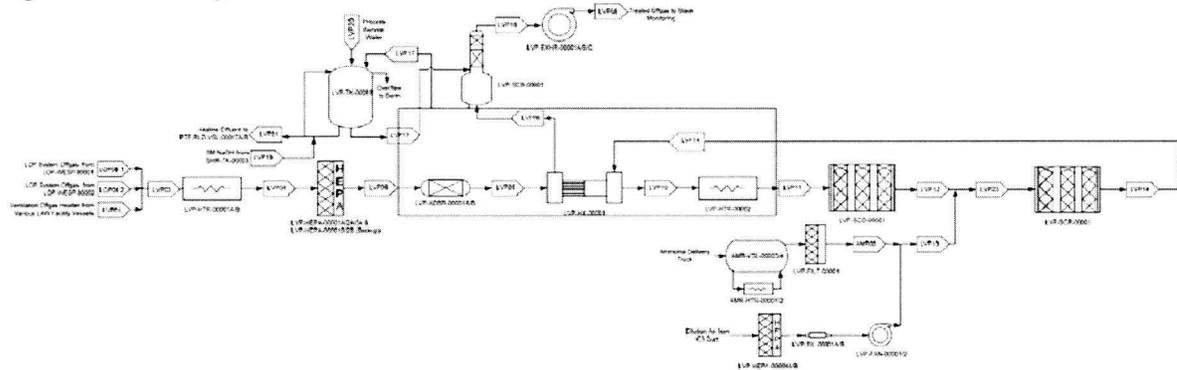
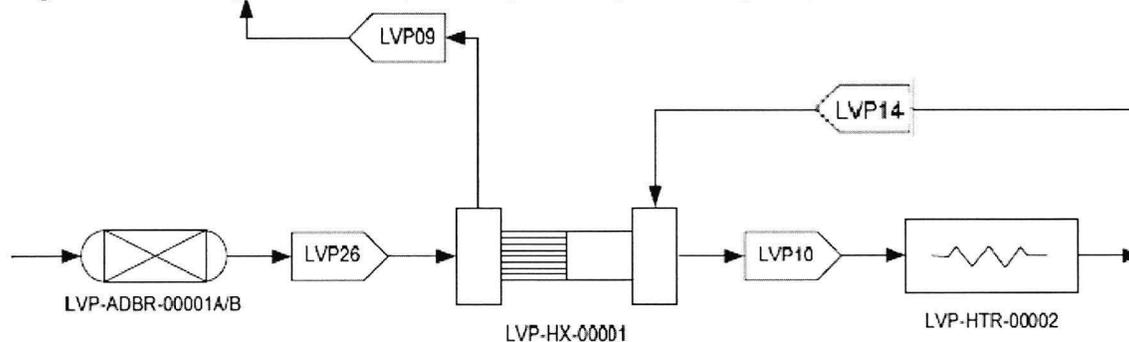


Figure 10b LVP System Sketch (detail of pertinent portion of system)



## 6.6.2 System Functions

The process functions of this system are as follows:

- Receive LAW Offgas from LOP System and LAW Facility Vessel Ventilation Streams
- Receive Reagents Streams Such as Ammonia or Dilution Air to Ensure Offgas Component Destruction
- Treat Offgas to Ensure Requirements are Met Before Emitting to Atmosphere
- Transfer Offgas to Stack
- Transfer Liquid Effluents to RLD-VSL-00017A/B

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These vessels perform additional system functions beyond the process functions, but these are outside the scope of this document. The non-process functions are not discussed any further in this document. However, they are listed below for completeness:

- Confine Hazardous Materials
- Flush System Components
- Report System Data

### 6.6.3 Description of Process Functions

All process streams have been taken from Process Flow Diagrams 24590-LAW-M5-V17T-00010 and 24590-LAW-M5-V17T-00011 and associated drawing change notices (DCNs) 24590-LAW-M5N-V17T-00012/15/17/29 and 24590-LAW-M5N-V17T-00012/19/23/29, respectively. The P&IDs have also been looked at to obtain the most accurate flow diagram. These are as follows: 24590-LAW-M6-LVP-00001001 / 1002 / 1003 / 1004 / 1005 / 1006 / 2001 / 2002 / 2003 / 2004 / 2005 / 2006 / 3001 / 4001 / 4002 / 4003 / 5001 / 5002 and 24590-BOF-M6-AMR-00002001 / 2002 / 3001 / 3002 / 5001. See Section 7.1.3 for corresponding references in this section. A description of the process function of each piece of equipment is listed as follows:

<u>Equipment</u>	<u>Process Function</u>
LVP-HX-00001	The heat recovery exchanger raises the offgas temperature from LVP-ADBR-00001A/B, using the hot offgas from the catalyst beds (LVP-SCR-00001).

#### 6.6.3.1 Receipt Streams

The LVP system primarily receives LAW offgas from the LOP system and LAW Facility vessel ventilation streams. Other LVP system equipment receives various streams to help process the offgas. The receipt streams for each piece of equipment are listed as follows, by vessel, in order of process flow:

##### LVP-HX-00001

- LVP26 - Offgas from LVP-ADBR-00001A/B
- LVP14 - Offgas from LVP-SCR-00001

##### 6.6.3.1.4 LVP26 - Offgas from LVP-ADBR-00001A/B

Stream LVP26 is the offgas from the adsorbers that enters the heat exchanger.

##### Molarity

N/A

##### Temperature

The temperature of stream LVP26 will normally be 169°F (24590-LAW-M4C-LOP-00001, pg. 37, Cell Q33, Ref. 7.1.4(12)). The maximum temperature is 189°F (24590-LAW-M4C-LOP-00001, pg. 41, Cell Q33, Ref. 7.1.4(12)).

**CORROSION EVALUATION****24590-WTP-RPT-PR-04-0001-04, Rev. 0A**  
**WTP Process Corrosion Data-Volume 4****Solids Concentration**

The solids concentration for stream LVP26 will normally be near zero or trace solids.

**Vapor Density**

The vapor density of stream LVP26 will normally be 4.47E-2 lb/ft<sup>3</sup> to 4.02E-2 lb/ft<sup>3</sup> (24590-LAW-M4C-LOP-00001, pg. 37, Cell AI33; pg. 41, Cell AI33, Ref. 7.1.4(12)).

**Liquid pH**

N/A

**6.6.3.1.5 LVP14 - Offgas from LVP-SCR-00001**

Stream LVP14 is the offgas from the catalytic reducer that enters the heat exchanger.

**Molarity**

N/A

**Temperature**

The temperature of stream LVP14 will normally be 724°F (24590-LAW-M4E-LOP-00009, pg. 11, Cell Q44, Ref. 7.1.4(13)). The maximum temperature is 792°F (24590-LAW-M4E-LOP-00009, pg. 15, Cell Q44, Ref. 7.1.4(13)).

**Solids Concentration**

The solids concentration for stream LVP14 will normally be near zero or trace solids.

**Vapor Density**

The vapor density of stream LVP14 will normally be 2.27E-2 lb/ft<sup>3</sup> to 1.95E-2 lb/ft<sup>3</sup> (24590-LAW-M4E-LOP-00009, pg. 11, Cell AI44; pg. 15, Cell AI44, Ref. 7.1.4(13)).

**Liquid pH**

N/A

**6.6.3.1.6 LVP10 - Offgas from LVP-HX-00001**

Stream LVP10 is the offgas from the heat exchanger that enters the electric heater.

**Molarity**

N/A

**Temperature**

The temperature of stream LVP10 will normally be 624°F (24590-LAW-M4E-LOP-00009, pg. 11, Cell Q36, Ref. 7.1.4(13)). The maximum temperature is 680°F (24590-LAW-M4E-LOP-00009, pg. 15, Cell Q36, Ref. 7.1.4(13)).

**Solids Concentration**

The solids concentration for stream LVP10 will normally be near zero or trace solids.

**Vapor Density**

The vapor density of stream LVP10 will normally be 2.56E-2 lb/ft<sup>3</sup> to 2.25E-2 lb/ft<sup>3</sup> (24590-LAW-M4E-LOP-00009, pg. 11, Cell AI36; pg. 15, Cell AI36, Ref. 7.1.4(13)).

**Liquid pH**

N/A

**CORROSION EVALUATION**24590-WTP-RPT-PR-04-0001-04, Rev. 0A  
WTP Process Corrosion Data-Volume 4**6.6.3.1.13 LVP09 - Offgas from LVP-SCR-00001 via LVP-HX-00001 to LVP-SCB-00001**

This stream is the offgas from the selective catalytic reducer via the heat exchanger to the scrubber.

**Molarity**

N/A

**Temperature**

The temperature will normally be 370°F (24590-LAW-M4E-LOP-00009, pg. 11, Cell Q45, Ref. 7.1.4(13)). The maximum temperature is 412°F (24590-LAW-M4E-LOP-00009, pg. 15, Cell Q45, Ref. 7.1.4(13)).

**Solids Concentration**

The solids concentration will normally be near zero or trace solids.

**Vapor Density**

The vapor density will normally be 3.27E-2 lb/ft<sup>3</sup> to 2.84E-2 lb/ft<sup>3</sup> (24590-LAW-M4E-LOP-00009, pg. 11, Cell AI44; pg. 15, Cell AI44, Ref. 7.1.4(13)).

**Liquid pH**

N/A

**6.6.3.2 Outlet Streams**

The outlet streams for each piece of equipment are listed as follows, by vessel, in order of process flow:

**LVP-HX-00001**

- LVP10 - Offgas from LVP-HX-00001
- LVP09 - Offgas from LVP-SCR-00001

**6.6.4 Process Modes****6.6.4.1 Normal Operations**

Based on the assessment of streams frequently transferred in and out of the LVP System equipment, the following normal processing modes are considered:

**LVP-HX-00001**

- LVP26 - Offgas from LVP-ADBR-00001A/B
- LVP14 - Offgas from LVP-SCR-00001
- LVP10 - Offgas from LVP-HX-00001
- LVP09 - Offgas from LVP-SCR-00001

**6.6.4.2 Infrequent Operations**

None identified.

**CORROSION EVALUATION**

24590-WTP-RPT-PR-04-0001-04, Rev. 0A  
WTP Process Corrosion Data-Volume 4

**6.6.5 Summary of Processing Conditions for LVP System****6.6.5.1 Normal Operations**

The following table summarizes the normal processing modes for LVP System equipment.

Stream Number	Weight % UDS		Na Molarity		Temperature (°F)	
	normal	upper	normal	upper	normal	upper
<u>LVP-HX-00001</u>						
LVP26 (in) - cold side	0	trace	n/a	n/a	169	189
LVP14 (in) - hot side	0	trace	n/a	n/a	724	792
LVP10 (out) - cold side	0	trace	n/a	n/a	624	680
LVP09 (out) - hot side	0	trace	n/a	n/a	370	412

**6.6.5.2 Infrequent Operations**

None identified.

## CORROSION EVALUATION

24590-LAW-3YD-LOP-00001, Rev. 003  
System Description for the LAW Primary  
Offgas (LOP) and Secondary  
Offgas/Vessel Vent (LVP) Systems

### 6.4.1.3 Catalytic Oxidizer/Reducer (LVP-SKID-00001 and LVP-SKID-00002)

The offgas has potentially high levels of  $\text{NO}_x$  because the melter decomposes the parent nitrate/nitrite compounds. Some of the resultant  $\text{NO}_x$  is decomposed to nitrogen and water in the melter, and some is removed by scrubbing in the SBS. VOCs are also present in the offgas stream. Both the VOCs and the remaining  $\text{NO}_x$  require removal.

The offgas is passed through a catalytic oxidizer/reducer skid (LVP-SKID-00002) housing a heat recovery exchanger (LVP-HX-00001), an electric heater (LVP-HTR-00002), VOC catalyst (LVP-SCO-00001), and SCR catalyst (LVP-SCR-00001). The skid is located in room L-0304F at the 48-foot elevation and approximate dimensions for the skid are 36 ft long by 11 ft high by 8 ft wide. The heat recovery exchanger first raises the offgas temperature using the hot offgas from the catalyst beds. This heat exchanger is designed to be of a plate and frame design to eliminate the problems associated with tube to plate joints. The hot side of the heat exchanger cools the offgas prior to discharge from the skid. [ 4.3.3.17 ]