VICTORY ENERGY®

OPERATIONS
&
MAINTENANCE
MANUAL

COLUMBIA PULP
PO# ACI14791P01/02

VEO JOB # 13288

VICTORY ENERGY®

Project Contact List

Project Manager:

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VICTORY ENERGY OPERATIONS, LLC. 110701 E 126th St. North
Collinsville, OK 74021
918.274.0023
Fax: 918.274.0059

May 24, 2018 **Delivered by Electronic Mail**

Air Clean Technologies
4725 W. Marginal Way SW
Seattle, WA 98106

Attn: Mr. Chris Dayton

RE: VEO Job: JVE-13288 / Air Clean PO ACJ14791P02
Equipment Warranty Notification

Dear Mr. Dayton:

In accordance with the purchase order Terms and Conditions the warranty period is 12 months from startup of the equipment or 18 months from shipment. The warranty period will expire the earlier of 12 months from startup or 18 months from shipment. The boiler shipment (delivery) date was May 24, 2018.

During the Warranty Period, please contact Sanat Shetty sshetty@victoryenergy.com 918-382-4886 for warranty claims.

Sincerely,

VICTORY ENERGY OPERATIONS, LLC

Greg McNutt
Senior Project Manager

Cc: Tom Haskell, VEO
Sanat Shetty, VEO
Ron Eddy, VEO

Victory Energy Operations, LLC
10701 E. 126th St. N.
Collinsville, OK 74021

Field Services
(918)274-0023

INDEX

SECTION A

FOREWORD

FOREWORD

This instruction booklet is furnished for the purpose of assisting buyer/owner in the operation and care of Victory Energy Operations (VEO) equipment. The instructions are general and should be interpreted and applied with due consideration for the requirements of your particular operating conditions. They are intended to supplement, not to replace the experience and judgment of your operators, upon whom sole responsibility for successful and safe operation rests.

The services of a VEO Service Engineer normally are not furnished unless specifically called for in the contract between you, the customer, and VEO. Should you desire the presence of a service engineer such service can be provided upon the receipt of a purchase order requesting such service.

When the service of a VEO engineer is provided, it is for the purpose of aiding in the training of plant personnel, not to replace them or to assume any of their duties. It should be understood that responsibility for operation rests solely with the licensed operators and VEO assumes no responsibility for the failure of the operators to properly perform their respective duties. Furthermore, the presence of a VEO engineer at your facility in no way relieves the licensed plant operating personnel of any of their responsibilities.

Victory Energy Operations, LLC
Field Services Department
10701 E. 126th St. N.
Collinsville, OK 74021
(918) 274-0023
www.victoryenergy.com

SECTION B

ASME DOCUMENTS

FORM P-3 MANUFACTURERS' DATA REPORT FOR WATERTUBE BOILERS, SUPERHEATERS, WATERWALLS, AND ECONOMIZERS

As Required by the Provisions of the ASME Code Rules, Section I

MASTER DATA REPORT YES ☒
(Check One) NO ☐

1. Manufactured by Victory Energy Operations, LLC 10701 E 126th St. North Collinsville, Oklahoma 74021 (Name and Address of Manufacturer)

2. Manufactured for Air Clean Technologies PO Box 46017 Seattle, WA 98146 (Name and Address of Purchaser)

3. Location of Installation Columbia Pulp 164 East Main St. Dayton, WA 99328 (Name and Address)

4. Unit Identification Watertube Boiler (Complete boiler, Superheater, waterwall, economizer, etc.) ID Nos. 13288 (Manufacturer's Serial No.) ---- (CRN) 00-13288-00 Rev B (Drawing No.) 589 (Nat'l Board No.) 2017 (Year Built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design conforms to Section I of the ASME BOILER AND PRESSURE VESSEL CODE 2015 (Year),

Addenda to N/A (Date) (if applicable), and Code Cases N/A (Numbers)

Supporting Manufacturer's Data Reports properly identified and signed by Commissioned Inspectors are attached for the following items of this report:

(Name of part, item number, manufacturer's name, and identifying Designator)

(1) Cylinder P-4 ID No. 6965, S/N- 6965-1 Green Bayou Pipe Mill S-42,545

(1) Cylinder P-4 ID No. 6965, S/N- 6965-2 Green Bayou Pipe Mill S-42,545

6(a). Drums

No.	Inside Diameter	Inside Length	Shell Plates			Tubesheets		Tube Hole Ligament Efficiency, %	
			Material Spec. No., Grade	Thickness	Inside Radius	Thickness	Inside Radius	Longitudinal	Circumferential
1	42"	29' 6 1/2"	SA-516-70N	2.50"	21"	----	----	49.20%	52.50%
2	30"	29' 6 1/2"	SA-516-70N	2"	15"	----	----	49.20%	44.10%
3	----	----	----	----	----	----	----	----	----

No.	Longitudinal Joints		Circum. Joints		Heads						Hydrostatic Test
	No. & Type*	Efficiency	No. & Type	Efficiency	Material Spec. No., Grade	Thickness		Type**	Radius of Dish	Manholes No. Size	
1	4(2)	100%	3(2)	100%	SA-516-70N	2"	1.875"	2:1 ellip	21"	(2) 12" x 16"	----
2	3(2)	100%	2(2)	100%	SA-516-70N	2"	1.830"	2:1 ellip	15"	(2) 12" x 16"	----
3	----	----	----	----	----	----	----	----	----	----	----

* Indicate if (1) Seamless; (2) Fusion welded

** Indicate if (1) Flat; (2) Dished; (3) Ellipsoidal; (4) Hemispherical

6(b). Boiler Tubes

Diameter	Thickness	Material Spec. No., Grade
2"	.135"	SA-178-A
2"	.120"	SA-178-A
--	---	----
--	---	----
--	---	----

6(c). Headers No. Sinuous, Box, Round; SA-106-B; 6"-Sch 80, 4"-Sch 80 (Box or sinuous or round; Mat'l. spec. No., Thickness)

Heads or Ends Flat; SA-516-70; .50" (Shape; Mat'l spec. no.; Thickness) Hydro. Test ---

6(d). Staybolts -------- (Mat'l. spec. no.; Diameter; Size telltale; Net area)

Pitch ---- (Horizontal and Vertical) Net Area ---- (Supported by one bolt) MAWP ----

6(e). Mud Drum -------- (For sect. header boilers, state size; shape Material spec. no.; thickness)

Heads or Ends -------- (Shape; Material spec. no.; Thickness) Hydro. Test ----

7(a). Waterwall Headers / 7(b). Waterwall Tubes

No.	Size and Shape	Material Spec. No.	Thickness	Heads or Ends			Hydro. Test	Diameter	Thickness	Material Spec. No.
				Shape	Thickness	Material Spec. No.				
	----	----	----	----	----	----	----	----	----	----
	----	----	----	----	----	----	----	----	----	----
	----	----	----	----	----	----	----	----	----	----

8(a). Economizer Headers / 8(b). Economizer Tubes

	----	----	----	----	----	----	----	----	----	----
	----	----	----	----	----	----	----	----	----	----

FORM P-3

Boiler No. 13288 (Mfr's Serial No.) ---- (CRN) 00-13288-00 Rev B (Drawing No.) 589 (Nat'l Board No.)

9(a). Superheater Headers / 9(b) Superheater tubes

				Heads or Ends				9(b) Superheater tubes		
No.	Size and Shape	Material Spec. No.	Thickness	Shape	Thickness	Material Spec. No.	Hydro. Test	Diameter	Thickness	Material Spec. No.
1	8" Round	SA-106-B	Sch 80	Round	Sch 80	SA-234-WPB	1425 psig	2" OD	.180" MW	SA-213-TP304H
1	8" Round	SA-335-P22	Sch 160	Round	Sch 160	SA-234-WP22	1425 psig	2" OD	.180" MW	SA-213-TP304H

10(a). Other Parts (1) ---- (2) ---- (3) ---- 10(b). Tubes for Other Parts

1	----	----	----	----	----	----	----	----	----	----
2	----	----	----	----	----	----	----	----	----	----
3	----	----	----	----	----	----	----	----	----	----

11. Openings (1) Steam (1) 6"-600# Studding Outlet (No., size, and type of nozzles or outlets) (2) Pressure Relief Valve (2) 1 1/2" -600# Studding Outlet (No., size, and type of nozzles or outlets)

(3) Blowoff (1) 1"-600# RFSW (No., size, and type of nozzles or outlets) (4) Feed (1) 3"-600# RFWN (No., size, type and location of connections)

12.

		Maximum Allowable Working Pressure	Code Par. and/or Formula on Which MAWP is	Shop Hydro. Test	Heating Surface
a	Boiler	950 psig	PG-27	1425 psig	7,344 ft²
b	Waterwall	----	----	----	----
c	Economizer	----	----	----	----
d	Superheater	950 psig	PG-27	1425 psig	980 ft²
e	Other Parts	----	----	----	----

Heating surface to be stamped on drum heads.

This heating surface not to be used for determining minimum pressure relief valve capacity.

13. Field Hydro. Test

14. Maximum Designed Steaming Capacity 90,000 #/hr.

15. Remarks See P-6 for additional openings
P-7 ID# 13288 for safety valves

CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements made in this data report are correct and that all details of design, material, construction, and workmanship of this boiler conform to Section I of the ASME BOILER AND PRESSURE VESSEL CODE.

Our Certificate of Authorization No. 34,139 to use the (S) S Designator expires September 24, 2018

Date 4-5-18 Signed Mark Deggendorf (Authorized Representative) Name Victory Energy Operations, LLC (Manufacturer)

CERTIFICATE OF SHOP INSPECTION

BOILER MADE BY Victory Energy Operations, LLC at 10701 E 126th St North Collinsville, OK 74021.

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by The Hartford Steam Boiler Inspection and Insurance Company have inspected parts of this boiler referred to as data items 1, 2, 3, 4, 5, 6, 11, 12, 14, 15 and have examined Supporting Manufacturer's Data Reports for items 6(a)1, 6(a)2 and state that, to the best of my knowledge and belief, the Manufacturer has constructed this boiler in accordance with Section I of the ASME BOILER AND PRESSURE VESSEL CODE.

By signing this certificate, neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the boiler described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 4/5/18 Signed (Authorized Inspector) Commission 14032 AI [National Board Commission Number and Endorsement]

CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE

We certify that the field assembly of all parts of this boiler conforms with the requirements of SECTION I of the ASME BOILER AND PRESSURE VESSEL CODE.

Our Certificate of Authorization No. ______ to use the (A) or (S) ______ Designator expires ______

Date ______ Signed ______ (Authorized Representative) Name ______ (Assembler)

MD 4-5-18
(Manufacturer's Representative)

SMD 4/5/18
(Authorized Inspector)

FORM P-3

Boiler No. 13288 (Mfr's Serial No.) ---- (CRN) 00-13288-00 Rev B (Drawing No.) 589 (Nat'l Board No.)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by have compared statements in this Manufacturer's Data report with the described boiler and state that the parts referred to as data items not included in the Certificate of Shop Inspection, have been inspected by me and that to the best of my knowledge and belief, the Manufacturer and/or the assembler has constructed and assembled this boiler in accordance with the applicable sections of the ASME BOILER AND PRESSURE VESSEL CODE. The described boiler was inspected and subjected to a hydrostatic test of psi. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the boiler described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date ____________ Signed ____________ (Authorized Inspector) Commissions ____________ [National Board Commission Number and Endorsement]

FORM P-6 MANUFACTURER'S DATA REPORT SUPPLEMENTARY SHEET
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules

1. Manufacturer (or Engineering-Contractor) Victory Energy Operations, LLC 10701 E 126th St. North Collinsville, Oklahoma 74021 (Name and address)

2. Purchaser AirClean Technologies PO Box 46017 Seattle, WA 98146 (Name and address)

3. Type of Boiler Watertube Boiler

4. Boiler

13288	----	00-13288-00 Rev B	589	2017
(Manufacturer's Serial no.)	(CRN)	(Drawing no.)	(National Board no.)	(Year built)

Data Items by Line No.	Continued from P-3
11(5)	(1) Vent: 1" -600#, RFSW, SA-105
11(6)	(1) Chemical Feed: 1" -600#, RFSW, SA-105
11(7)	(2) Water Column: 1" -600#, RFSW, SA-105
11(8)	(2) Drum Level Transmitter: 1" -600#, RFSW, SA-105
11(9)	(1) Continuous Blowdown: 1" -600#, RFSW, SA-105
11(10)	(1) ALWCO: 1" -600#, RFSW, SA-105
11(11)	(4) Temperature and Pressure: 1" -Sch 40, SA-106-B
11(12)	(1) Furnace Pressure: 1" -Sch 40, SA-106-B
11(13)	(1) Superheater Inlet: 6" -600#, RFWN, SA-105
11(14)	(1) Superheater Oulet: 8" -1500#, RFWN, SA-105
11(15)	(1) Superheater Relief Valve: 1 1/2" -1500#, RFWN, SA-105
11(16)	(2) Superheater Drain: 1" -Sch 80, SA-106-B

Date 4-5-18 Signed By Victory Energy Operations, LLC

Date 4/5/18

(Authorized Inspector)

Commission 14032 AI
[National Board Commission Number and Endorsement]

ASME BPVC, Sect. I, 2013 revision by B.Longcrier

FORM P-7 MANUFACTURERS' DATA REPORT FOR SAFETY VALVES
As Required by the Provisions of the ASME Code Rules, Section I

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1. Boiler manufactured by Victory Energy Operations, LLC 10701 E 126th St. North Collinsville, Oklahoma 74021 (Name and address of manufacturer) P-7 ID No. 13288

2. Boiler manufactured for AirClean Technologies PO Box 46017 Seattle, WA 98146 (Name and address of purchaser)

3. Location of Installation Columbus Pulp 164 East Main St. Dayton, WA 99328 (Name and Address)

4. Unit identification Watertube Boiler (Complete boiler, superheater, waterwall, economizer, etc.) ID Nos. 13288 (Mfr's. Serial No.) N/A (CRN) 00-13288-00 RB (Drawing No.) 589 (Nat'l Board No.)

5. Identification of Safety Valves

Tag No.	Service Location	Quantity	Size	Manufacturer Name	Design or Type No.	Material * Conn.**	Set Press.	Capacity
	Steam drum	1	1 1/2"	Kunkle	600NHG01-ASO950	2D	950	35,220 lb/hr
	Steam drum	1	1 1/2"	Kunkle	600NHG01-ASO955	2D	955	35,403 lb/hr
	Superheater	1	1 1/2"	Consolidated	1-1/2" 2717 D-1-X1-F1	2D	870	40,936 lb/hr

* Material: (1) SA-216, WCB. (2) SA-217, WC6. (3) SA-217, WC9. (4) SA-182, F 22. (5) Other

* * Connector type: (A) Groove Weld, (B) Socket Weld, (C) Threaded, (D) Flanged.

6. Unit Relieving Capacity

Circuit	Minimum Required	Furnished
Boiler	67,500 lb/hr	70,623 lb/hr
Economizer		
Superheater	19,377	31,807
Reheater Inlet		
Reheater Outlet		
Other		

7. Determination of Unit Relieving Capacity

Is PG-67.2.1.1 applicable to this boiler? No

Approach taken to address capacity ________ PG-67.2.1.1.1 ________ PG-67.2.1.1.2

CERTIFICATE OF COMPLIANCE

We certify the statements in this Manufacturer's Data Report for Pressure Relief Valves to be correct and that all details conform to Section I of the ASME BOILER AND PRESSURE VESSEL CODE.

Our Certificate of Authorization No. 34,139 to use the (S) or (M) S Designator expires September 24, 2018

Date 4-5-18 Signed (Authorized Representative) Name Victory Energy Operations, LLC (Manufacturer)

FORM P-4 MANUFACTURER'S PARTIAL DATA REPORT
As Required by the Provisions of the ASME Code Rules, Section I

1. Manufactured by Greens Bayou Pipe Mill 13935 Industrial Road Houston, Texas 77015 (Name and address of manufacturer), P-4 ID No. 6965

2. Manufactured for Unknown (Name and address of purchaser)

3. Identification of Part(s)

Name of Part	Quantity	Line No.	Mfr's. Identifying Numbers	Manufacturer's Drawing No.	CRN	National Board No.	Year Built
Cylinder	1	6(a)1	6965-1	6965-3			2017
Cylinder	1	6(a)2	6965-2	6965-2			2017

4. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design (as indicated on line 14, Remarks) conforms to ASME Rules, Section I of ASME BOILER ANDPRESSURE VESSEL CODE.

2015 (Year), Addenda to (Date) (if applicable), and Code Cases (Numbers)

6(a). Drums

No.	Inside Diameter	Inside Length	Shell Plates			Tubesheets		Tube Hole Ligament Efficiency, %	
			Material Spec. No., Grade	Thickness	Inside Radius	Thickness	Inside Radius	Longitudinal	Circumferential
1	42"	29'-6.50"	SA516-70N	2.50"	21"				
2	30"	29'-6.50"	SA516-70N	2.00"	15"				
3									
4									

No.	Longitudinal Joints		Circum. Joints		Heads							Hydrostatic Test
	No. & Type*	Efficiency	No. & Type	Efficiency	Material Spec. No., Grade	Thickness		Type**	Radius of Dish	Manholes No.	Manholes Size	
1	4 & 2	100%	3 & 2	100%								
2	3 & 2	100%	2 & 2	100%								
3												
4												

*Indicate if (1) Seamless; (2) Fusion welded.

**Indicate if (1) Flat; (2) Dished; (3) Ellipsoidal; (4) Hemispherical.

6(b). Boiler Tubes

Diameter	Thickness	Material Spec. No., Grade

6(c). Headers No. or (Box or sinuous or round; Material spec. no.; Thickness)

Heads or Ends (Shape; Material spec. no.; Thickness) Hydro. Test

6(d). Staybolts (Material spec. no.; Diameter; Size telltale; Net area)

Pitch (Horizontal and vertical) Net Area (Supported by one bolt) MAWP

6(e). Mud Drum or (For sect. header boilers, state: Size; Shape; Mat'l. spec. no.; Thickness) Heads or Ends (Shape; Material spec. no.; Thickness) Hydro Test, psi

7(a). Waterwall Headers

7(b). Waterwall Tubes

No.	Size and Shape	Material Spec. No.	Thickness	Heads or Ends			Hydro. Test	Diameter	Thickness	Material Spec. No.
				Shape	Thickness	Material Spec. No.				

(07/13)

FORM P-4

P-4 ID No. 6965

8(a). Economizer Headers | 8(b). Economizer Tubes

				Heads or Ends						
No.	Size and Shape	Material Spec. No.	Thickness	Shape	Thickness	Material Spec. No.	Hydro. Test	Diameter	Thickness	Material Spec. No.
			or							

9(a). Superheater Headers | 9(b). Superheater Tubes

10(a). Other Parts (1) ______ (2) ______ (3) ______ | 10(b). Tubes for Other Parts

1										
2										
3										

11. Openings (1) Steam ______ (No., size, and type of nozzles or outlets)

(2) Pressure Relief Valve ______ (No., size, and type of nozzles or outlets)

(3) Blowoff ______ (No., size, and type of nozzles or outlets)

(4) Feed ______ (No., size, type, and location of connections)

12.		Maximum Allowable Working Pressure	Code Para. and/or Formula on Which MAWP Is Based	Hydro. Test	Heating Surface
a	Boiler				
b	Waterwall				
c	Economizer				
d	Superheater				
e	Other Parts				

{Heating surface to be stamped on drum heads.

{This heating surface not to be used for determining minimum pressure relief valve capacity.

14. Remarks Rolled, Welded and 100% radiograph of welded seam(s). * No drawing or design functions by GBPM.

CERTIFICATE OF COMPLIANCE

We certify the statements made in this Manufacturer's Partial Data Report to be correct and that all details of design (as indicated on line 14, Remarks), material, construction, and workmanship of this boiler part conform to Section I of the ASME BOILER AND PRESSURE VESSEL CODE.

Our Certificate of Authorization No. 42,545 to use the (PP) or (S) S Designator expires 1/19/2018.

Date 11/20/2017 Signed ______ (Authorized Representative) Name Greens Bayou Pipe Mill (Manufacturer)

CERTIFICATE OF INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by Authorized Inspection Associates, LLC have inspected the part of the boiler described in this Manufacturer's Partial Data Report on 11/20/2017, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this part in accordance with the applicable sections of the ASME BOILER AND PRESSURE VESSEL CODE.

By signing this certificate, neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the part described in this Manufacturer's Partial Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 11/20/2017 Signed ______ (Authorized Inspector) Commission NB13919AIR [National Board Commission Number and Endorsement]

FORM P-3 MANUFACTURERS' DATA REPORT FOR WATERTUBE BOILERS, SUPERHEATERS, WATERWALLS, AND ECONOMIZERS

As Required by the Provisions of the ASME Code Rules, Section I

MASTER DATA REPORT YES ☒
(Check One) NO ☐

---

1. Manufactured by Victory Energy Operations, LLC 10701 E 126th St. North Collinsville, Oklahoma 74021
(Name and Address of Manufacturer)

2. Manufactured for Air Clean Technologies PO Box 46017 Seattle, WA 98146
(Name and Address of Purchaser)

3. Location of Installation Columbia Pulp 164 East Main St. Dayton, WA 99328
(Name and Address)

4. Unit Identification Economizer (Complete boiler, Superheater, waterwall, economizer, etc.) ID Nos. 13288-E (Manufacturer's Serial No.) N/A (CRN) 30-13288-00 Rev 1 (Drawing No.) 587 (Nat'l Board No.) 2018 (Year Built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design conforms to Section I of the ASME BOILER AND PRESSURE VESSEL CODE 2015 (Year),

Addenda to N/A (Date) (if applicable), and Code Cases None (Numbers)

Supporting Manufacturer's Data Reports properly identified and signed by Commissioned Inspectors are attached for the following items of this report:

(Name of part, item number, manufacturer's name, and identifying Designator)

6(a). Drums

No.	Inside Diameter	Inside Length	Shell Plates			Tubesheets		Tube Hole Ligament Efficiency, %	
			Material Spec. No., Grade	Thickness	Inside Radius	Thickness	Inside Radius	Longitudinal	Circumferential
1									
2									
3	----	----	----	----	----	----	----	----	----

No.	Longitudinal Joints		Circum. Joints		Heads						Hydrostatic Test
	No. & Type*	Efficiency	No. & Type	Efficiency	Material Spec. No., Grade	Thickness		Type**	Radius of Dish	Manholes No. Size	
1											
2											
3	----	----	----	----	----	----	----	----	----	----	----

* Indicate if (1) Seamless; (2) Fusion welded

** Indicate if (1) Flat; (2) Dished; (3) Ellipsoidal; (4) Hemispherical

6(b). Boiler Tubes

Diameter	Thickness	Material Spec. No., Grade
--	---	----
--	---	----
--	---	----
--	---	----
--	---	----

6(c). Headers No. -------- (Box or sinuous or round; Mat'l. spec. No., Thickness)

Heads or Ends ---- (Shape; Mat'l spec. no.; Thickness) Hydro. Test ---

6(d). Staybolts -------- (Mat'l. spec. no.; Diameter; Size telltale; Net area)

Pitch ---- (Horizontal and Vertical) Net Area ---- (Supported by one bolt) MAWP ----

6(e). Mud Drum -------- (For sect. header boilers, state size; shape Material spec. no.; thickness) Heads or Ends -------- (Shape; Material spec. no.; Thickness) Hydro. Test ----

7(a). Waterwall Headers

7(b). Waterwall Tubes

No.	Size and Shape	Material Spec. No.	Thickness	Heads or Ends			Hydro. Test	Diameter	Thickness	Material Spec. No.
				Shape	Thickness	Material Spec. No.				
	----	----	----	----	----	----	----	----	----	----
	----	----	----	----	----	----	----	----	----	----
	----	----	----	----	----	----	----	----	----	----

8(a). Economizer Headers

8(b). Economizer Tubes

2	4" Pipe	SA-106-B	Sch 80	Round	Sch 80	SA-234-WPB	1500 psig	2"	.135 MW	SA-178
	----	----	----	----	----	----	----	----	----	----

FORM P-3

Boiler No. 13288-E (Mfr's Serial No.) ________ (CRN) 30-13288-00 Rev 1 (Drawing No.) 587 (Nat'l Board No.)

9(a). Superheater Headers

				Heads or Ends			9(b) Superheater tubes			
No.	Size and Shape	Material Spec. No.	Thickness	Shape	Thickness	Material Spec. No.	Hydro. Test	Diameter	Thickness	Material Spec. No.
	----	----	----	----	----	----	----	----	----	----

10(a). Other Parts (1) Inlet/Outlet (2) (1) 'Drain (1) Vent (3) (2) Temp conn. 10(b). Tubes for Other Parts

1	4" x 3" Red	SA234WPB	Sch STD	RFWN	3" -600#	SA-105	----	----	----	----
2	1" FNPT	SA-105	3000#	RFWN	3" -600#	SA-105	----	----	----	----
3	1" FNPT	SA-105	3000#	----	----	----	----	----	----	----

11. Openings (1) Steam ---- (No., size, and type of nozzles or outlets) (2) Pressure Relief Valve ________ (No., size, and type of nozzles or outlets)

(3) Blowoff ---- (No., size, and type of nozzles or outlets) (4) Feed ---- (No., size, type and location of connections)

12.

		Maximum Allowable Working Pressure	Code Par. and/or Formula on Which MAWP is	Shop Hydro. Test	Heating Surface
a	Boiler	----	----	----	----
b	Waterwall	----	----	----	----
c	Economizer	1000 psig	PG-27	1500 psig	17,380 ft²
d	Superheater	----	----	----	----
e	Other Parts	----	----	----	----

Heating surface to be stamped on drum heads. (a, b)

This heating surface not to be used for determining minimum pressure relief valve capacity. (c, d, e)

13. Field Hydro. Test

14. Maximum Designed Steaming Capacity ----.

15. Remarks Tube length: J-Bends 16' 0 9/16", Straight tubes 14' 11 1/2" Heat transferred: 13.6301 MMBTU/HR

CERTIFICATE OF SHOP COMPLIANCE

We certify that the statements made in this data report are correct and that all details of design, material, construction, and workmanship of this boiler conform to Section I of the ASME BOILER AND PRESSURE VESSEL CODE.

Our Certificate of Authorization No. 34,139 to use the (S) S Designator expires September 24, 2018

Date 1-19-18 Signed Mark Deggendorf (Authorized Representative) Name Victory Energy Operations, LLC (Manufacturer)

CERTIFICATE OF SHOP INSPECTION

BOILER MADE BY Victory Energy Operations, LLC at 10701 E 126th St North Collinsville, OK 74021.

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by The Hartford Steam Boiler Inspection and Insurance Company of Connecticut ________ have inspected parts of this boiler referred to as data items 4, 5, 8, 10, 11, 12, 15 ________ and have examined Supporting Manufacturer's Data Reports for items None and state that, to the best of my knowledge and belief, the Manufacturer has constructed this boiler in accordance with Section I of the ASME BOILER AND PRESSURE VESSEL CODE.

By signing this certificate, neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the boiler described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date 1/19/18 Signed ________ (Authorized Inspector) Commission 14032 A I, R, IS [National Board Commission Number and Endorsement]

CERTIFICATE OF FIELD ASSEMBLY COMPLIANCE

We certify that the field assembly of all parts of this boiler conforms with the requirements of SECTION I of the ASME BOILER AND PRESSURE VESSEL CODE.

Our Certificate of Authorization No. ________ to use the (A) or (S) ________ Designator expires ________

Date ________ Signed ________ (Authorized Representative) Name ________ (Assembler)

MD 1-19-18
(Manufacturer's Representative)

SAW 1/19/18
(Authorized Inspector)

FORM P-3

Boiler No. 13288-E (Mfr's Serial No.) ______ (CRN) 30-13288-00 Rev 1 (Drawing No.) 587 (Nat'l Board No.)

CERTIFICATE OF FIELD ASSEMBLY INSPECTION

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and employed by have compared statements in this Manufacturer's Data report with the described boiler and state that the parts referred to as data items not included in the Certificate of Shop Inspection, have been inspected by me and that to the best of my knowledge and belief, the Manufacturer and/or the assembler has constructed and assembled this boiler in accordance with the applicable sections of the ASME BOILER AND PRESSURE VESSEL CODE. The described boiler was inspected and subjected to a hydrostatic test of psi. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the boiler described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.

Date ______ Signed ______ (Authorized Inspector) Commissions ______ [National Board Commission Number and Endorsement]

SECTION C

BUYER/OWNER RESPONSIBILITY

Buyer/Owner Responsibility

Buyer/Owner is responsible for keeping adequate logs and records to establish proper equipment operation. Proper operation includes, but is not limited to, proper erection, proper start up, proper equipment maintenance, avoidance of damage from abrasion, corrosion, or excessive temperature, and proper servicing of equipment by VEO's personnel only.

VEO's warranty does not cover wear and tear or other results of equipment operation, including but not limited to:

(1) damage resulting from the treatment of feedwater and/or the conditioning of boiler water, such as damage due to the presence of oil, grease, scale, or deposits: damage resulting from foaming caused by chemical conditions of the water; or damage resulting from corrosion or caustic embrittlement, or

(2) damage or impaired performance which may result from corrosion, erosion, fouling, any chemical elements that reduce or eliminate the effectiveness of a catalyst when an SCR or CO System is included, or other factors which may be due to corrosive agents, combustible residues, ash, or other constituents of the fuel. Buyer bears responsibility for verifying the fuel analysis, utilizing fuel additives where necessary, and properly operating sootblowing equipment.

SECTION D

EQUIPMENT DESCRIPTION

EQUIPMENT DESCRIPTION – Voyager Series Model VS-5-78SP SH

Victory Energy Operations, LLC is pleased to provide one package steam boiler designed to provide process superheated steam for Columbia Pulp near Star Buck, WA. The boiler design has been registered with the National Board and has been assigned NB# 589.

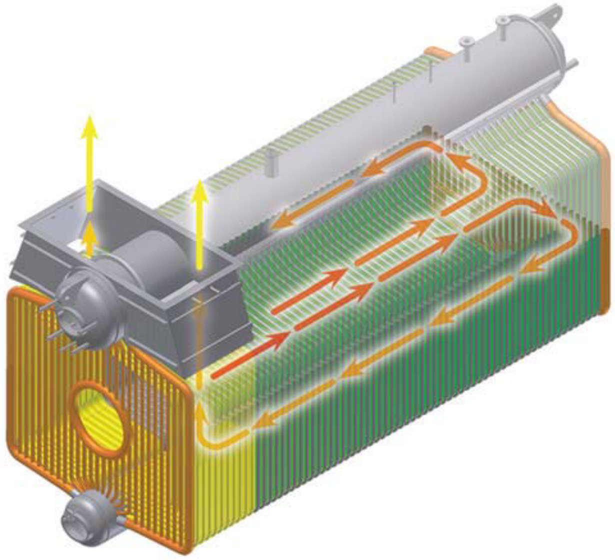
The boiler is designed with the following characteristics:

➢ Quantity:	One (1) Boiler
➢ Capacity	90,000 lb/hr Saturated Steam
➢ Design Pressure:	950 PSIG
➢ Operating Pressure:	800 PSIG
➢ Operating Temperature:	863°F SH Steam at the NRV outlet
➢ Feedwater Temperature:	227°F to Economizer Inlet
➢ Primary Fuel:	Natural Gas
➢ Boiler Location:	Outdoors

The VEO boiler design offers the least amount of furnace refractory compared to other designs. The tube and membrane seal welded front and rear walls virtually eliminate all refractory in the furnace, other than localized seals. This design greatly reduces maintenance costs and offers increased unit availability. The furnace sidewalls are tube and membrane construction for the entire length of the furnace to eliminate the possibility of gas bypassing. The outer sidewalls are also tube and membrane design for gas tight construction. This design offers 100% water cooling.

The furnace wall tubes of any boiler encounter the highest heat flux. The VEO boiler design, has the shortest furnace wall tubes in the industry. This advantage removes heat from the furnace quickly and extends boiler life.

The VEO boiler design has a single lower drum which reduces maintenance compared to other designs that may have two lower drums or headers. The single large diameter drum makes it easier to perform inspections and to maintain lower tube connections. The steam drum includes steam separation equipment.



SCOPE OF SUPPLY

Supply		**ITEM**	**Installation**	
VEO	***Buyer***		***VEO***	***Buyer***
X		Boiler (Shop Assembled) including insulation, flat, painted lagging, corrugated galvanized lagging		X
X		Boiler Trim Package (Trim Piping Ships Loose)	X	
X		Water column is a Tie Bar w/ Level Gauges	X	
X		Auxiliary Low Water Cutoff	X	
X		Drum Level Transmitters		X
X		Steam Pressure Gauge		X
X		Natural Gas Burner System:	X	
X		Burner (JZ Coen D RMB)	X	
X		Fuel Trains (incl. pilot line)	X	
	X	Fuel PRV (Regulator) By Others		X
X		Burner Management System (BMS) By JZ		X
X		Combustion Control System (CCS) By JZ		X
X		Forced Draft Fan (Mounted on Burner)		X
X		Forced Draft Fan Drive (Motor ships on FD fan)		X
X		Economizer		X
	X	Ducting and Expansion Joints		X
	X	Boiler Outlet Transition (Insulation and Lagging by Others)		X
	X	Flue Gas Recirculation Duct		X
	X	Boiler Outlet mounted Single Wall Stack (Insulation by Customer)		X
	X	Platforms and Walkways (side and rear of boiler)		X
	X	Interconnecting Piping within Terminal Points		X
	X	Interconnecting Piping Insulation and Lagging		X
	X	Piping External of Terminal Points		X
X		Safety Valve Drip Pan Elbows		X
X		Safety Valves		X
	X	Foundation, Anchor Bolts, Concrete, Grout		X
	X	Chemical Feed Storage and Feed Pump		X

SCOPE OF SUPPLY (CONT'D)

Supply			**Installation**	
VEO	***Buyer***	**ITEM**	***VEO***	***Buyer***
	X	Feedwater Treatment System (Water Soft/ Filter System)		X
	X	Blow Down Tanks (Continuous and Intermittent)		X
	X	Deaerator & Feedwater Pump(s) with Drives		X
	X	Spare Parts (Optional – Available Direct from VEO – priced sep.)		X
	N/A	Special Tools		
	N/A	Economizer By-Pass System		X
	X	Sample Cooler System		X
	N/A	Steam Coil Air Heater		X
X		Loading Equipment at Shop		X
	X	Unloading Equipment at Jobsite		X
	X	Boil-Out Chemicals		X
	X	Site Disposal of Chemicals and Water		X
	X	Boiler Room/Site Modifications		X
	X	Site Storage Prior to Installation		X
	X	Environmental Permit		X
	X	Erection and Start-Up Labor		X
	X	Field Balancing and Alignment of Rotating Equipment		X
	X	Electrical Power Supply and Lighting Protection		X
	X	Interconnecting Wiring or Cabling		X
	X	Erection Consultant		X
	X	Class Room Training		X
	X	Field Testing Labor, Equipment and Consumables		X
	X	Start-Up Consultant		X
X		Documentation		X
X		O & M Manuals		X

Heating Surfaces and Furnace Size

➢ Furnace Radiant Heating Surface	889 Sq. Ft.
➢ Boiler Convective Heating Surface	6,455 Sq. Ft.
➢ Total Heating Surface	7,344 Sq. Ft.
➢ Superheater Surface	980 Sq. Ft.
➢ Furnace Volume	1,633 Cu. Ft
➢ Overall Width	8'- 10"
➢ Average Height	8'- 6"
➢ Furnace Length	21'- 11"

Drums

Submerged arc automatic welded and stress relieved with radiographed welded seams

- Drum material is SA-516 Gr. 70
- Tubes are rolled and expanded into the drum
- Mud Drum is provided with a 12" x 16" hinged manway access in each drum head
- Steam Drum is provided with a 12" x 16" hinged manway access in each drum head

<u>Upper (Steam) Drum</u>

< Inside diameter is 42 inches
< External connections consist of the following connections:
  < main steam outlet, water column, drum level, auxiliary low water cut-off, steam gauge, vent, safety valve, feedwater, chemical feed and continuous blowdown.
< The upper drum includes a feedwater distribution pipe and a blowdown collection pipe.

<u>Lower (Mud) Drum</u>

< Inside diameter is 30 inches
< External connections consist of intermittent blowdown
< The intermittent blowdown connection is at the lowest point for draining of the unit

Tubes*

- All tubes enter the drum radially with full parallel bearing through the drum plate
- All tubes are full diameter tubes with no swaging

< Front Wall	2" O.D., 0.135" M.W., SA-178 A
< Rear Wall	2" O.D., 0.135" M.W., SA-178 A
< Furnace Floor, Sides & Roof	2" O.D., 0.135" M.W., SA-178 A
< Convection:	2" O.D., 0.120" M.W., SA-178 A
< Outer Side Wall:	2" O.D., 0.135" M.W., SA-178 A
< Superheater:	2" O.D., 0.180" M.W., SA-213TP304H

BOILER (CONT'D)

Boiler Wall Construction

The outer lagging of the boiler will have an average surface temperature of 140 Deg. F ambient with 2 MPH wind velocity. The boiler walls include the following:

- The furnace sides, roof and floor consist of a tube and membrane design. The wall is constructed with 2" O.D. tubes with 1" wide by ¼" thick steel membranes welded to each tube.

- The front wall consists of a tube and membrane design. The first layer is 2" O.D. tubes with 2" exposed width by ¼" thick carbon steel membranes welded to the tubes. The second layer is 3" of 1200 Deg. F. board insulation. The outer surface is flat carbon steel lagging properly stiffened.

- The rear wall consists of a tube and membrane design. The first layer is 2" O.D. tubes with 2" exposed width by ¼" thick carbon steel membranes welded to the tubes. The second layer is 3" of 1200 Deg. F. board insulation. The outer surface is flat carbon steel lagging properly stiffened.

- The outer boiler side wall is a tube and membrane design. The first layer is 2" O.D. tubes with 1" wide by ¼" thick carbon steel membrane welded to the tubes. The second layer is 3" of 1200 Deg. F. board insulation. The outer surface is galvanized corrugated lagging properly stiffened.

- The drum is insulated with 2" of 1200 Deg. F. blanket insulation. The outer lagging is 16 gauge carbon steel.

Boiler Access and Observation Ports

The furnace is accessible through one (1) 16" x 18" rear wall access door. The rear wall also includes three (3) 1 1/2" diameter self closing, air purged observation ports.

Steam Purification

The Voyager upper (steam) drum includes steam purifiers to provide 99.5% steam purity, when boiler water quality is in accordance with the ABMA recommendations as indicated in herein.

Structural Base

The boiler includes a rigid structural steel base frame designed to distribute the loads onto a flat concrete foundation.

Painting

Preparation and painting was done in accordance with the "Base" system shown on the following page. The top coat color is white.

Piping, Trim and Accessories

- Water level piping to water column and auxiliary water cutout
- Water level piping to three drum level transmitters
- Drain piping for water column, radar, water gauge glass, auxiliary cutout, and pressure gauge
- Steam pressure piping to pressure gauge
- Cooling air piping to the observation ports and flame scanners supplied and installed by others
- Chemical feed and continuous blowdown trim is provided at the rear of the steam drum
- Feedwater piping, control valve skid and piping to economizer & boiler supplied by others

BOILER (CONT'D)

Preparation and Painting Standards

Components	Base
Drum	Insulated and covered with flat rolled casing, 16 Gauge C.S., c/w 3-5 Mils D.F.T. High Temp. VEO Blue
Drum Heads	Insulated with insulating covers, 16 Gauge C.S., c/w 3-5 Mils D.F.T. High Temp. VEO Blue
Base Frame	Surface Preparation-SP3 Primer – 3-5 Mils D.F.T. VEO Blue
Exposed Casing	Surface Preparation-SP3 Primer – 3-5 Mils D.F.T. VEO Blue
Flue Gas Outlet	No Paint - Insulated and covered with galvanized corrugated lagging
Windbox/ Burner	Surface Preparation-SP6 Finish – 3-5 Mils High Temperature Gray
Steam Piping	2-3 Mils High Temp. Gray
Feedwater Piping	2-3 Mils High Temp. Gray
Trim Piping – (subassemblies)	2-3 Mils High Temp. Gray

Boiler Trim Package (Quantities listed for one (1) boiler)

BOILER	QUANTITY	SIZE	MANUFACTURER
Water Column (Tie Bar)	1	1”	VEO Titan
Water Column Drain Valve	1	1”	Vogt
Water Column Gauge Drain Valve	2	1”	Vogt
Steam Gauge	1	6”	Ashcroft
Steam Gauge Siphon	1	½”	VEO
Steam Drum Vent Valve	1	1”	Vogt
Steam Pressure Switches	2	N/A	Ashcroft
Steam Flow Transmitter	1	N/A	Rosemount
Steam Drum PSVs	2	2 1/2”	Kunkle
Superheater PSV	1	1 ½”	Consolidated
Intermittent Blowoff Valve (1st valve)	1	1 1/2”	Edwards
Intermittent Blowoff Valve (2nd valve)	1	1 1/2”	Edwards
Continuous Blowdown Shutoff Valve	1	1”	Vogt
Continuous Blowdown Meetering Valve	1	1”	Vogt
Drum Level Transmitter Shutoff	1	1”	Vogt
Main Steam Non-Return Valve	1	6”	Edwards
Main Steam Gate Valve	1	6”	Crane
Drum Level Transmitter	1	N/A	Rosemount
Drum Pressure Transmitter	1	N/A	Rosemount
Oxygen Analyzer	1	N/A	Rosemount
Flue gas Temperature Gauges	1	4”	Ashcroft
Airflow Transmitter	1	N/A	Rosemount
Combustion Air Temperature Transmitters	2	N/A	Rosemount
Flue Gas Recirculation Flow & Temp	1	N/A	FCI

BOILER WATER CHEMISTRY RECOMMENDATIONS

ABMA RECOMMENDED BOILER WATER LIMITS

Boiler Type	Drum pressure, psig	Total dissolved solids[b] in boiler water, ppm (max.)	Total Alkalinity[c] in boiler water, ppm	Suspended solids in boiler water, ppm (max.)	Total dissolved solids[c,e] in steam, ppm (max. expected value)
Drum-type boiler	0-300	700-3500	140-700	15	0.2-1.0
Drum-type boiler	301-450	600-3000	120-600	10	0.2-1.0
Drum-type boiler	451-600	500-2500	100-500	8	0.2-1.0
Drum-type boiler	601-750	200-2000	40-400	3	0.1-0.5
Drum-type boiler	751-900	150-1500	30-300	2	0.1-0.5
Drum-type boiler	901-1000	125-1250	25-250	1	0.1-0.5
Drum-type boiler	1001-1800	100	variable[d]	1	0.1
Drum-type boiler	1801-2350	50	variable[d]	N/A	0.1
Drum-type boiler	2351-2600	25	variable[d]	N/A	0.05
Drum-type boiler	2601-2900	15	variable[d]	N/A	0.05
Once-through boiler	1400 & above	0.05	N/A	N/A	0.05

[b] Actual values within the range reflect the TDS in the feedwater. Higher values are for high solids; lower values are for low solids in the feedwater.

[c] Actual values within the range are directly proportional to the actual value of TDS of boiler water. Higher values are for high solids; lower values are for low solids in the boiler water.

[d] Dictated by boiler water treatment.

[e] These values are exclusive of silica.

Steam purity is often confused with steam quality. Steam quality is a measure of the amount of moisture in the steam. Steam quality is expressed as the weight of dry steam in a mixture of steam and water droplets. For example, steam with 99% quality contains 1% liquid water.

Steam purity refers to the amount of solid, liquid, or vaporous contamination in the steam. High-purity steam contains very little contamination. Normally, steam purity is reported as the solids content.

SECTION E

VEO DRAWINGS

VEO PROJECT: VE-13288
COLUMBIA PULP
VS-5-78 BOILER

DRAWING INDEX

VICTORY ENERGY

J-VE-13288
COLUMBIA PULP PROJECT

TAB	DRAWING NUMBER	PROJECT DRAWINGS
	00-13288-00 R0	BOILER GENERAL ARRANGEMENT
	00-13288-01 R0	BOILER GENERAL ARRANGEMENT - FRONT & REAR VIEWS
	00-13288-02 R0	EQUIPMENT GENERAL ARRANGEMENT - RIGHT SIDE ELEVATION
	00-13288-03 R0	EQUIPMENT GENERAL ARRANGEMENT - LEFT SIDE ELEVATION
	00-13288-04 R0	EQUIPMENT GENERAL ARRANGEMENT - PLAN VIEW
	00-13288-05 R0	EQUIPMENT GENERAL ARRANGEMENT - FRONT & REAR VIEWS
	14-STD-010 R1	ACCESS DOOR BRICK INSTALLATION
	21-13288-01 R1	BOILER P&ID - FEEDWATER & DRUM TRIM
	21-13288-02 R2	BOILER P&ID - STEAM & FLUE GAS
	21-13288-99 R2	DRUM LEVEL ARRANGEMENT
	30-13288-00 R2	ECONOMIZER GENERAL ARRANGEMENT
	50-13288-00 R0	PIPING GENERAL ARRANGEMENT - NOTES
	50-13288-01 R0	PIPING GENERAL ARRANGEMENT - PLAN VIEW
	50-13288-02 R0	PIPING GENERAL ARRANGEMENT - SIDE VIEW
	50-13288-03 R0	PIPING GENERAL ARRANGEMENT - FRONT & REAR VIEW
	50-13288-04 R0	MAIN STEAM CROSSOVER PIPING
	50-13288-04A R0	MAIN STEAM CROSSOVER PIPING
	50-13288-04B R0	MAIN STEAM CROSSOVER PIPING
	50-13288-05 R2	SUPERHEATED STEAM PIPING
	50-13288-06 R0	TIE BAR PIPING ASSEMBLY
	50-13288-06A R0	TIE BAR PIPING ASSEMBLY
	50-13288-07 R0	LEVEL TRANSMITTER PIPING ASSEMBLY (UPPER)
	50-13288-08 R0	LEVEL TRANSMITTER PIPING ASSEMBLY (LOWER)
	50-13288-09 R0	LEVEL TRANSMITTER PIPING ASSEMBLY (UPPER)
	50-13288-10 R0	LEVEL TRANSMITTER PIPING ASSEMBLY (LOWER)
	50-13288-11 R0	LEVEL TRANSMITTER PIPING ASSEMBLY (UPPER)
	50-13288-12 R0	LEVEL TRANSMITTER PIPING ASSEMBLY (LOWER)
	50-13288-13 R0	PRESSURE INDICATOR PIPING ASSEMBLY
	50-13288-13A R0	PRESSURE INDICATOR PIPING ASSEMBLY
	50-13288-14 R0	CONTINUOUS BLOWDOWN PIPING ASSEMBLY
	50-13288-15 R0	CHEMICAL FEED PIPING ASSEMBLY
	50-13288-16 R0	INTERMITTENT BLOWDOWN PIPING ASSEMBLY
	50-13288-17 R0	BOILER VENT & SAFETY VALVES PIPING ASSEMBLY
	50-13288-18 R0	ECONOMIZER VENT & DRAIN PIPING ASSEMBLY
	50-13288-19 R0	ALWCO PIPING ASSEMBLY
	50-13288-20 R0	PSV TO DRIP PAN ELBOW SPOOLS
	60-13288-22 R1	WATER COLUMN HUNCTION BOX
	60-13288-23 R0	PUSH BUTTON BY PASS
	66-13288-01 R0	THERMOCOUPLE INSTALLATION DETAIL
	66-13288-02 R0	THERMOWELL INSTALLATION DETAIL
	66-13288-03 R0	THERMOWELL INSTALLATION DETAIL
	71-13288-01 R0	FAN TO BURNER DUCT ASSEMBLY
	90-13288-00 R2	BOILER FOUNDATION & REACTIONS
	90-13288-01 R0	FOUNDATION PLAN
	90-13288-02 R0	ECONOMIZER BASE
	90-13288-10 R1	BOILER SHIPPING ARRANGEMENT
	90-13288-30 R1	ECONOMIZER LIFTING DIAGRAM
	99-13288-01 R0	EQUIPMENT FIELD ASSEMBLY

Table

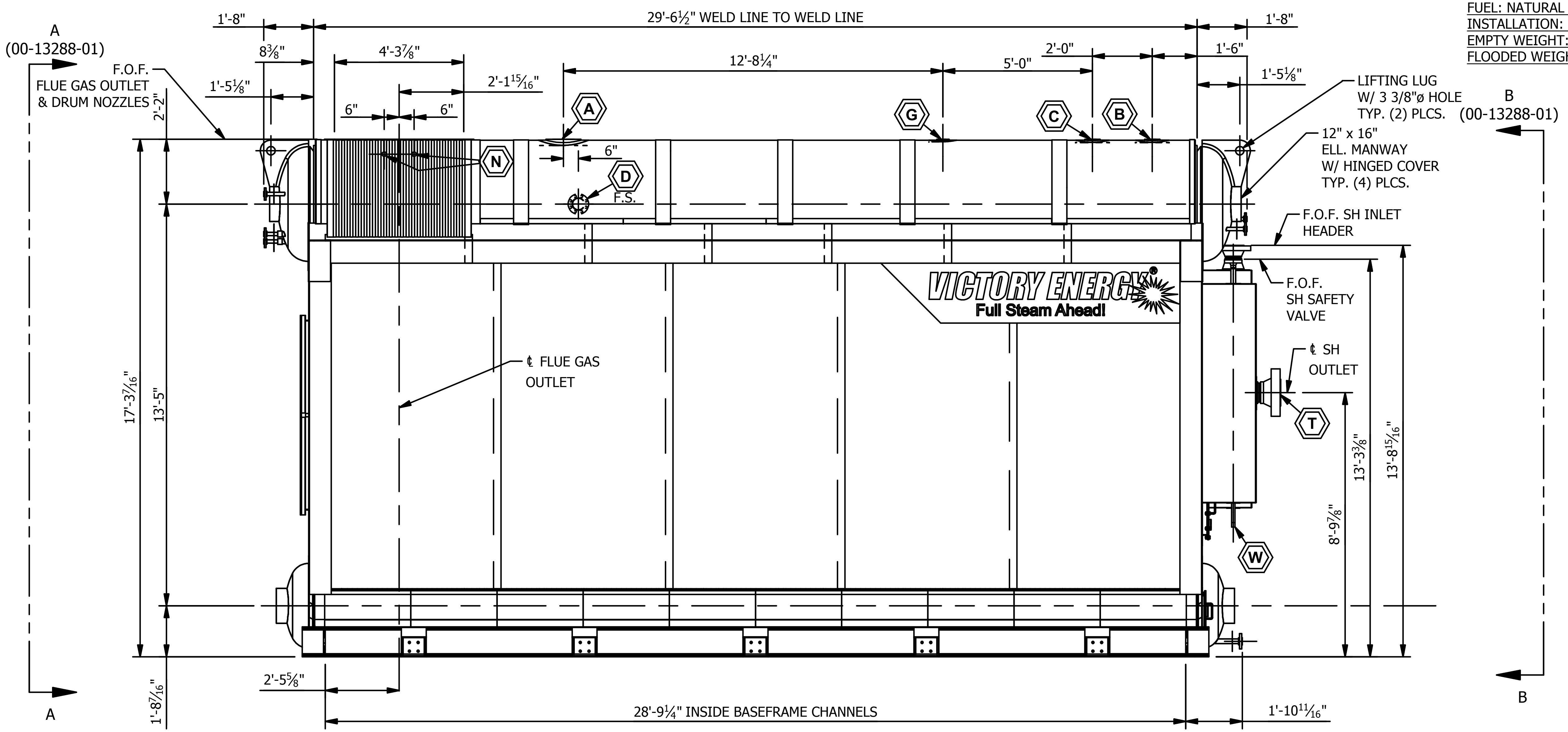
MARK	DESCRIPTION	QTY.	SIZE	TYPE
A	STEAM OUTLET	1	6"	600# RF
B	SAFETY RELIEF VALVE	1	1 1/2"	600# RF
C	SAFETY RELIEF VALVE	1	1 1/2"	600# RF
D	FEEDWATER INLET	1	3"	600# RF
E	BOILER BLOWOFF	1	1 1/2"	600# RF
F	CHEMICAL FEED	1	1"	600# RF
G	VENT	1	1"	600# RF
H	WATER COLUMN	2	1"	600# RF
J	DRUM LEVEL TRANSMITTER	2	1"	600# RF

Table

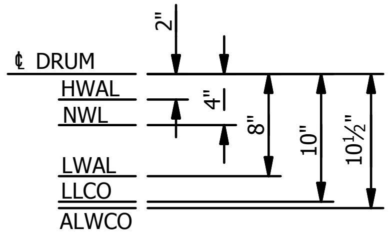
MARK	DESCRIPTION	QTY.	SIZE	TYPE
K	AUX. LOW WATER CUTOFF	1	1"	600# RF
L	CONTINUOUS BLOWDOWN	1	1"	600# RF
N	TEST PORTS	4	1"	SCH. 40
P	FURNACE PRESSURE	1	1"	SCH. 40
S	SUPERHEATER INLET	1	6"	600# RF
T	SUPERHEATER OUTLET	1	8"	1500# RF
V	SUPERHEATER RELIEF VALVE	1	1 1/2"	1500# RF
W	SUPERHEATER DRAIN	2	1"	SCH. 80

NOTE:
ALL MATERIAL AND FABRICATION
TO BE PER A.S.M.E. CODE
SECTION I 2015 EDITION

ONE (1) SHOP ASSEMBLED VOYAGER STEAM GENERATOR
BOILER HEATING SURFACE: TOTAL 7344 SQ.FT.
CONVECTION: 6455 SQ.FT.
RADIANT: 889 SQ.FT.
SUPERHEATER SURFACE: 980 SQ.FT.
MAWP: 950 PSIG @ 650°F
OPERATING PRESSURE: 837 PSIG
HYDROSTATIC TEST: 1425 PSIG
100% RT OF DRUM LONGITUDINAL &
CIRCUMFERENTIAL WELDS
100% VISUAL OF WELD & FIT UPS
SHELL & HEAD CORROSION ALLOWANCE: NONE
CAPACITY: 90,000 #/HR
STEAM PURITY: 0.05%
BLOWDOWN: 1%
FEEDWATER TEMPERATURE: 227°F @ CONTROL VALVE
FUEL: NATURAL GAS
INSTALLATION: OUTDOORS
EMPTY WEIGHT: 186,900 LBS.
FLOODED WEIGHT: 232,000 LBS.



BOILER SIDE VIEW



DRUM LEVELS

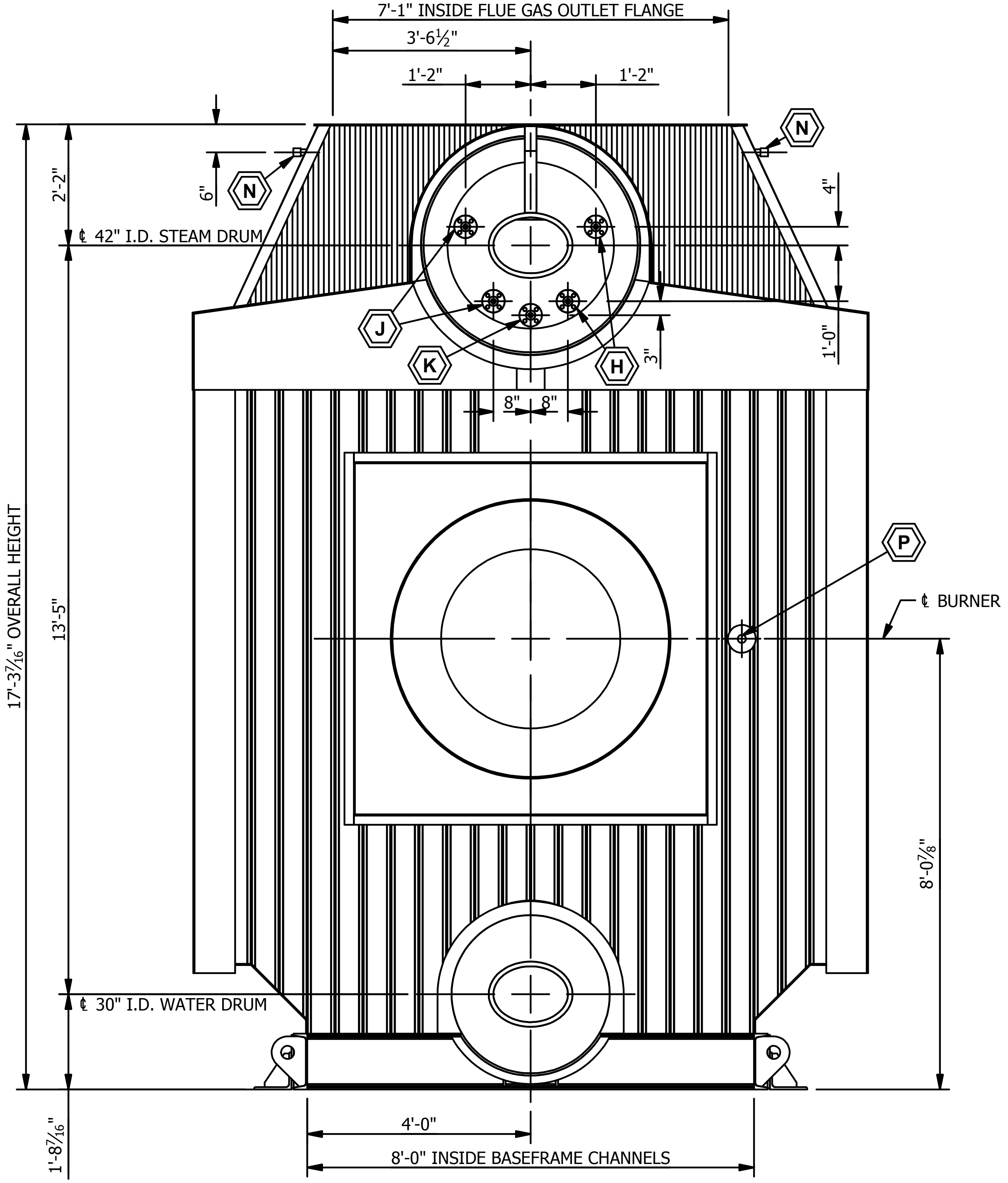
WORK THIS DWG. W/ DWG. 00-13288-01

REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0	JMP	12/27/17	JP	12/27/17	RELEASED FOR CONSTRUCTION

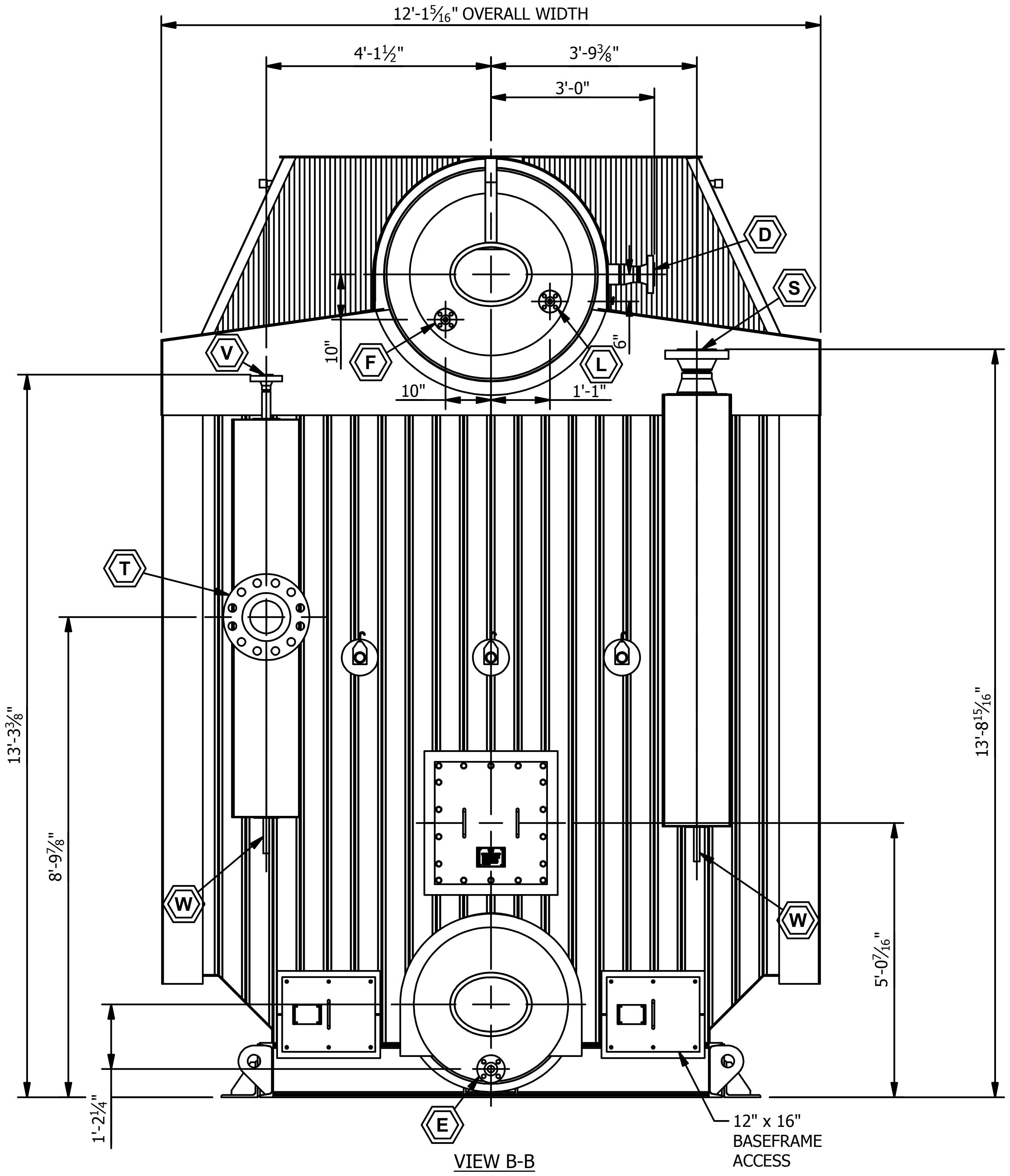
VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP-SH / COLUMBIA PULP
Title: BOILER GENERAL ARRANGEMENT

By: JMP	Chk'd: JP	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 11/8/2017	Date: 11/8/2017	Date: 11/8/2017	NTS	00-13288-00	0



VIEW A-A
(00-13288-00)



VIEW B-B
(00-13288-00)

WORK THIS DWG. W/ DWG. 00-13288-00

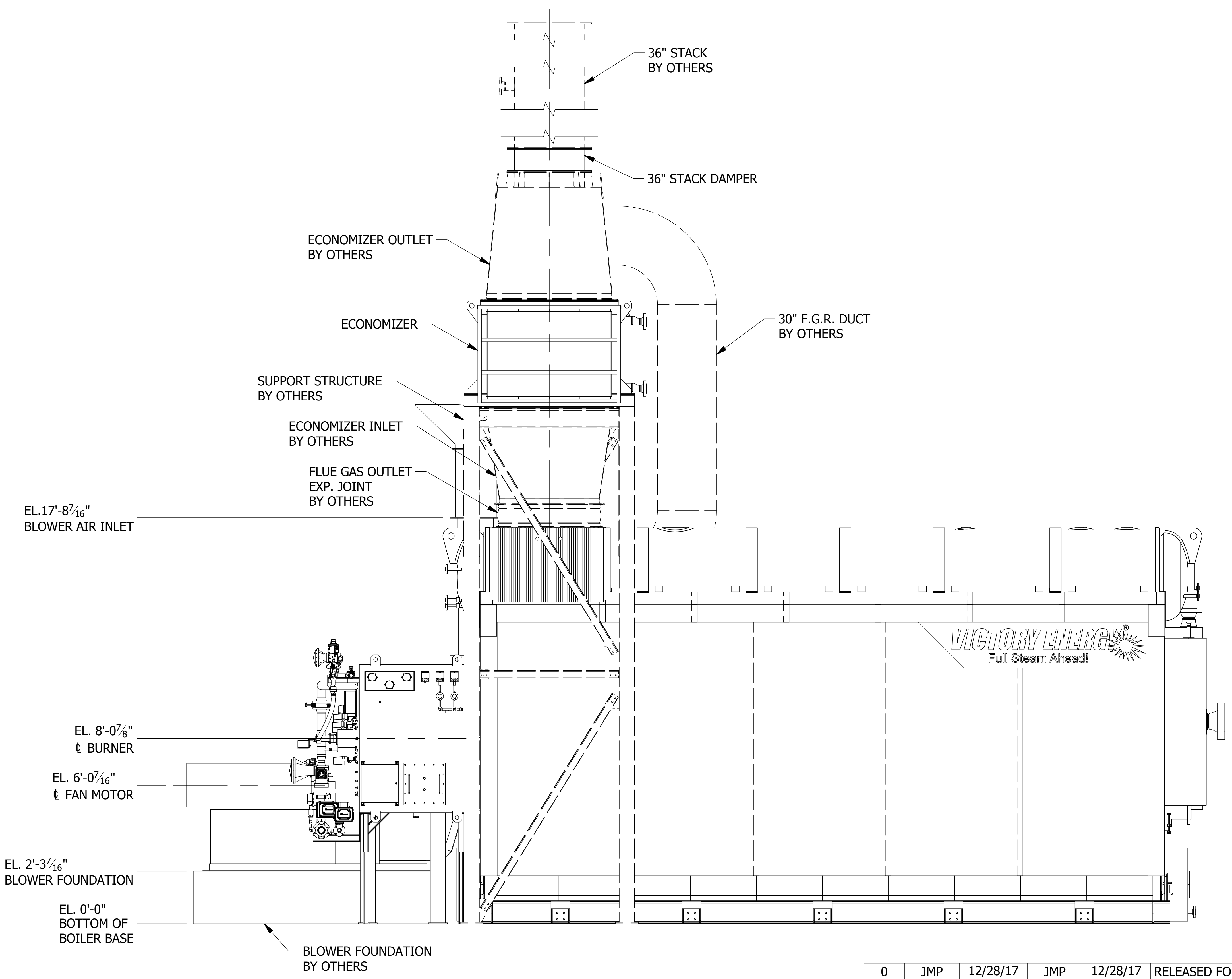
0	JMP	12/27/17	JP	12/27/17	RELEASED FOR FABRICATION
REV	BY	DATE	CHK'D	DATE	DESCRIPTION

VICTORY ENERGY®
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP-SH / COLUMBIA PULP

Title: BOILER GENERAL ARRANGEMENT

By: JMP	Chk'd: JP	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 11/8/2017	Date: 11/8/2017	Date: 11/8/2017	NTS	00-13288-01	0



RIGHT SIDE ELEVATION VIEW

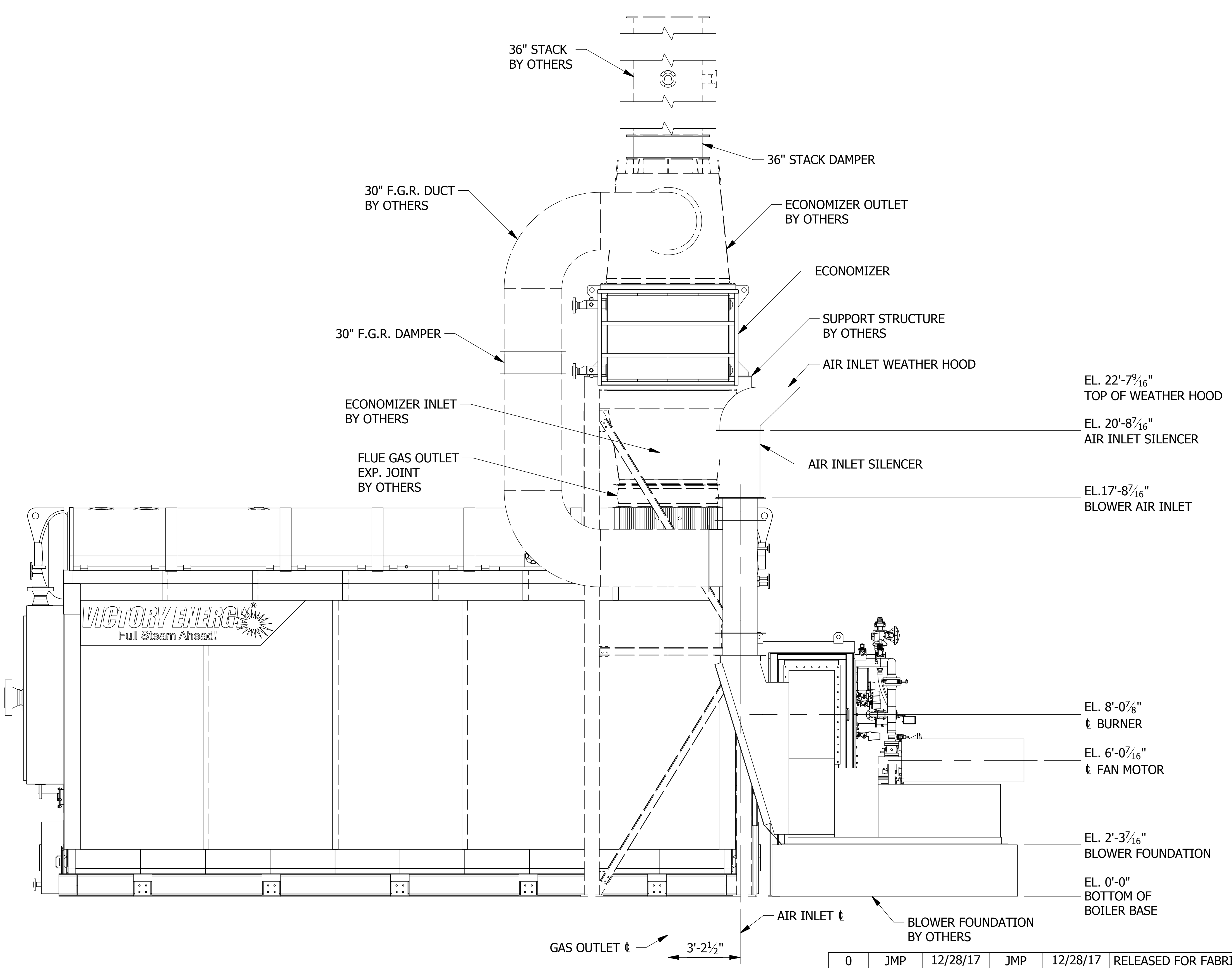
REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0	JMP	12/28/17	JMP	12/28/17	RELEASED FOR FABRICATION

VICTORY ENERGY®
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP- SH / COLUMBIA PULP

Title: SYSTEM ARRANGEMENT RIGHT ELEVATION

By: ADM	Chk'd: JMP	Aprv'd: GMC	Scale:	Dwg no:	Rev:
Date: 11/8/2017	Date: 11/8/2017	Date: 11/8/2017	NTS	00-13288-02	0



LEFT SIDE ELEVATION VIEW

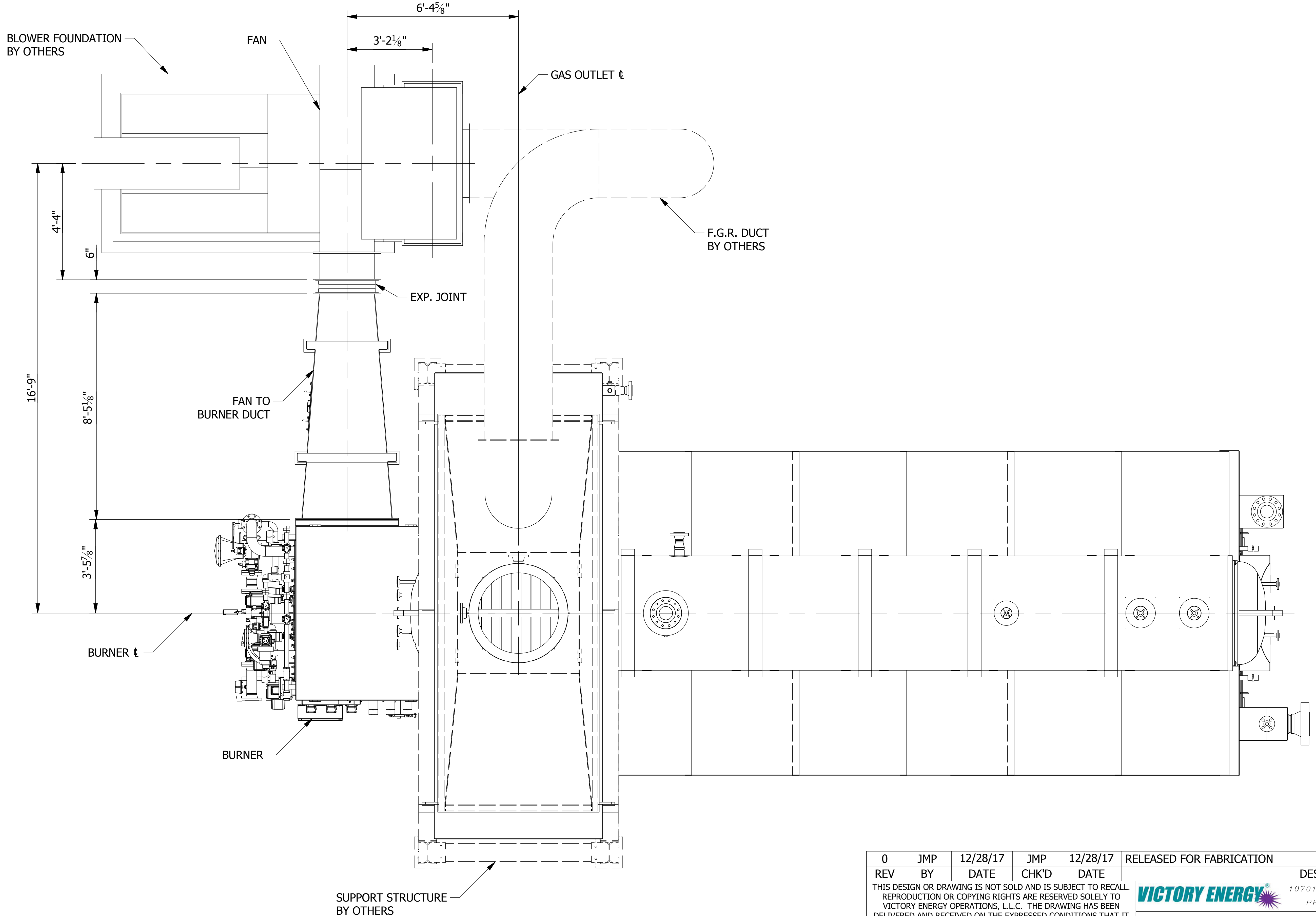
REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0	JMP	12/28/17	JMP	12/28/17	RELEASED FOR FABRICATION

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP- SH / COLUMBIA PULP

Title: SYSTEM ARRANGEMENT LEFT ELEVATION

By: ADM	Chk'd: JMP	Aprv'd: GMC	Scale:	Dwg no:	Rev:
Date: 11/8/2017	Date: 11/8/2017	Date: 11/8/2017	NTS	00-13288-03	0



SYSTEM ARRANGEMENT PLAN VIEW

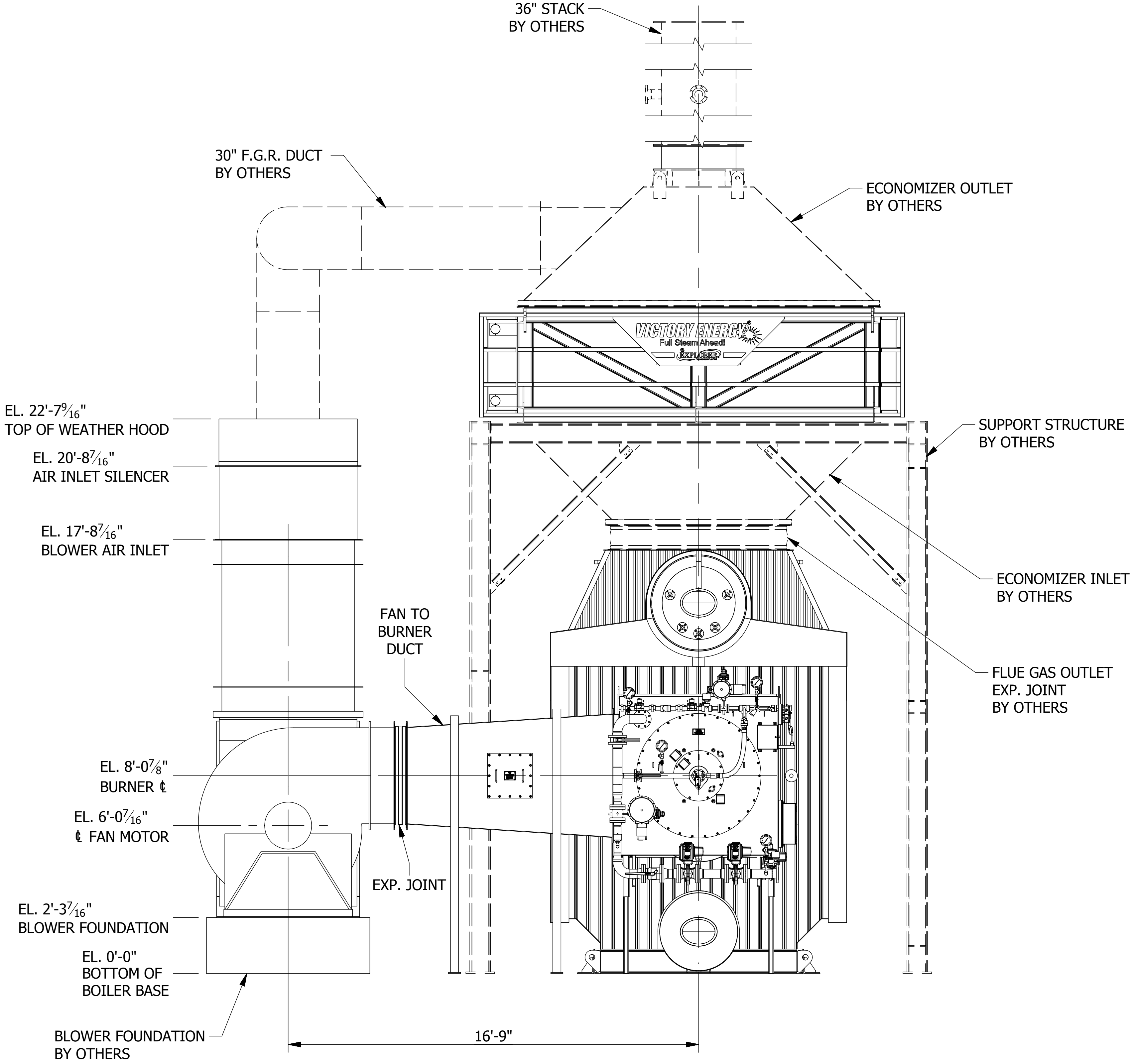
REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0	JMP	12/28/17	JMP	12/28/17	RELEASED FOR FABRICATION

VICTORY ENERGY®
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

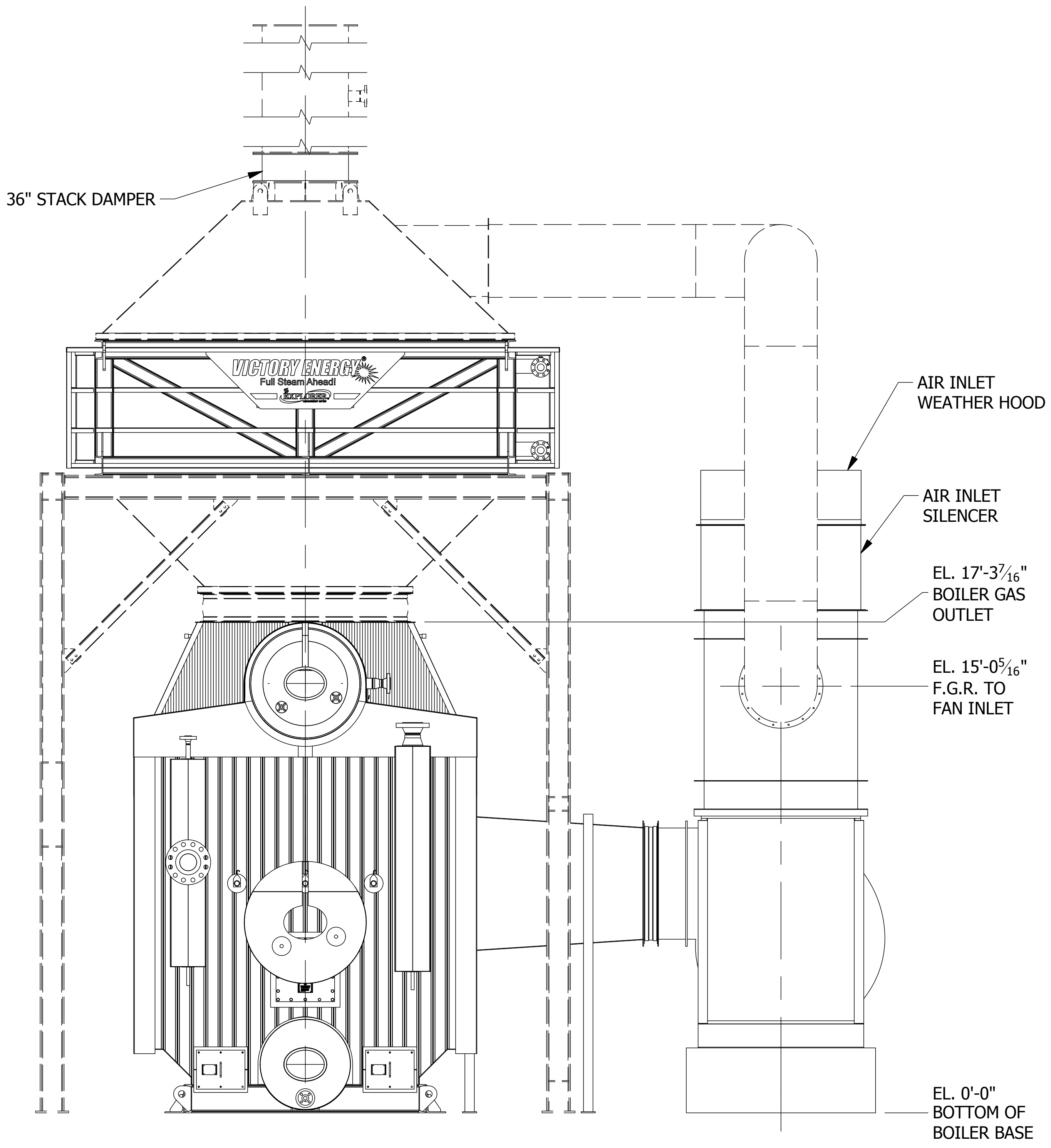
Unit Type/Cust: VS-5-78SP- SH / COLUMBIA PULP

Title: SYSTEM ARRANGEMENT PLAN VIEW

By: ADM	Chk'd: JMP	Aprv'd: GMC	Scale:	Dwg no:	Rev:
Date: 11/8/2017	Date: 11/8/2017	Date: 11/8/2017	NTS	00-13288-04	0



SYSTEM ARRANGEMENT FRONT ELEVATION VIEW



SYSTEM ARRANGEMENT BACK ELEVATION VIEW

REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0	JMP	12/28/17	JMP	12/28/17	RELEASED FOR FABRICATION

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP- SH / COLUMBIA PULP

Title: SYSTEM ARRANGEMENT FRONT/BACK ELEVATIONS

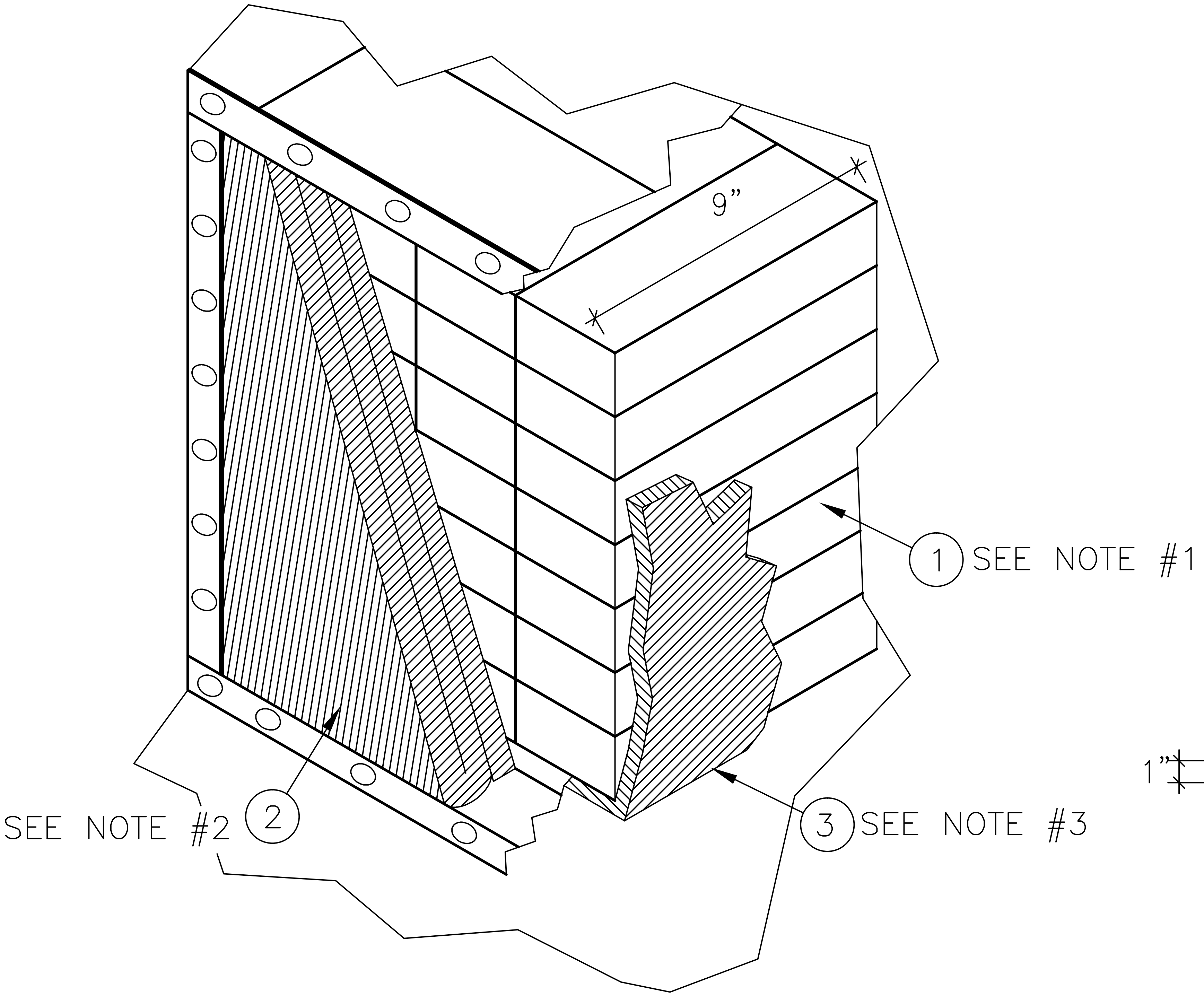
By: ADM	Chk'd: JMP	Aprv'd: GMC	Scale:	Dwg no:	Rev:
Date: 11/8/2017	Date: 11/8/2017	Date: 11/8/2017	NTS	00-13288-05	0

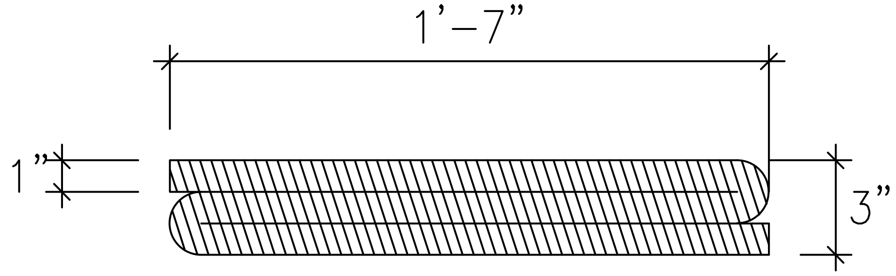
BILL OF MATERIAL

ITEM	QTY	DESCRIPTION	FT.	IN.	MATL.	WT:
1	24	9" X 4 1/2" X 2 1/2" 2300° F INSULATED FIRE BRICK				
2	10 SQ/FT	1" THK. 8 PCF 2600° F CFNB X 24" WIDE	4	10		
3	4SQ/FT	1" THK X 9" 8 PCF-2600° F CFNB X 24"				

INSTALLATION NOTES:

1. FIRST QUALITY FIRE BRICK LAID LOOSE AND DRY (NO MORTOR REQUIRED)
2. FOLD INSULATION PER FOLD DIAGRAM AND PLACE IN FRONT OF FIRE BRICK PRIOR TO PERMENANTLY FASTENING ACCESS DOOR
3. INSTALL 1" THK X 9" STRIP OF 8 PCF-2600° F CFNB AROUND PERIMETER OF FIRE BRICK





INSULATION FOLD DIAGRAM

TYP. ACCESS DOOR BRICK INSTALLATION

rev.	by	date	chk'd	date	description
6					
5					
4					
3					
2					
1	RDR	5-15-15	RR	5-15-15	REVISED B.O.M. TO MATCH PROPER ITEMS

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

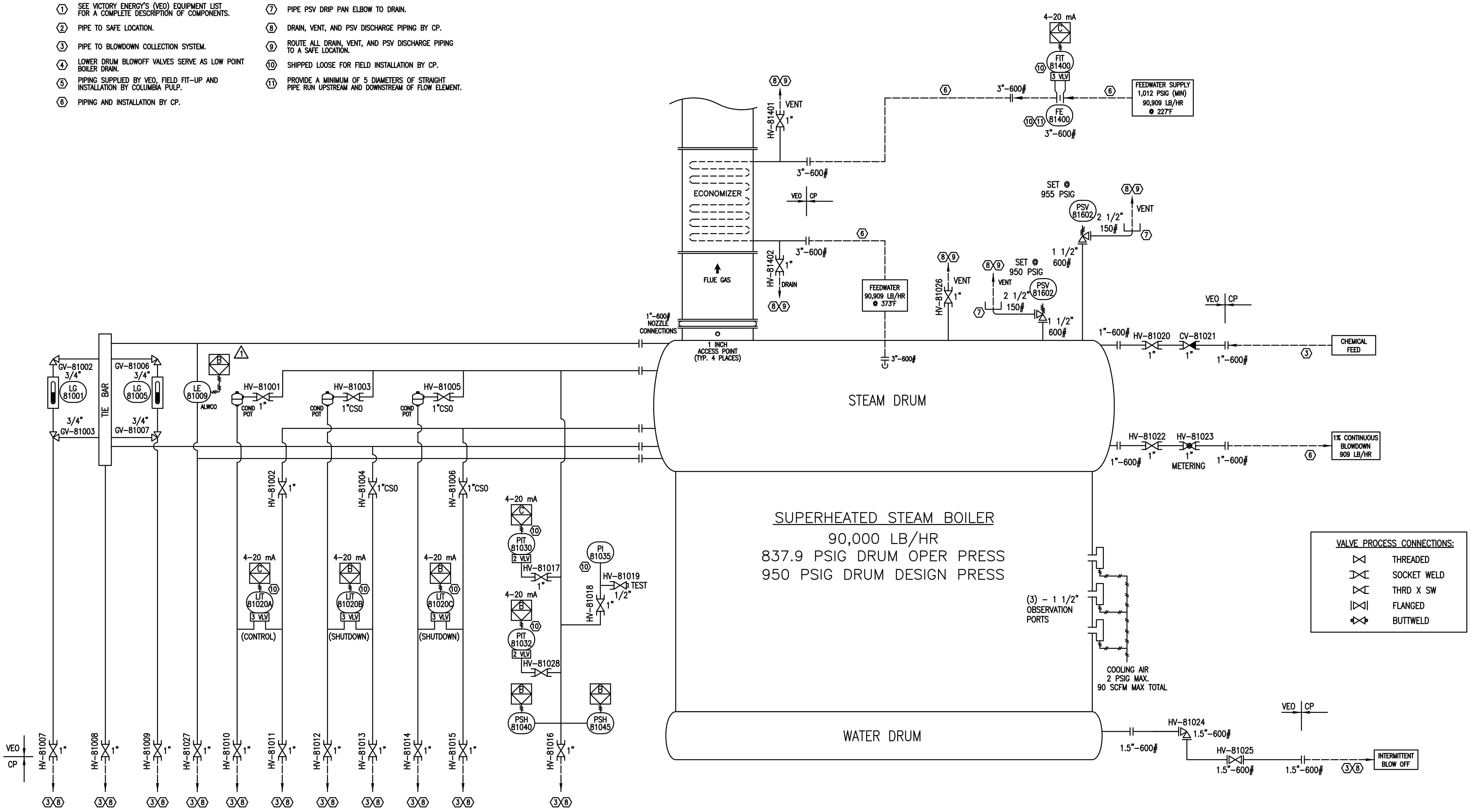
cust/proj.#: STANDARD

title: TYP. ACCESS DOOR BRICK INSTALLATION

by: B.S.	chk'd: C.LOG	aprv'd: T.M	scale:	dwg. no:	rev:
date: 10.15.07	date: 10.15.07	date: 10.15.07	N/A	14-STD-10	1

NOTES:

1. SEE VICTORY ENERGY'S (VEO) EQUIPMENT LIST FOR A COMPLETE DESCRIPTION OF COMPONENTS.
2. PIPE TO SAFE LOCATION.
3. PIPE TO BLOWDOWN COLLECTION SYSTEM.
4. LOWER DRUM BLOWOFF VALVES SERVE AS LOW POINT BOILER DRAIN.
5. PIPING SUPPLIED BY VEO, FIELD FIT-UP AND INSTALLATION BY COLUMBIA PULP.
6. PIPING AND INSTALLATION BY CP.
7. PIPE PSV DRIP PAN ELBOW TO DRAIN.
8. DRAIN, VENT, AND PSV DISCHARGE PIPING BY CP.
9. ROUTE ALL DRAIN, VENT, AND PSV DISCHARGE PIPING TO A SAFE LOCATION.
10. SHIPPED LOOSE FOR FIELD INSTALLATION BY CP.
11. PROVIDE A MINIMUM OF 5 DIAMETERS OF STRAIGHT PIPE RUN UPSTREAM AND DOWNSTREAM OF FLOW ELEMENT.



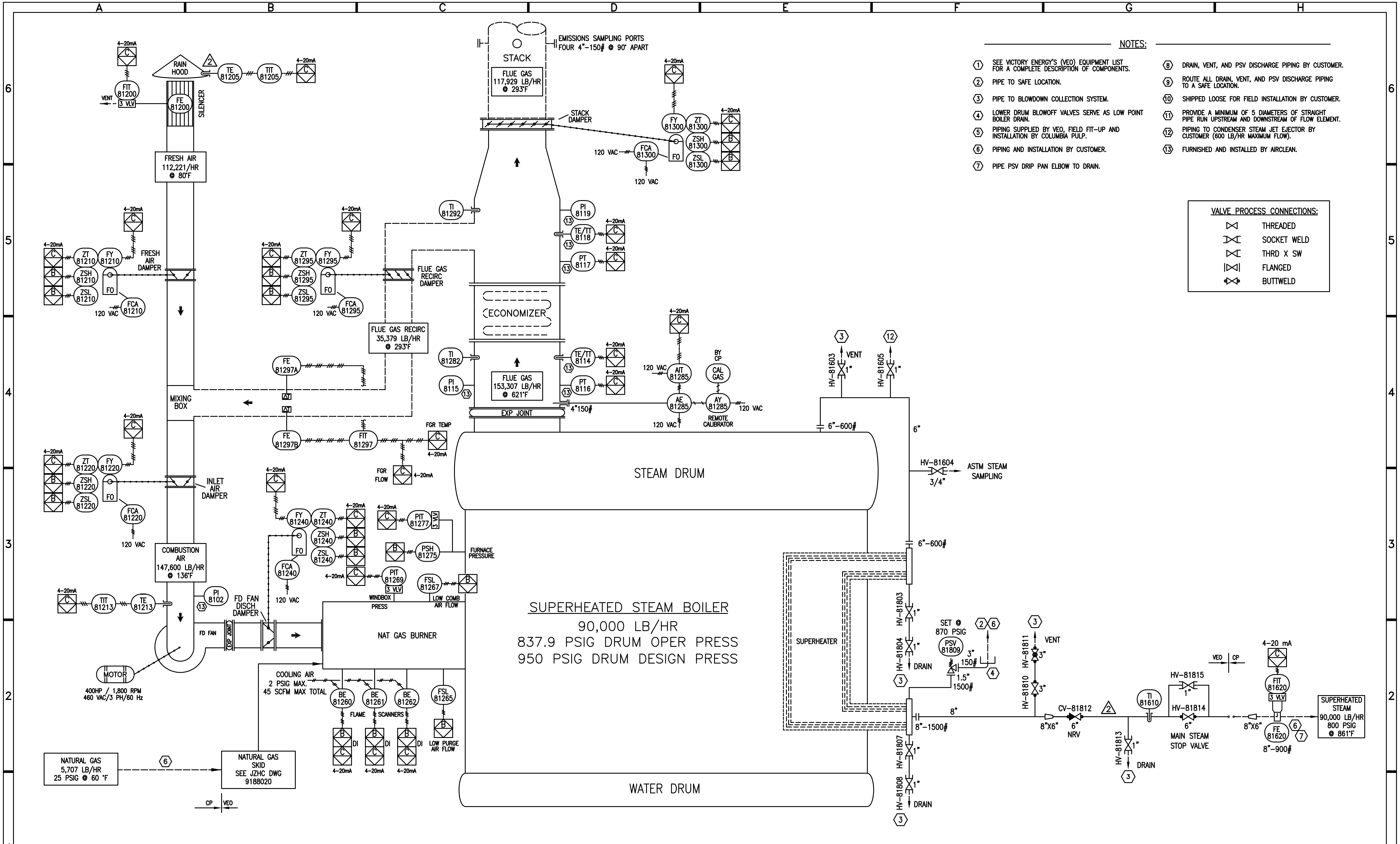
B BURNER MANAGEMENT SYSTEM by JZHC/COEN
C COMBUSTION CONTROL SYSTEM by JZHC/COEN
ELECTRIC OR ELECTRONIC SIGNAL
PNEUMATIC SIGNAL
I/A INSTRUMENT AIR SUPPLY
SOFTWARE LINK
PIPING BY OTHERS
MECHANICAL LINKAGE
FC – FAIL CLOSED
FO – FAIL OPEN
FIP – FAIL IN PLACE
NC – NORMALLY CLOSED
CONTROL VALVE
GATE VALVE
M MOTOR OPERATED BALL VALVE
PRESSURE SAFETY VALVE
EXPANSION JOINT
ORIFICE PLATE
GLOBE VALVE
FLOW CHECK VALVE
EXPANDER / REDUCER
ANGLE VALVE

Rev.	By	Date	Checked	Date	Description
1	FBL	16MAR18	GMc	16MAR18	CORRECTED LE-81009 INPUT
0	FBL	15DEC17	CJP	15DEC17	ADDED LE & PIT, REVISED TAG NUMBERS, ISSUED FOR CONSTRUCTION
C	FBL	23OCT17	CJP	23OCT17	INCORPORATED INTERNAL REVIEW COMMENTS
B	FBL	11OCT17	CJP	11OCT17	REDRAWN – FOR REVIEW AND APPROVAL

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Customer: COLUMBIA PULP / VE-13288
Title: WATER TUBE BOILER P&ID – FEEDWATER & DRUM TRIM

By: FBL	Chk'd: CJP	Aprv'd: GM	Scale:	Dwg. no:	Rev:
Date: 11OCT17	Date: 11OCT17	Date: 11OCT17	NONE	21-13288-01	1



NOTES:

1. SEE VICTORY ENERGY'S (VEO) EQUIPMENT LIST FOR A COMPLETE DESCRIPTION OF COMPONENTS.
2. PIPE TO SAFE LOCATION.
3. PIPE TO BLOWDOWN COLLECTION SYSTEM.
4. LOWER DRUM BLOWOFF VALVES SERVE AS LOW POINT BOILER DRAIN.
5. PIPING SUPPLIED BY VEO, FIELD FIT-UP AND INSTALLATION BY COLUMBIA PULP.
6. PIPING AND INSTALLATION BY CUSTOMER.
7. PIPE PSV DRIP PAN ELBOW TO DRAIN.
8. DRAIN, VENT, AND PSV DISCHARGE PIPING BY CUSTOMER.
9. ROUTE ALL DRAIN, VENT, AND PSV DISCHARGE PIPING TO A SAFE LOCATION.
10. SHIPPED LOOSE FOR FIELD INSTALLATION BY CUSTOMER.
11. PROVIDE A MINIMUM OF 5 DIAMETERS OF STRAIGHT PIPE RUN UPSTREAM AND DOWNSTREAM OF FLOW ELEMENT.
12. PIPING TO CONDENSER STEAM JET EJECTOR BY CUSTOMER (600 LB/HR MAXIMUM FLOW).
13. FURNISHED AND INSTALLED BY AIRCLEAN.

VALVE PROCESS CONNECTIONS:

THREADED
SOCKET WELD
THRD X SW
FLANGED
BUTTWELD

BURNER MANAGEMENT SYSTEM by JZHC/COEN
COMBUSTION CONTROL SYSTEM by JZHC/COEN
ELECTRIC OR ELECTRONIC SIGNAL
PNEUMATIC SIGNAL
I/A INSTRUMENT AIR SUPPLY
SOFTWARE LINK
PIPING BY OTHERS
MECHANICAL LINKAGE
FC – FAIL CLOSED
FO – FAIL OPEN
FIP – FAIL IN PLACE
NC – NORMALLY CLOSED
CONTROL VALVE
GATE VALVE
MOTOR OPERATED BALL VALVE
PRESSURE SAFETY VALVE
EXPANSION JOINT
PITOT TUBE
GLOBE VALVE
FLOW
CHECK VALVE
EXPANDER / REDUCER
ANGLE VALVE

Rev.	By	Date	Checked	Date	Description
1	FBL	06MAR18	GM	06MAR18	UPDATED DAMPER STYLES
0	FBL	15DEC17	CJP	15DEC17	ADDED AIRCLEAN INSTR, REVISED TAG NOS, ISSUED FOR CONSTRUCTION
C	FBL	23OCT17	CJP	23OCT17	INCORPORATED INTERNAL REVIEW COMMENTS
2	FBL	07MAR18	GM	07MAR18	REMOVED 8x6 REDUCER UPSTREAM OF TI-81610, MOVED TE-81205

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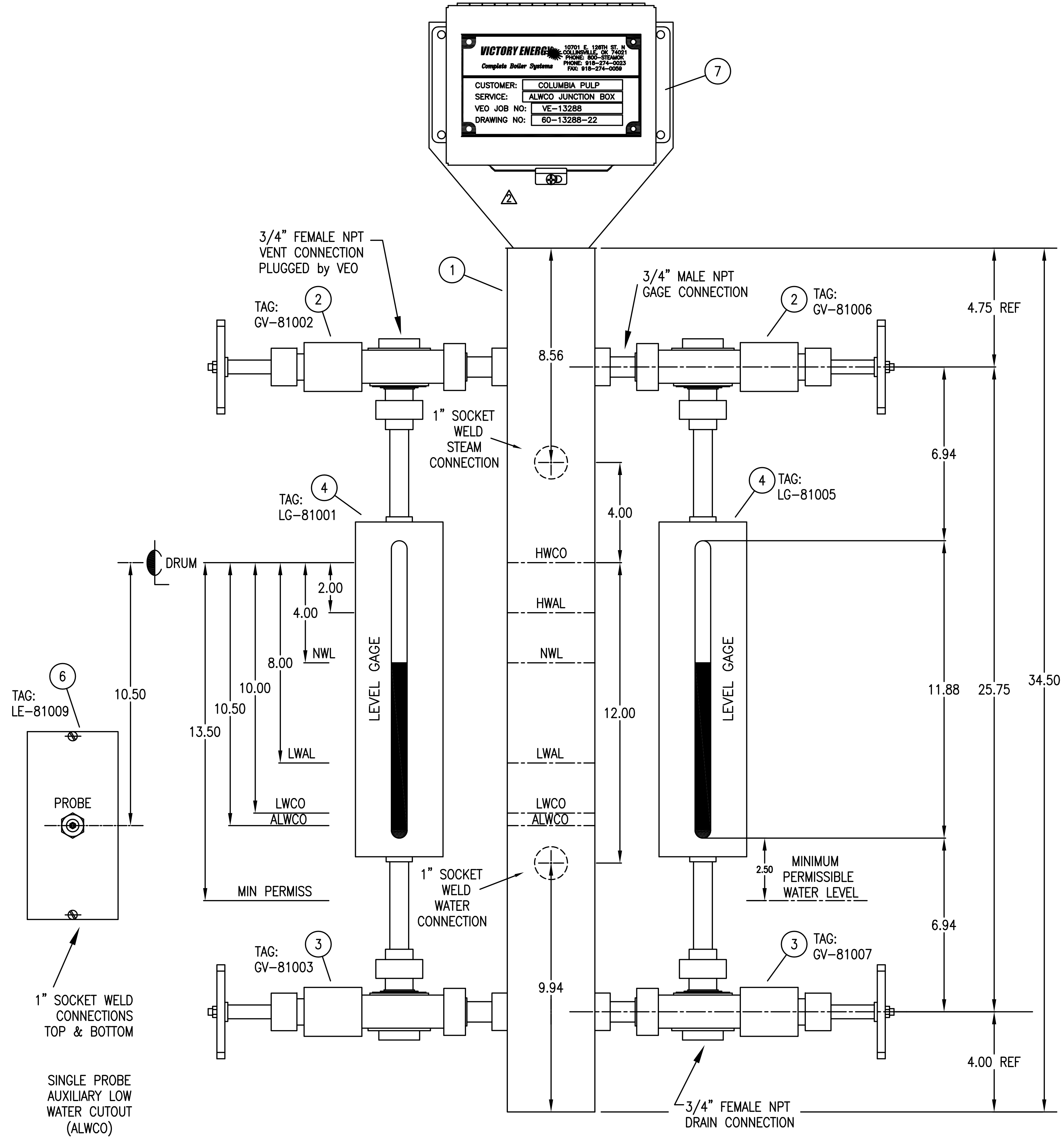
VICTORY ENERGY

10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Customer: COLUMBIA PULP / VE-13288

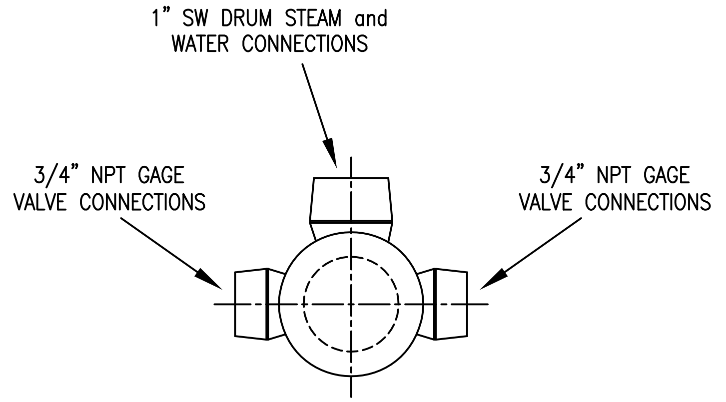
Title: WATER TUBE BOILER P&ID – STEAM, AIR FLOW, FLUE GAS

By: FBL	Chk'd: CJP	Aprv'd: GM	Scale:	Dwg. no:	Rev:
Date: 11OCT17	Date: 11OCT17	Date: 11OCT17	NONE	21-13288-02	2



MATERIAL LIST		
ITEM	QTY.	DESCRIPTION
1	1	VEO TIE BAR
2	2	UPPER GAGE VALVE, Q-T MODEL SV-1600-V06M-G06N-D06T-QL, LEVER OPERATED
3	2	LOWER GAGE VALVE, Q-T MODEL SV-1600-V06M-G06N-D06T-QL, LEVER OPERATED
4	2	LEVEL GAGE WITH 11.88" VISIBILITY, Q-T MODEL ST-1000-81-TB-06-N
		FURNISHED WITH BOIL-OUT KIT
5	2	QUEST-TEC SLI-81A-115AC GAGE ILLUMINATOR (NOT SHOWN)
6	1	VEO "TITAN" AUXILIARY LOW WATER CUTOUT
7	1	JUNCTION BOX PER DWG. 60-13288-22

REFERENCE DATA	
BOILER DRUM DESIGN PRESSURE	950 PSIG
BOILER DRUM OPERATING PRESSURE	837.9 PSIG
BOILER DRUM DESIGN TEMPERATURE	650 °F
BOILER DRUM OPERATING TEMPERATURE	526 °F
QUEST-TEC LEVEL GAGE WORKING STEAM PRESSURE	1,000 PSIG
Q-T LEVEL GAGE VALVE WORKING STEAM PRESSURE	1,600 PSIG



PARTIAL PLAN VIEW OF TIE BAR CONNECTIONS

Rev.	*By*	*Date*	*Checked*	*Date*	*Description*
2	FBL	15DEC17	AWG	22JAN18	ADDED J-BOX AND MOUNTING PLATE
1	FBL	15DEC17	AWG	15DEC17	ADDED STEAM AND WATER CONN REF DIMENSIONS
0	FBL	12DEC17	AWG	12DEC17	FOR CONSTRUCTION

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Customer: *COLUMBIA PULP / VE-13288*

Title: *STEAM DRUM TIE BAR ARRANGEMENT*

By: FBL	*Chk'd:* AWG	*Aprv'd:* GM	*Scale:*	*Dwg. no:*	*Rev:*
Date: 12DEC17	*Date:* 12DEC17	*Date:* 12DEC17	NONE	21-13288-99	2

SCHEDULE OF OPENINGS

MK	QTY	SERVICE	SIZE	RATIN	TYPE
A	1	INLET	3"	600#	RFWN
B	1	OUTLET	3"	600#	RFWN
C	1	VENT	1"	3000#	FNPT w/ PLUG
D	1	DRAIN	1"	3000#	FNPT w/ PLUG
E	2	TEMP. CONN.	1"	3000#	FNPT w/ PLUG

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

DESIGN DATA:

JOB NUMBER: VEO-13288
CODE STAMP ASME SECTION I (2015 EDITION) △1
M.A.W.P.: 1,000 PSIG △1
HYDROTEST PRESSURE: 1,500 PSIG △1
POST WELD HEAT TREATMENT: NOT REQUIRED
TOTAL EFFECTIVE HEAT SURFACE: 17,380 FT² △1
HEAT EXCHANGED: 13.6301 MMBTU/HR △1
UNIT WEIGHT DRY: 30,015 LBS △1
UNIT WEIGHT WET: 32,630 LBS △1

TUBE SIDE DATA:

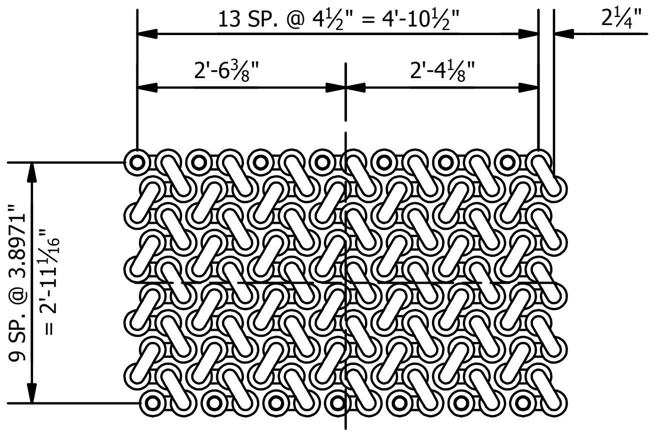
HEADERS: 4" IPS x SCH. 80 x SA-106-B MAT'L.
TUBES: 2" O.D. x 0.135" M.W. SA-178-A MAT'L.
FINS: 7/8" HIGH x 0.05" THK. x 6.5 FINS/IN C/STL MAT'L. △1
EFFECTIVE FIN LENGTH: 14'-3"
FIN TYPE: SERRATED
TUBE END PREP: BEVEL
TUBE DESIGN TEMP.: 700° F. △1
HEADER DESIGN TEMP.: 650° F.
COLD BENT RETURNS

SHELL SIDE DATA:

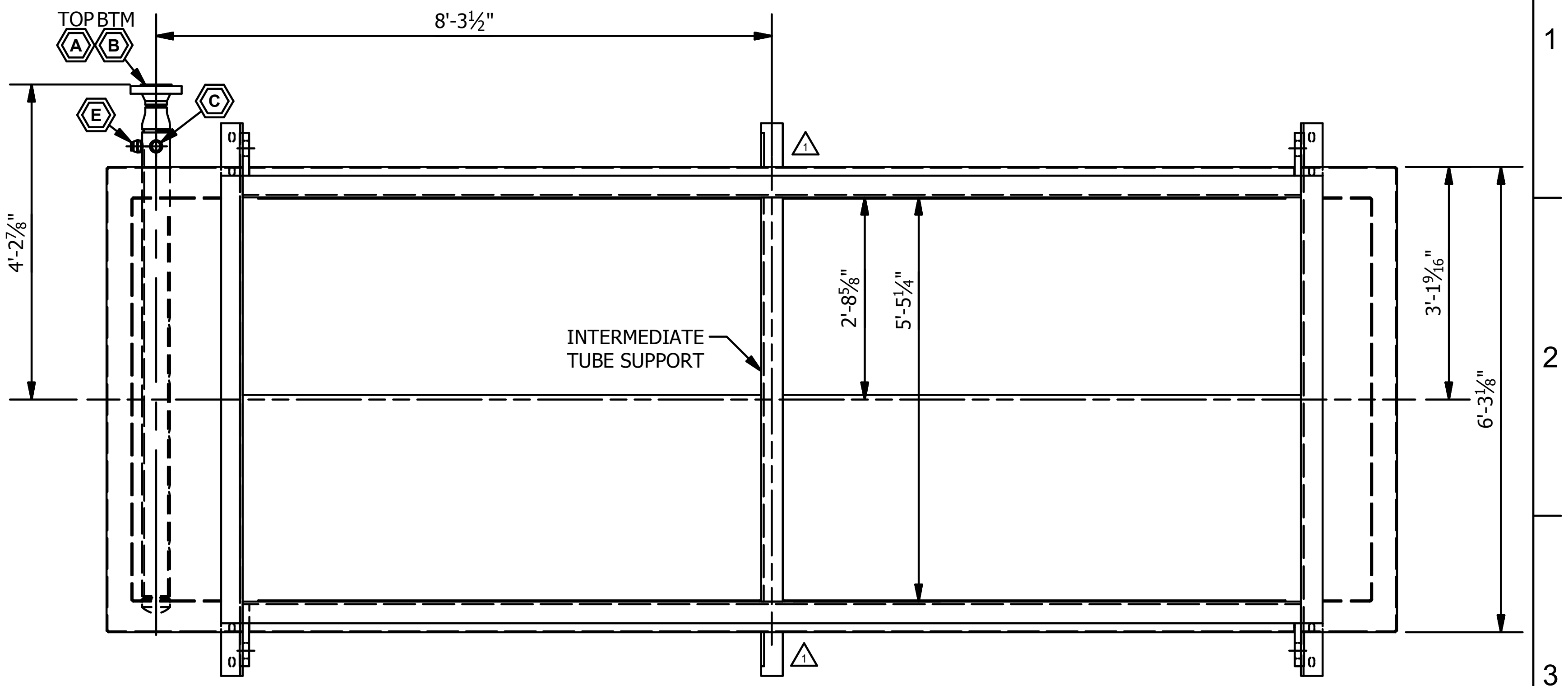
ALL INNER CASING JOINTS TO BE SEAL WELDED

RADIOGRAPHY: 100% OF 10% TUBE TO TUBE WELDS
(ONE ELLIP. SHOT PER WELD)
1-MANIFOLD WELD (100%)

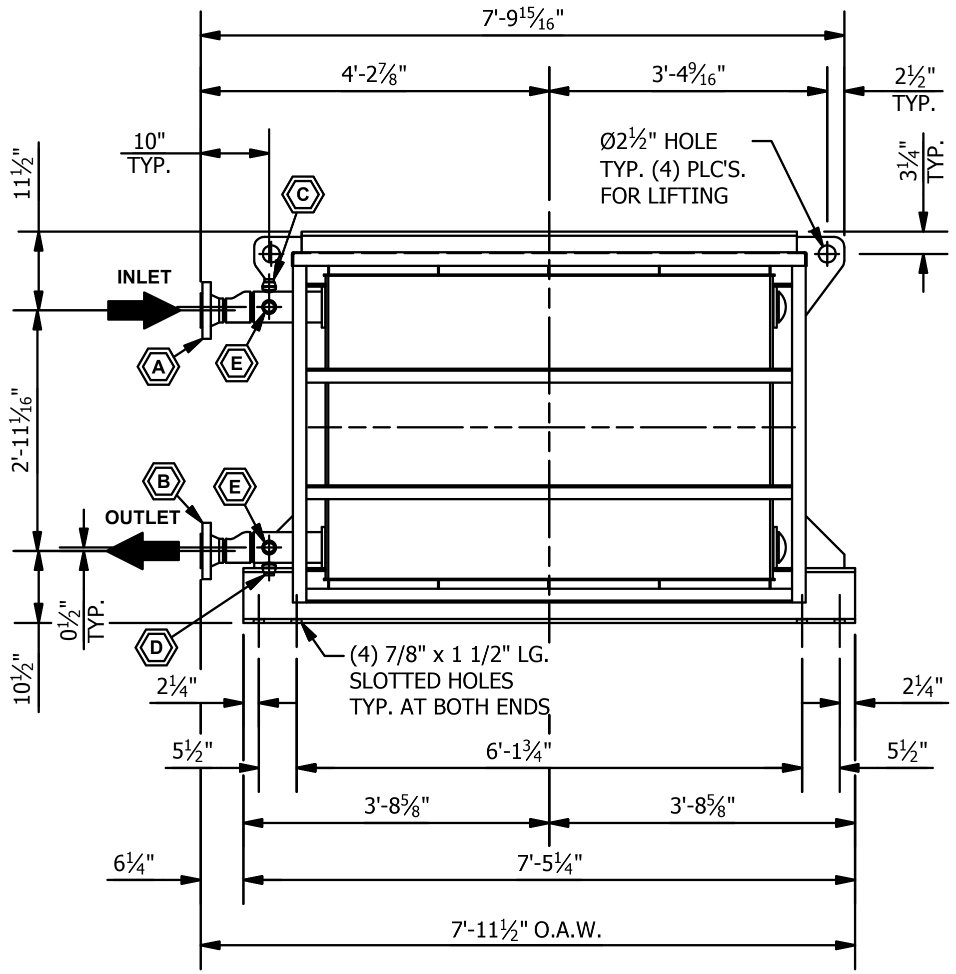
△1



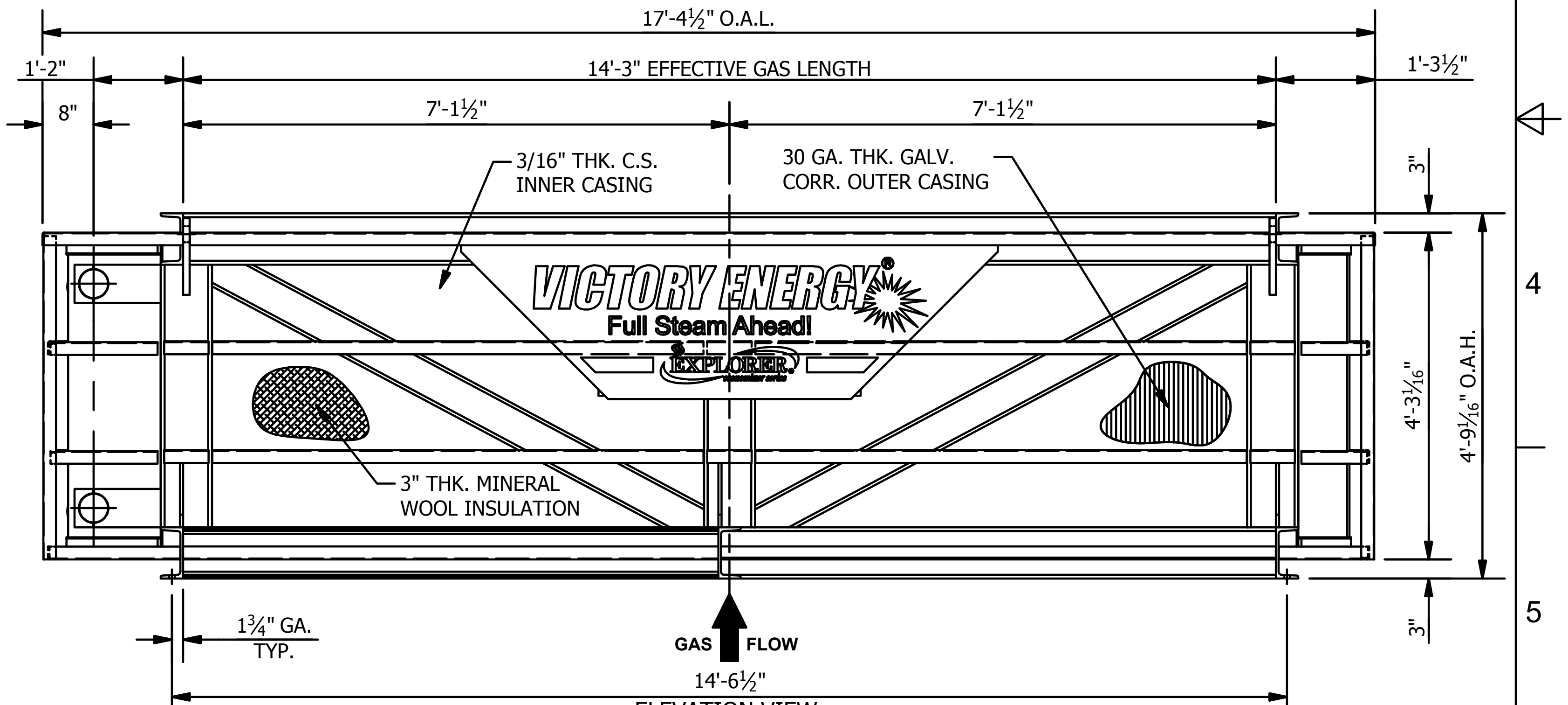
TERMINAL END TUBE LAYOUT



PLAN VIEW



END VIEW



ELEVATION VIEW

REV	BY	DATE	CHK'D	DATE	DESCRIPTION
2	JMP	5/31/18	GM	5/31/18	ADDED APPROVED INITIALS
1	ED	9/1/17	DAR	9/5/17	UPDATED GA

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: COLUMBIA PULP / VEO-13288
Title: ECONOMIZER GENERAL ARRANGEMENT

By: ELD	Chk'd: JS	Aprv'd: GM	Scale:	Dwg no:	Rev:
Date: 12/4/2015	Date: 12/8/2015	Date: 5/23/2018	NTS	30-13288-00	2

CUSTOMER CONNECTIONS

MARK	DESCRIPTION	QTY.	SIZE	TYPE
A1	MAIN STEAM OUTLET CONNECTION	1	6"	B.W.
A2	MAIN STEAM VENT CONNECTION	1	3"	B.W.
A3	MAIN STEAM DRAIN CONNECTION	1	1"	S.W.
A4	PRIMARY SUPERHEATER DRAIN CONNECTION	1	1"	S.W.
A5	SECONDARY SUPERHEATER DRAIN CONNECTION	1	1"	S.W.
A6	MAIN STEAM CROSSOVER VENT CONNECTION	2	1"	S.W.
A7	MAIN STEAM CROSSOVER SAMPLING CONNECTION	1	3/4"	S.W.
B1	ECONOMIZER INLET CONNECTION	1	3"	600# R.F.
B2	ECONOMIZER OUTLET CONNECTION	1	3"	600# R.F.
B3	ECONOMIZER VENT CONNECTION	2	1"	S.W.
B4	ECONOMIZER DRAIN CONNECTION	2	1"	S.W.
C1	BOILER SAFETY RELIEF CONNECTION	2	2 1/2"	150# R.F.
C2	SUPERHEATER SAFETY RELIEF CONNECTION	1	3"	150# R.F.
D1	INTERMITTENT BLOWDOWN CONNECTION	1	1 1/2"	600# R.F.
E1	CHEMICAL FEED CONNECTION	1	1"	600# R.F.
F1	BOILER VENT CONNECTION	1	1"	S.W.
G1	TIE BAR DRAIN CONNECTION	1	1"	S.W.
G2	SITE GLASS DRAIN CONNECTION	2	1"	S.W.
H1	LEVEL TRANSMITTER DRAIN CONNECTION	6	1"	S.W.
J1	PRESSURE INDICATOR DRAIN CONNECTION	1	1"	S.W.
J2	PRESSURE INDICATOR TEST CONNECTION	1	1/2"	S.W.
K1	CONTINUOUS BLOWDOWN CONNECTION	1	1"	600# R.F.
L1	AUXILIARY LOW WATER CUT OFF DRAIN CONNECTION	1	1"	S.W.

DRAWINGS

DWG#	ITEM	QTY.	DESCRIPTION	INSTALL
50-13288	-00	1	PIPING GENERAL ARRANGEMENT (NOTES)	
50-13288	-01	1	PIPING GENERAL ARRANGEMENT (PLAN VIEW)	
50-13288	-02	1	PIPING GENERAL ARRANGEMENT (ELEVATION VIEW)	
50-13288	-03	1	PIPING GENERAL ARRANGEMENT (VIEWS "FRONT" & "BACK")	
50-13288	-04	1	MAIN STEAM CROSSOVER PIPING ASSEMBLY	FIELD
50-13288	-05	1	MAIN STEAM PIPING ASSEMBLY	FIELD
50-13288	-06	1	TIE BAR PIPING ASSEMBLY	FIELD
50-13288	-07	1	LEVEL TRANSMITTER PIPING ASSEMBLY (UPPER)	FIELD
50-13288	-08	1	LEVEL TRANSMITTER PIPING ASSEMBLY (LOWER)	FIELD
50-13288	-09	1	LEVEL TRANMITTER PIPING ASSEMBLY (UPPER)	FIELD
50-13288	-10	1	LEVEL TRANSMITTER PIPING ASSEMBLY (LOWER)	FIELD
50-13288	-11	1	LEVEL TRANMITTER PIPING ASSEMBLY (UPPER)	FIELD
50-13288	-12	1	LEVEL TRANSMITTER PIPING ASSEMBLY (LOWER)	FIELD
50-13288	-13	1	PRESSURE INDICATOR PIPING ASSEMBLY	FIELD
50-13288	-14	1	CONTINUOUS BLOWDOWN PIPING ASSEMBLY	FIELD
50-13288	-15	1	CHEMICAL FEED PIPING ASSEMBLY	FIELD
50-13288	-16	1	INTERMITTENT BLOWDOWN PIPING ASSEMBLY	FIELD
50-13288	-17	1	BOILER VENT & SAFETY VALVES PIPING ASSEMBLY	FIELD
50-13288	-18	1	ECONOMIZER VENT & DRAIN PIPING ASSEMBLY	FIELD
50-13288	-19	1	ALWCO PIPING ASSEMBLY	FIELD

GENERAL PIPING DESIGN NOTES:

1) RADIOGRAPHY (NOT REQUIRED).
2) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
3) CONSTRUCT TO ASME B31.1
4) ALL PIPE LENGTHS BASED ON 1/8" GAP.
5) ALL WELDS TO BE DEBURRED.
6) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
7) ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
8) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.

DESIGN NOTES:

INTERMITTENT BLOW-OFF

1) DESIGN TEMP @ 650°
2) MAWP @ 1,175 PSIG.
4) HYDROTEST PRESSURE @ 1,763 PSIG.

DESIGN NOTES:

SATURATED STEAM OUTLET & BOILER TRIM PIPING

1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
4) HYDROTEST PRESSURE @ 1,425 PSIG.

DESIGN NOTES:

SUPERHEATED STEAM PIPING

1) DESIGN TEMP @ 950°F
2) MAWP @ 900 PSIG.
4) HYDROTEST PRESSURE @ 1,350 PSIG.

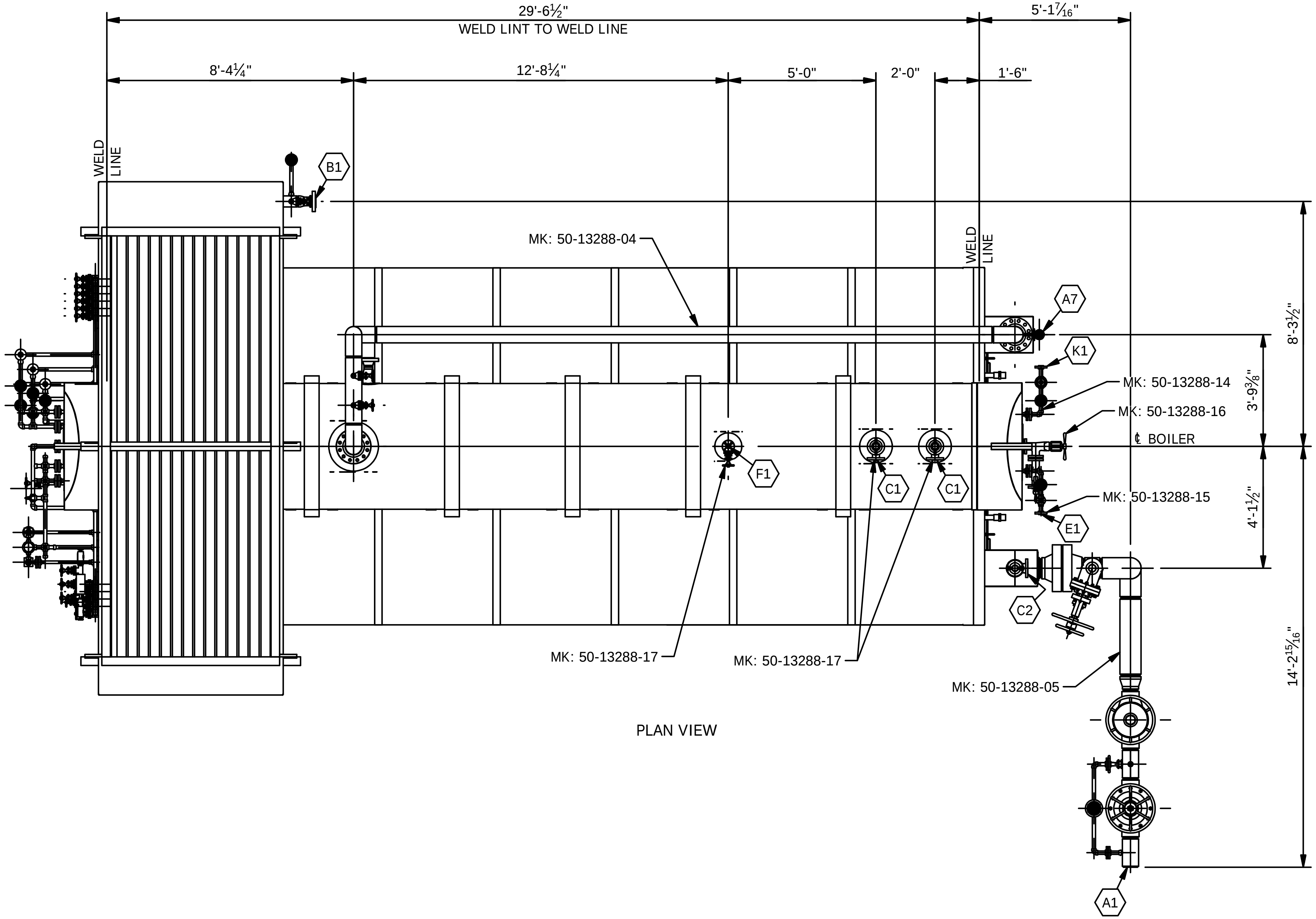
REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0	TWS	8/30/18	TWS	8/30/18	RELEASED FOR FABRICATION

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP SH

Title: PIPING GENERAL ARRANGEMENT (NOTES)

By: TWS	*Chk'd:* GMc	*Aprv'd:* DAR	*Scale:*	*Dwg no:*	*Rev:*
Date: 1/2/2018	*Date:* 1/2/2018	*Date:* 1/2/2018	NTS	50-13288-00	0



PLAN VIEW

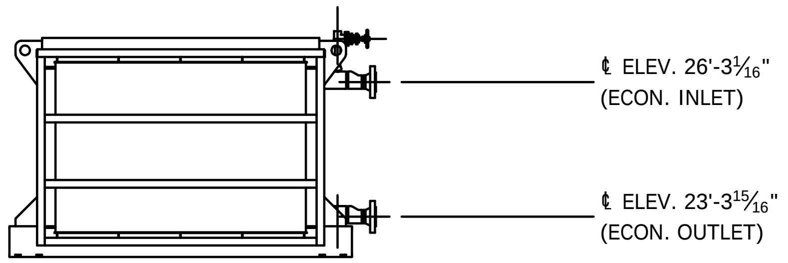
0	TWS	8/30/18	TWS	8/30/18	RELEASED FOR FABRICATION
REV	BY	DATE	CHK'D	DATE	DESCRIPTION

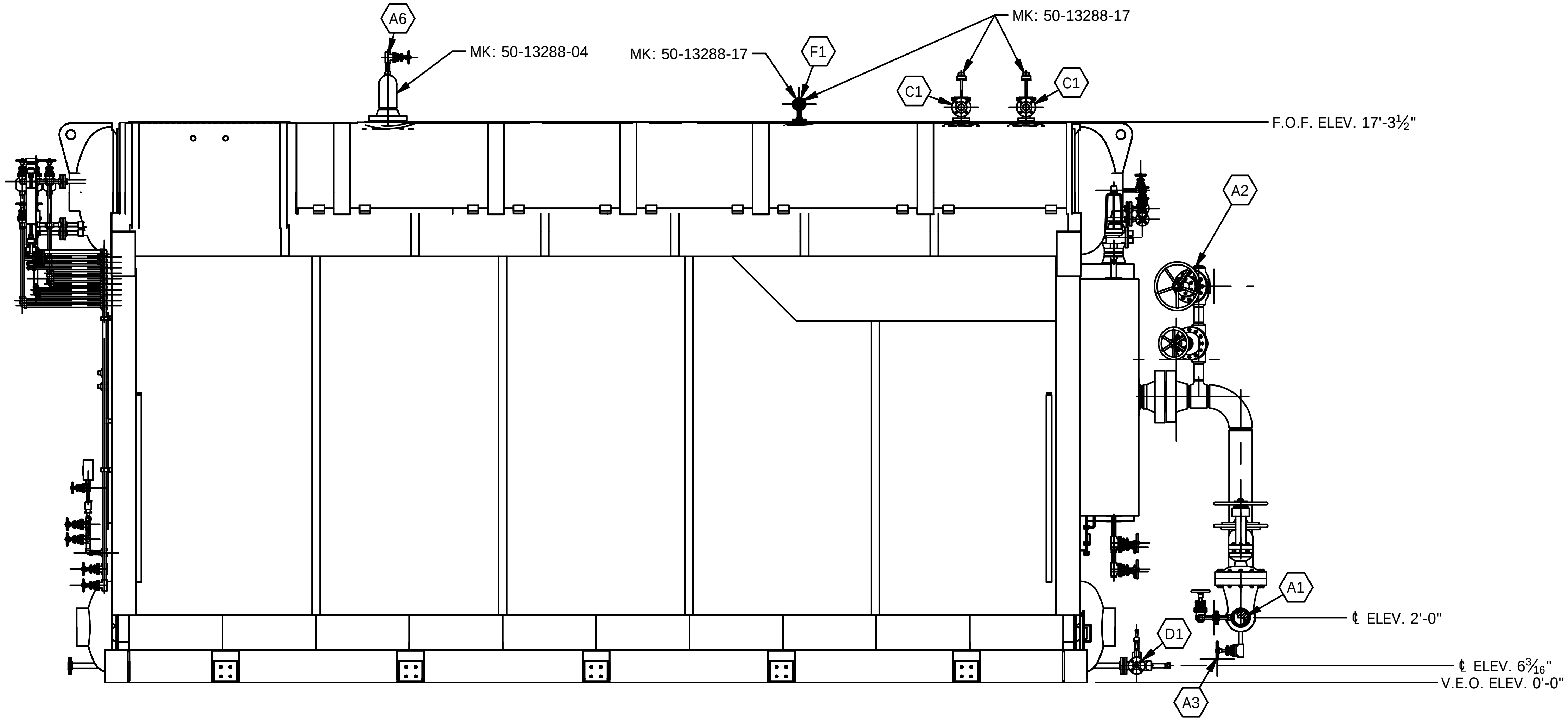
VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust:

Title: PIPING GENERAL ARRANGEMENT (PLAN VIEW)

By: TWS	Chk'd: GMc	Aprv'd: DAR	Scale:	Dwg no:	Rev:
Date: 1/2/2018	Date: 1/2/2018	Date: 1/2/2018	NTS	50-13288-01	0





ELEVATION VIEW

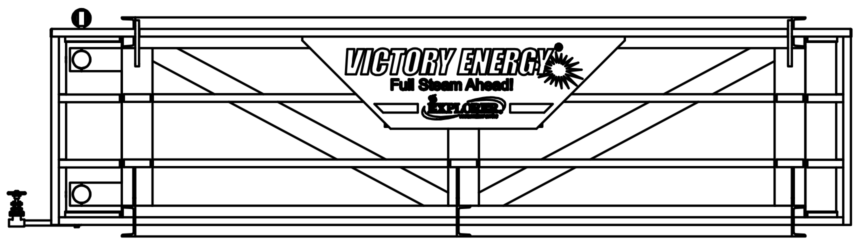
0	TWS	8/30/18	TWS	8/30/18	RELEASED FOR FABRICATION
REV	BY	DATE	CHK'D	DATE	DESCRIPTION

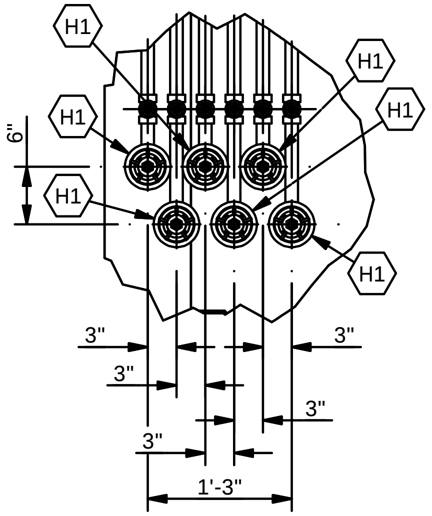
VICTORY ENERGY®
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust:

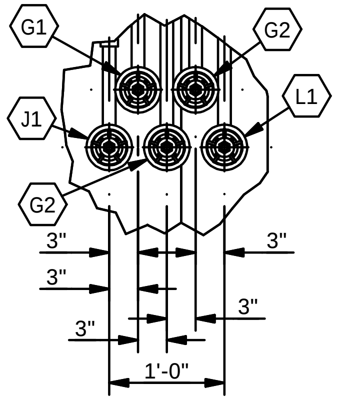
Title: PIPING GENERAL ARRANGEMENT (ELEVATION VIEW)

By: TWS	*Chk'd: GMc*	*Aprv'd: DAR*	*Scale:*	*Dwg no:*	*Rev:*
Date: 1/2/2018	*Date: 1/2/2018*	*Date: 1/2/2018*	*NTS*	*50-13288-02*	*0*

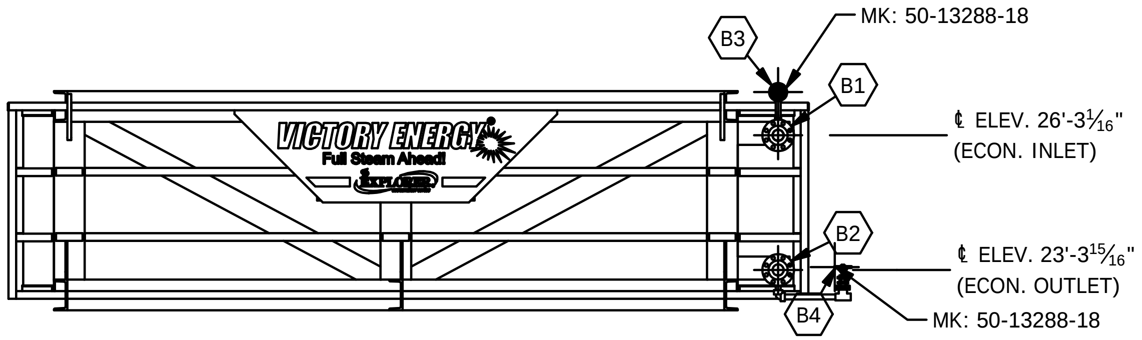


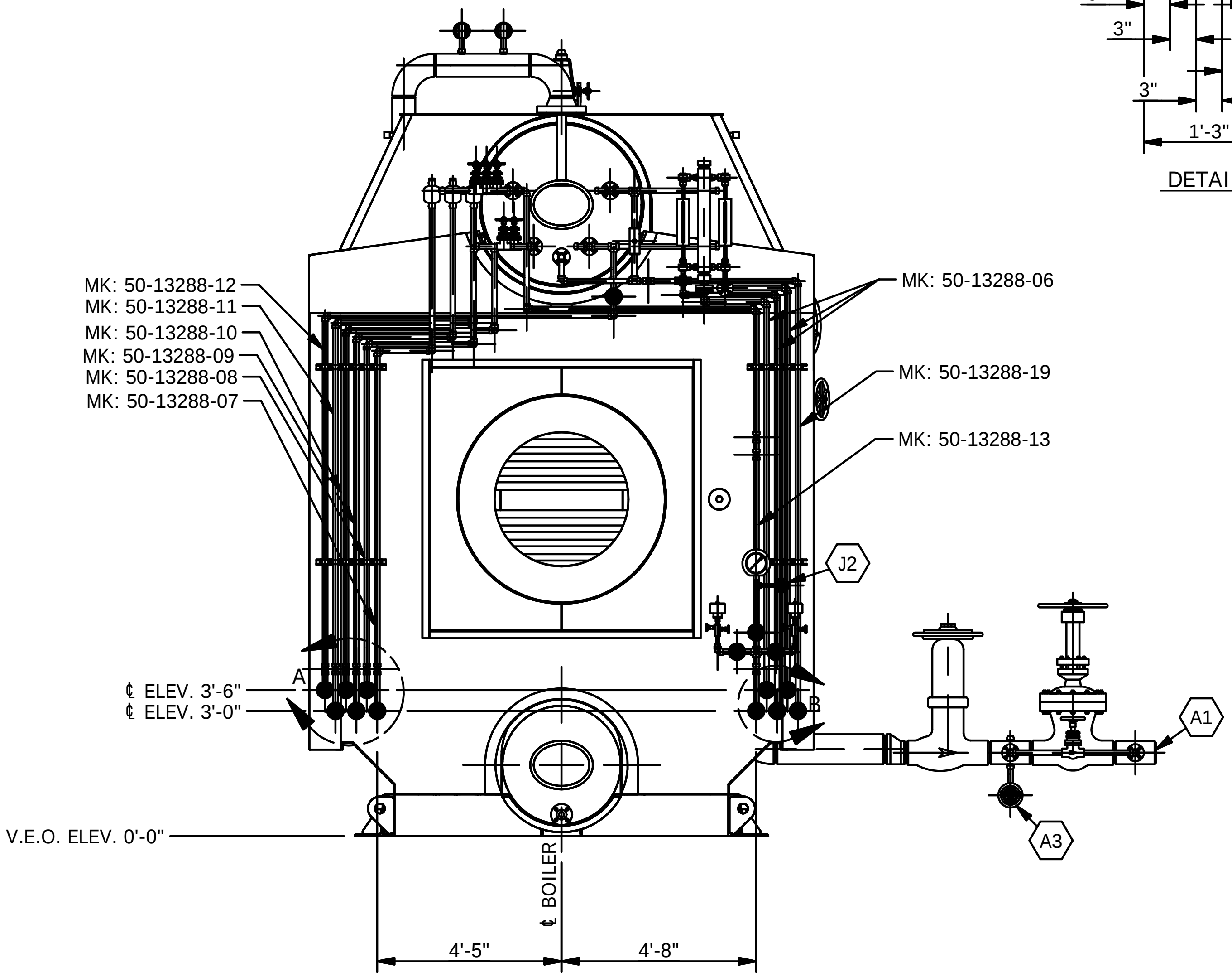


DETAIL A

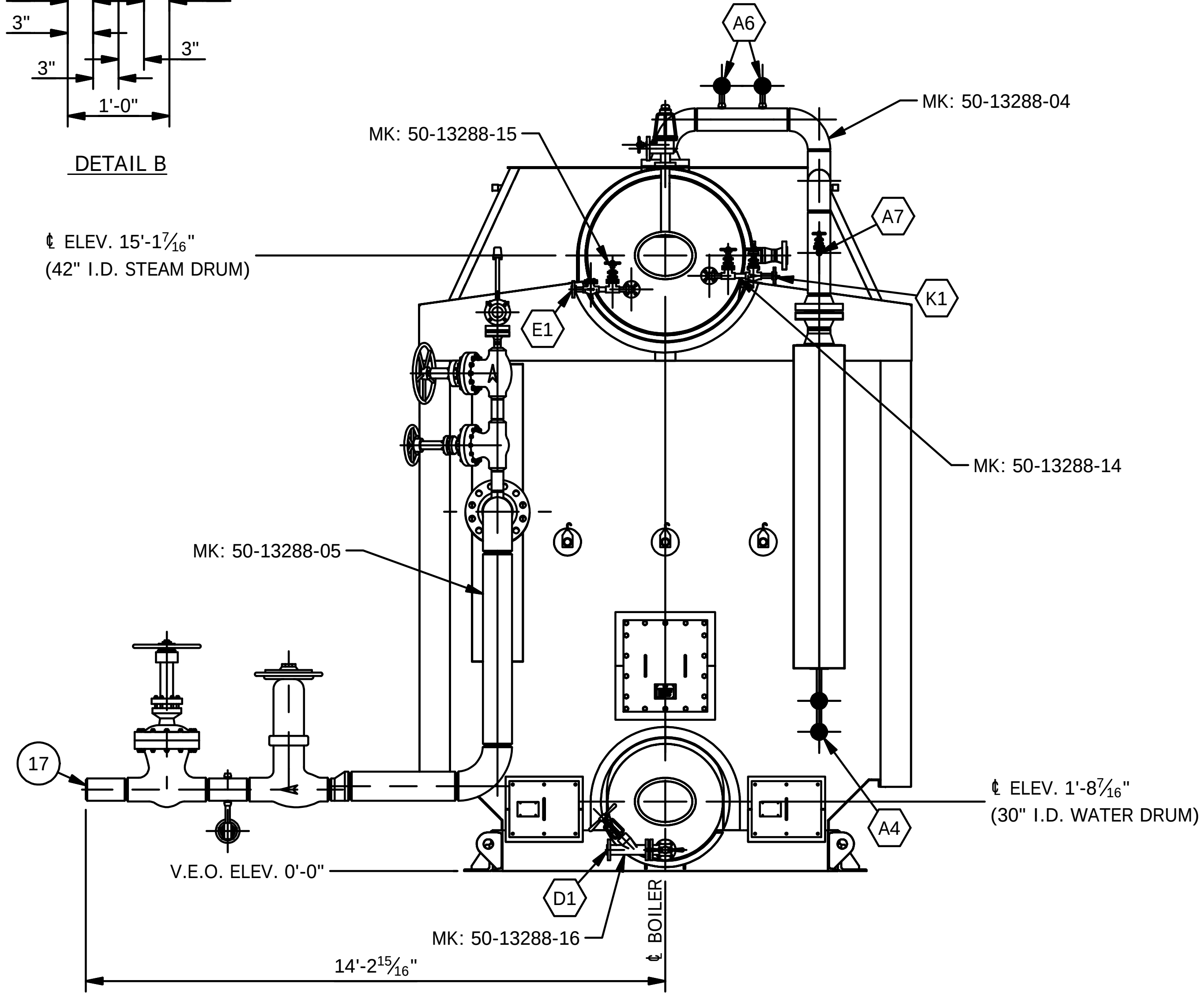


DETAIL B





FRONT VIEW



REAR VIEW

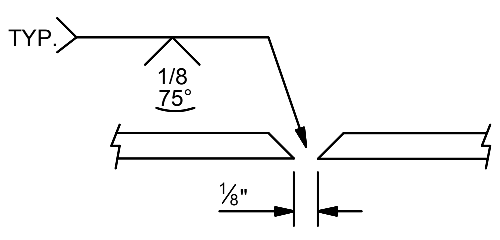
0	TWS	8/30/18	TWS	8/30/18	RELEASED FOR FABRICATION
REV	BY	DATE	CHK'D	DATE	DESCRIPTION

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

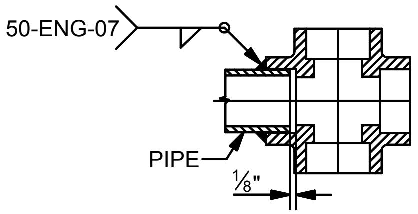
Unit Type/Cust:

Title: PIPING GENERAL ARRANGEMENT (FRONT & REAR VIEWS)

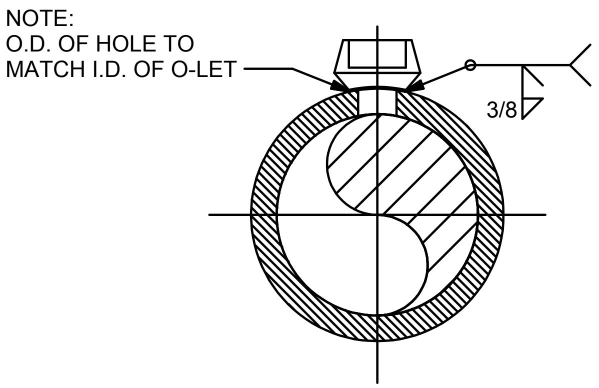
By: TWS	Chk'd: GMc	Aprv'd: DAR	Scale:	Dwg no:	Rev:
Date: 1/2/2018	Date: 1/2/2018	Date: 1/2/2018	NTS	50-13288-03	0



TYPICAL BUTTWELD DETAIL



TYPICAL SOCKET WELD DETAIL

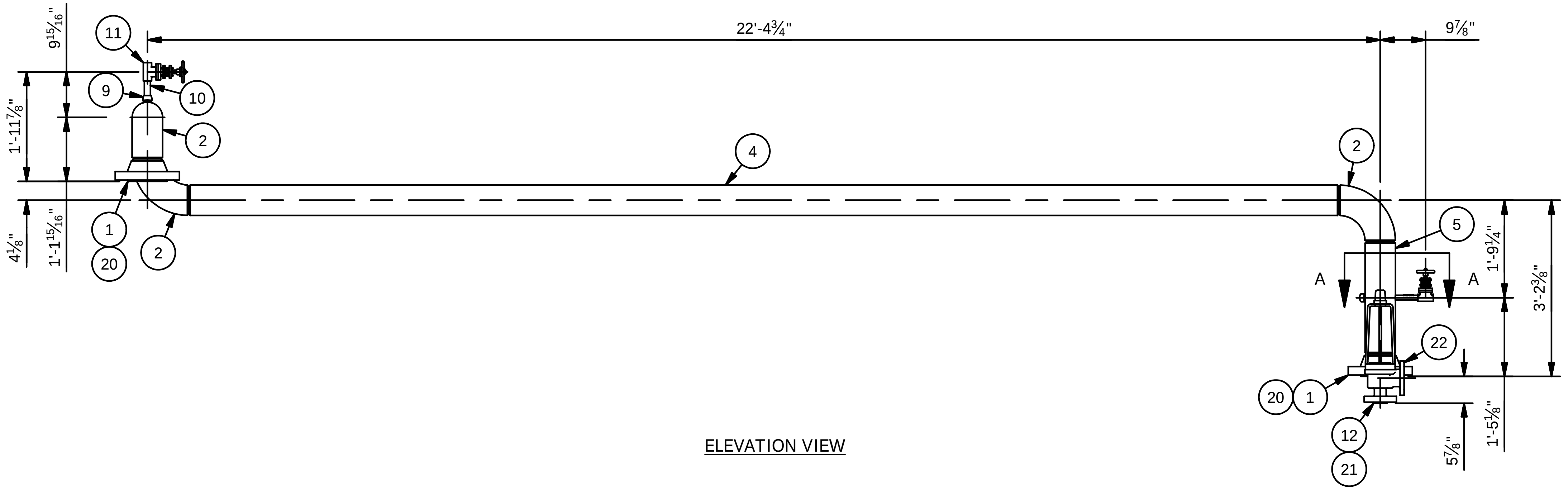


TYPICAL O-LET DETAIL

BILL OF MATERIAL							
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATI.	WT.
1	2	50-13288-04-01	FLANGE: 6"-600#, R.F.W.N., SCH 80 BORE			SA-105	146
2	4	50-13288-04-02	ELBOW: 6" SCH 80, 90°, L.R., B.W.			SA-106-B	98
3	1	50-13288-04-03	PIPE: 6"SCH. 80	2'-3 1/4"	(B.B.E)	SA-106-B	64
4	1	50-13288-04-04	PIPE: 6"SCH. 80	20'-10 5/8"	(B.B.E)	SA-106-B	598
5	1	50-13288-04-05	PIPE: 6"SCH. 80	2'-3/8"	(B.B.E)	SA-106-B	57
6	1	50-13288-04-06	PIPE: 3/4" SCH. XXH	1'-0"	(P.B.E.)	SA-106-B	2
7	1	50-13288-04-07	CAP: 1"-3000#, S.W.			SA-105	0
8	1	50-13288-04-08	GATE VALVE: 3/4"-800#, (VOGT SW12111)		(HV-81604)	SA-105	5
9	2	50-13288-04-09	FLEX-O-LET: 1"-3000# ON 3" PIPE SW			SA-105	0
10	2	50-13288-04-10	PIPE: 1" SCH. 80	4"	(P.B.E.)	SA-106-B	1
11	1	50-13288-04-11	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81603)	SA-105	8
12	1	50-13288-04-12	SAFETY VALVE: 1 1/2"-1500# INLET x 3"-150# OUTLET, (CONSOLLIDATED 2717)		(PSV-81809)	SA-182-F22	87
13	1	50-13288-04-13	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81803)	SA-105	8
14	1	50-13288-04-14	PIPE: 1" SCH. 80	6"	(P.B.E.)	SA-106-B	1
15	1	50-13288-04-15	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81804)	SA-105	8
16	1	50-13288-04-16	PIPE: 1" SCH. 80	6"	(P.B.E.)	SA-335-P11	1
17	1	50-13288-04-17	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81605)	SA-105	8
18	1	50-13288-04-18	GATE VALVE: 1"-1,500#, (VOGT SW15321)		(HV-81807)	SA-182-F11	18
19	1	50-13288-04-19	GATE VALVE: 1"-1,500#, (VOGT SW15321)		(HV-81808)	SA-182-F11	18
20	2		GASKET: 6"-600#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-6P	1
20A	24		STUD: 1"Ø	7"		SA-193-B7	40
20B	48		NUT: 1" HVY. HEX			SA-194-2H	20
21	1		GASKET: 1 1/2"-1500#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-15F	1
21A	4		STUD: 1"Ø	5 1/2"		SA-193-B16	6
21B	8		NUT: 1" HVY. HEX			SA-194-GR7	3
22	1		GASKET: 3"-150#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-1J	1
22A	4		STUD: 5/8"Ø	3 3/4"		SA-193-B16	1
22B	8		NUT: 5/8" HVY. HEX			SA-194-GR7	1

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

TOTAL WT.: 1,202



ELEVATION VIEW

DESIGN NOTES:

1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.

WORK THIS DRAWING WITH: 50-13288-04A & 50-13288-04B

0					
REV	BY	DATE	CHK'D	DATE	DESCRIPTION

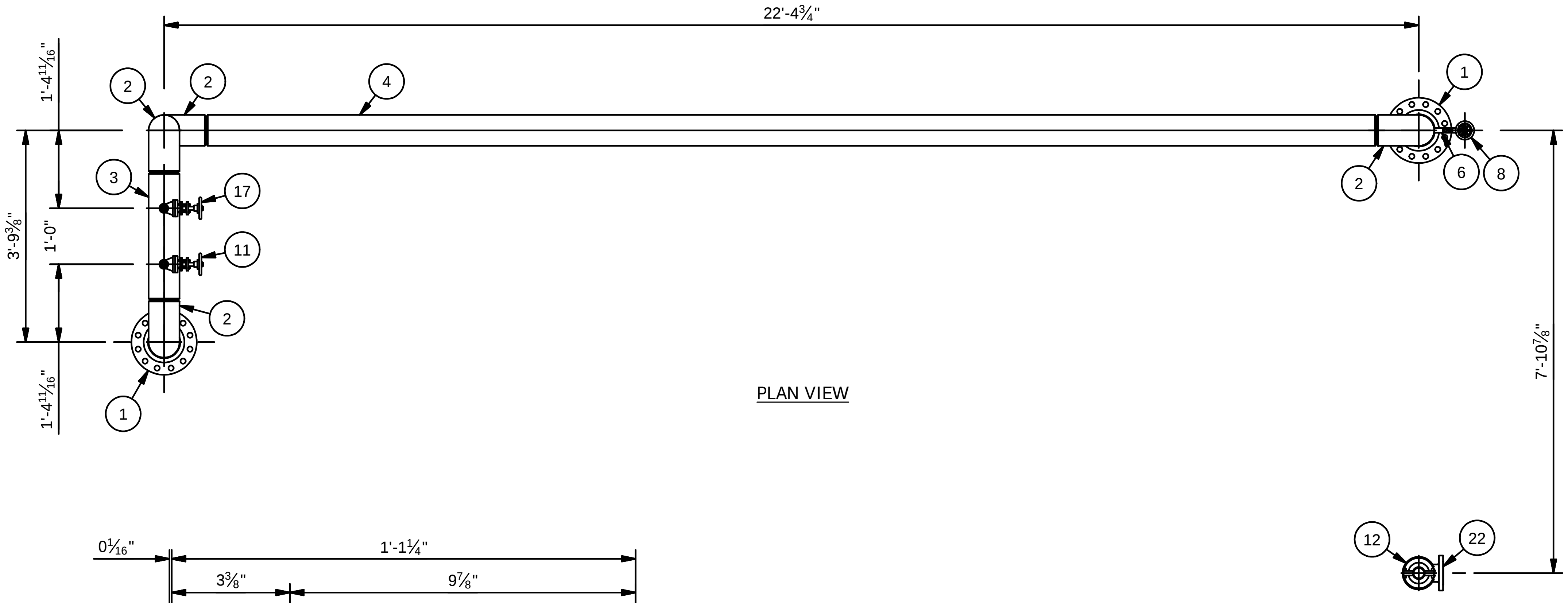
THIS DESIGN OR DRAWING IS NOT SOLD AND IS SUBJECT TO RECALL. REPRODUCTION OR COPYING RIGHTS ARE RESERVED SOLELY TO VICTORY ENERGY OPERATIONS, L.L.C. THE DRAWING HAS BEEN DELIVERED AND RECEIVED ON THE EXPRESSED CONDITIONS THAT IT IS NOT USED IN ANY WAY AGAINST THE INTERESTS AND BENEFITS OF VICTORY ENERGY OPERATIONS, L.L.C., AND THAT THIS DRAWING AND ALL COPIES OF IT WILL BE RETURNED TO VICTORY ENERGY OPERATIONS, L.L.C. IMMEDIATELY UPON DEMAND, AND THAT ALL INFORMATION DISCLOSED BY THIS DRAWING TO THE HOLDER SHALL BE HELD IN CONFIDENCE.

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

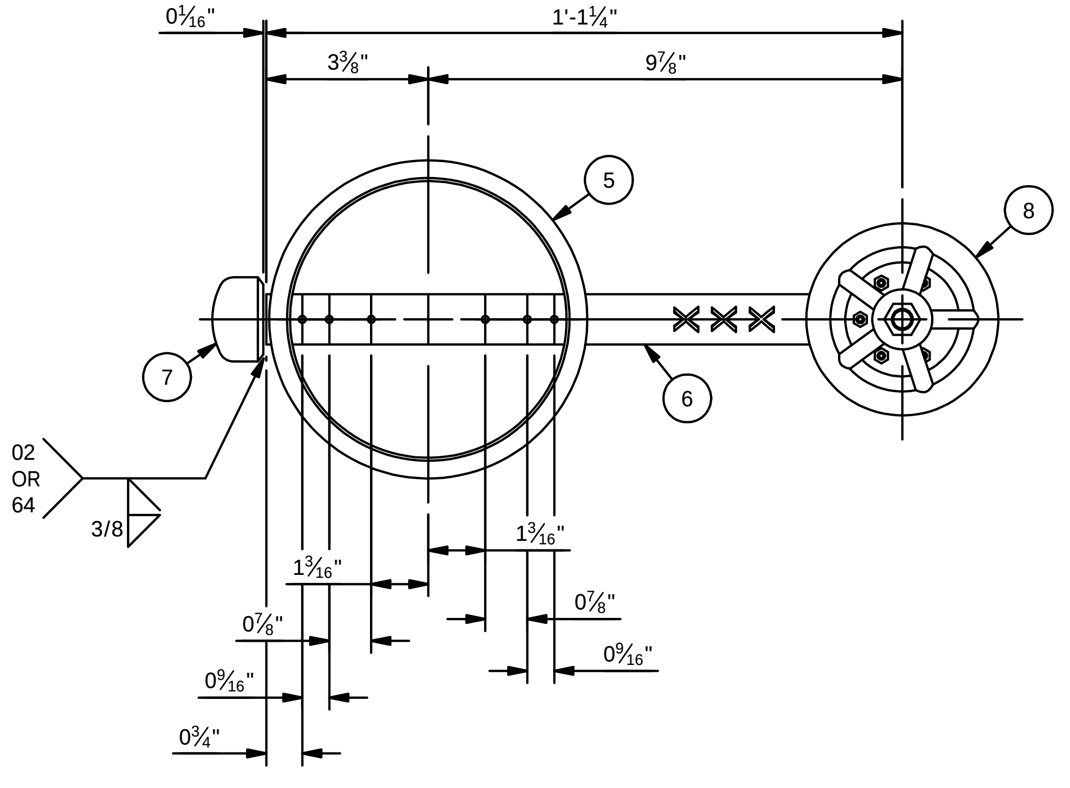
Unit Type/Cust: VS-5-78SP SH

Title: MAIN STEAM CROSSOVER PIPING ASSEMBLY

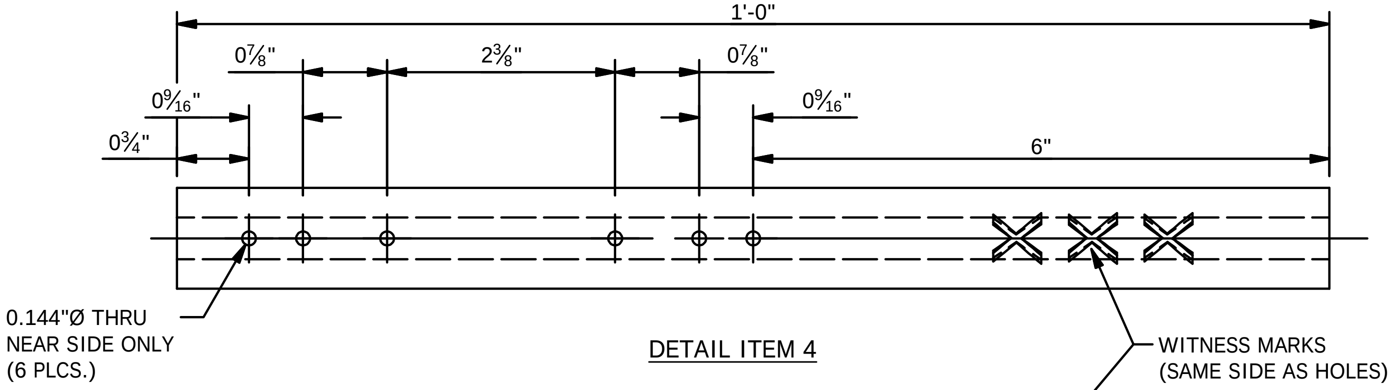
By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 2/08/2018	Date: 2/08/2018	Date: 2/08/2018	NTS	50-13288-04	0



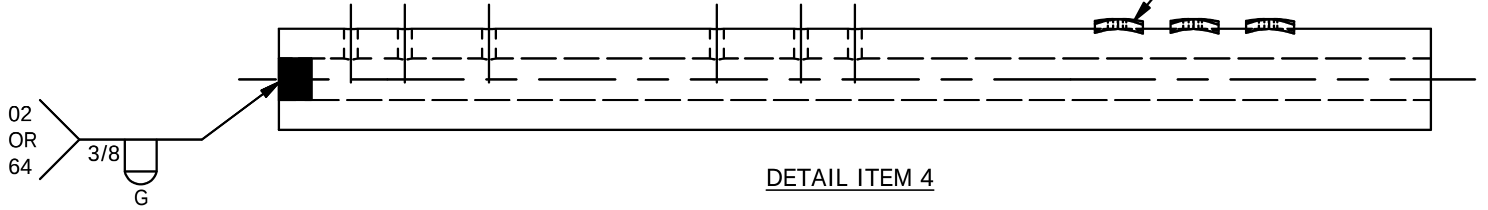
PLAN VIEW



SECTION A-A



DETAIL ITEM 4



DETAIL ITEM 4

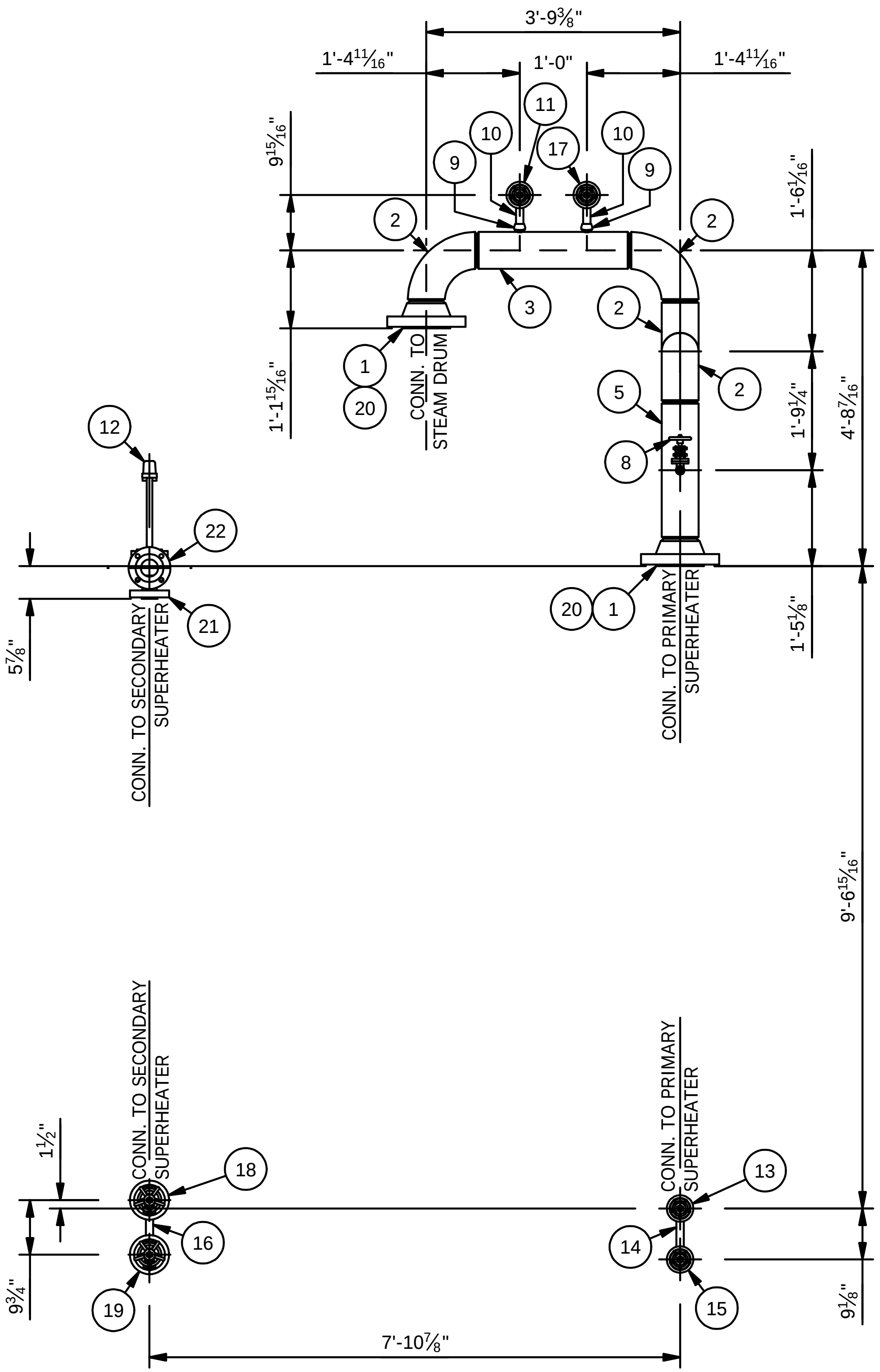
WORK THIS DRAWING WITH: 50-13288-04 & 50-13288-04B

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP SH

Title: MAIN STEAM CROSSOVER PIPING ASSEMBLY

By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 2/08/2018	Date: 2/08/2018	Date: 2/08/2018	NTS	50-13288-04A	0



SIDE ELEVATION VIEW

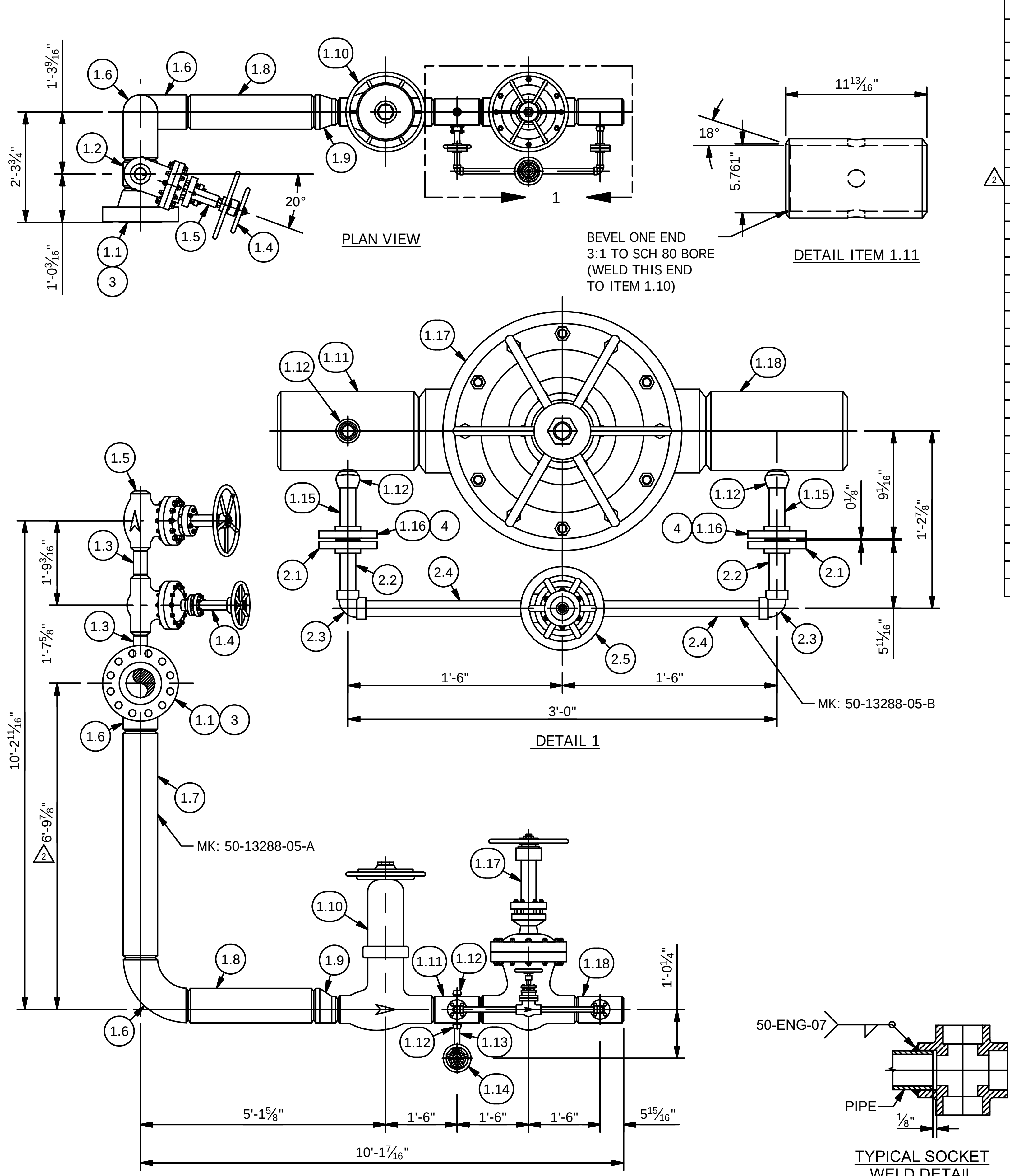
WORK THIS DRAWING WITH: 50-13288-04 & 50-13288-04A

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP SH

Title: MAIN STEAM CROSSOVER PIPING ASSEMBLY

By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 2/08/2018	Date: 2/08/2018	Date: 2/08/2018	NTS	50-13288-04B	0



PLAN VIEW

BEVEL ONE END
3:1 TO SCH 80 BORE
(WELD THIS END
TO ITEM 1.10)

DETAIL ITEM 1.11

MK: 50-13288-05-B

DETAIL 1

MK: 50-13288-05-A

ELEVATION VIEW

TYPICAL SOCKET WELD DETAIL

TOLERANCE: ± 1/8" NON-CUMULATIVE

BILL OF MATERIAL

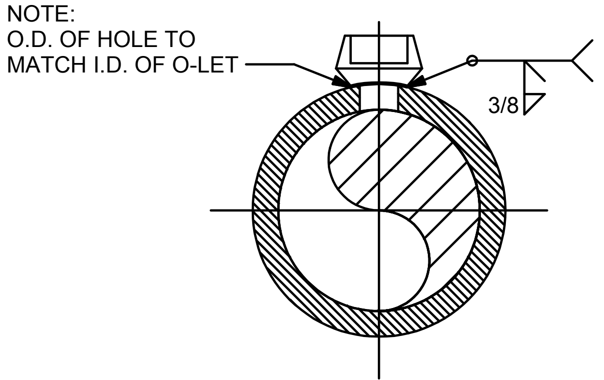
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATI.	WT.
1	1		SPOOL 50-13288-05-A				4033
1.1	1	50-13288-05-01.1	FLANGE: 8"-1500#, R.F.W.N., SCH 120 BORE			SA-182-F11	273
1.2	1	50-13288-05-01.2	TEE, REDUCING: 8" SCH 120 x 8" SCH 120 x 3" SCH 80, B.W.			SA-234-WP11	50
1.3	2	50-13288-05-01.3	PIPE: 3" SCH 80	1'-4"	(B.B.E)	SA-335-P11	10
1.4	1	50-13288-05-01.4	GATE VALVE: 3"-900#, B.W., (NEWAY)		(HV-81810)	SA-182-F11	295
1.5	1	50-13288-05-01.5	GLOBE VALVE: 3"-900#, B.W., (PACIFIC)		(HV-81811)	SA-217-WC6	322
1.6	2	50-13288-05-01.6	ELBOW: 8" SCH 120, 90°, L.R., B.W.			SA-234-WP11	236
2 1.7	1	50-13288-05-01.7	PIPE: 8" SCH 120	4'-8 3/4"	(B.B.E)	SA-335-P11	285
1.8	1	50-13288-05-01.8	PIPE: 8" SCH 120	2'-7 7/16"	(B.B.E)	SA-335-P11	157
1.9	1	50-13288-05-01.9	REDUCER, ECCENTRIC: 8" SCH 120 x 6" SCH 80			SA-234-WP11	36
1.10	1	50-13288-05-01.10	NON-RETURN VALVE: 6"-900#, B.W., (EDWARDS B4002Y)		(CV-81812)	SA-182-F11	642
1.11	1	50-13288-05-01.11	PIPE: 6"SCH 120, (PER DETAIL)	11 13/16"	(B.B.E)	SA-335-P11	34
1.12	4	50-13288-05-01.12	FLEX-O-LET: 1"-3000# ON 6" PIPE SW			SA-182-F11	1
1.13	1	50-13288-05-01.13	PIPE: 1" SCH 80	6"	(P.B.E.)	SA-335-P11	1
1.14	1	50-13288-05-01.14	GATE VALVE: 1"-1,500#, (VOGT SW15321)		(HV-81813)	SA-182-F11	18
1.15	2	50-13288-05-01.15	PIPE: 1" SCH 80	4"	(P.B.E.)	SA-335-P11	1
1.16	2	50-13288-05-01.16	FLANGE: 1"-1500#, R.F.S.W., SCH 80 BORE			SA-182-F11	6
1.17	1	50-13288-05-01.17	GATE VALVE: 6"-900#, B.W., (NEWAY)		(HV-81814)	SA-182-F11	1631
1.18	1	50-13288-05-01.18	PIPE: 6"SCH 120	11 13/16"	(B.B.E)	SA-335-P11	34
2	1		SPOOL 50-13288-05-B				37
2.1	2	50-13288-05-02.1	FLANGE: 1"-1500#, R.F.S.W., SCH 80 BORE			SA-182-F11	6
2.2	2	50-13288-05-02.2	PIPE: 1" SCH 80	4"	(P.B.E.)	SA-335-P11	1
2.3	2	50-13288-05-02.3	ELBOW: 1"-3000#, 90°, S.W.			SA-182-F11	2
2.4	2	50-13288-05-02.4	PIPE: 1" SCH 80	1'-2 3/8"	(P.B.E.)	SA-335-P11	5
2.5	1	50-13288-05-02.5	GLOBE VALVE: 1"-1,500#, (VOGT SW15351)		(HV-81815)	SA-182-F11	22
3	1		GASKET: 8"-1500#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-15Q	1
3A	12		STUD: 1 5/8"Ø	11 3/4"		SA-193-B16	81
3B	24		NUT: 1 5/8" HVY. HEX			SA-194-7	40
4	2		GASKET: 1"-1500#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-15D	1
4A	8		STUD: 7/8"Ø	5"		SA-193-B16	7
4B	16		NUT: 7/8" HVY. HEX			SA-194-7	4

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

TOTAL WT.: 8,150

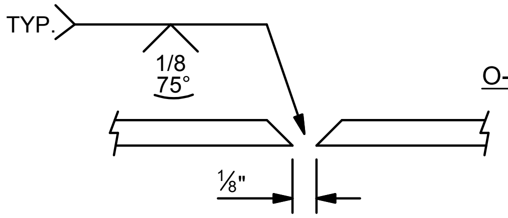
DESIGN NOTES:

1) DESIGN TEMP @ 950°F
2) MAWP @ 900 PSIG.
3) HYDROTEST PRESSURE @ 1,350 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



NOTE:
O.D. OF HOLE TO
MATCH I.D. OF O-LET

TYPICAL O-LET DETAIL



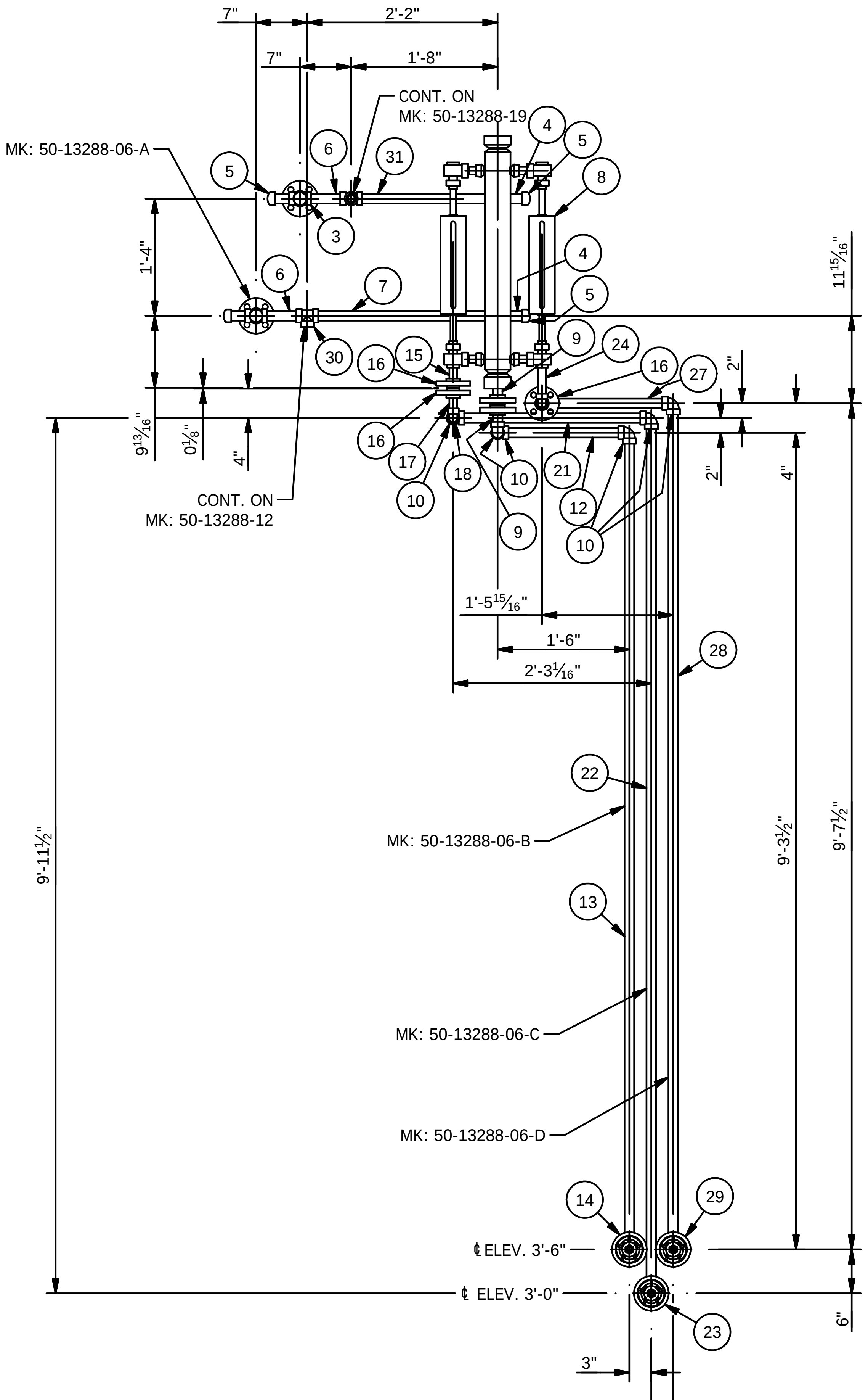
TYPICAL BUTTWELD DETAIL

REV	BY	DATE	CHK'D	DATE	DESCRIPTION
2	TWS	8/28/18	TWS	8/28/18	ADJUSTED DIMENSION, CHG'D LENGTH ITEM 1.7

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP SH
Title: MAIN STEAM PIPING ASSEMBLY

By: TWS	Chk'd: TWS	Aprv'd: DAR	Scale:	Dwg no:	Rev:
Date: 7/18/18	Date: 7/18/18	Date: 7/18/18	NTS	50-13288-05	2



ELEVATION VIEW

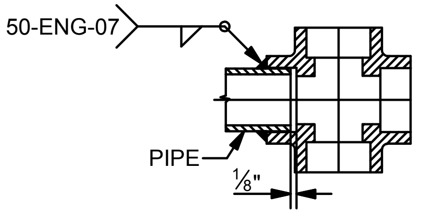
BILL OF MATERIAL							
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATl.	WT.
1	4	50-13288-06-01	FLANGE: 1"-600#, R.F.S.W., SCH 80 BORE			SA-105	16
2	4	50-13288-06-02	PIPE: 1" SCH. 80	3"	(P.B.E.)	SA-106-B	2
3	4	50-13288-06-03	CROSS: 1"-3000#, S.W.			SA-105	6
4	8	50-13288-06-04	PIPE: 1" SCH. 80	3"	(T.O.E. & P.O.E.)	SA-106-B	4
5	8	50-13288-06-05	CAP: 1"-3000#, N.P.T.			SA-105	2
6	2	50-13288-06-06	PIPE: 1" SCH. 80	5"	(P.B.E.)	SA-106-B	2
7	1	50-13288-06-07	PIPE: 1" SCH. 80	2'-0"	(P.B.E.)	SA-106-B	4
8	1	50-13288-06-08	TIE BAR: (MK: 21-13288-99)			SA-106-B	152
9	2	50-13288-06-09	PIPE: 1" SCH. 80	1 3/4"	(P.B.E.)	SA-106-B	1
10	7	50-13288-06-10	ELBOW: 1"-3000#, 90°, S.W.			SA-105	7
11	1	50-13288-06-11	PIPE: 1" SCH. 80	2'-1 1/8"	(P.B.E.)	SA-106-B	5
12	1	50-13288-06-12	PIPE: 1" SCH. 80	1'-4"	(P.B.E.)	SA-106-B	3
13	1	50-13288-06-13	PIPE: 1" SCH. 80	9'-15/16"	(P.B.E.)	SA-106-B	20
14	1	50-13288-06-14	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81007)	SA-105	8
15	1	50-13288-06-15	PIPE: 3/4" SCH. 80	2 3/16"	(T.O.E. & P.O.E.)	SA-106-B	0
16	4	50-13288-06-16	FLANGE: 3/4"-600#, R.F.S.W., SCH 80 BORE			SA-105	12
17	1	50-13288-06-17	PIPE: 3/4" SCH. 80	2 3/16"	(P.B.E.)	SA-106-B	0
18	2	50-13288-06-18	ELBOW: 3/4"-3000#, 90°, S.W.			SA-105	1
19	1	50-13288-06-19	PIPE: 3/4" SCH. 80	2'-5/16"	(P.B.E.)	SA-106-B	3
20	2	50-13288-06-20	REDUCING INSERT: 1" x 3/4"-3000#, S.W., (T1)			SA-105	2
21	1	50-13288-06-21	PIPE: 1" SCH. 80	2'-1 1/16"	(P.B.E.)	SA-106-B	5
22	1	50-13288-06-22	PIPE: 1" SCH. 80	9'-8 15/16"	(P.B.E.)	SA-106-B	21
23	1	50-13288-06-23	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81008)	SA-105	8
24	1	50-13288-06-24	PIPE: 3/4" SCH. 80	4 3/8"	(T.O.E. & P.O.E.)	SA-106-B	1
25	1	50-13288-06-25	PIPE: 3/4" SCH. 80	2"	(P.B.E.)	SA-106-B	0
26	1	50-13288-06-26	PIPE: 3/4" SCH. 80	1'-8 3/16"	(P.B.E.)	SA-106-B	2
27	1	50-13288-06-27	PIPE: 1" SCH. 80	1'-3 15/16"	(P.B.E.)	SA-106-B	3
28	1	50-13288-06-28	PIPE: 1" SCH. 80	9'-4 15/16"	(P.B.E.)	SA-106-B	21
29	1	50-13288-06-29	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81009)	SA-105	8
30	2	50-13288-06-30	TEE: 1"-3000#, S.W.			SA-105	3
31	1	50-13288-06-31	PIPE: 1" SCH. 80	1'-6"	(P.B.E.)	SA-106-B	3
32	3		GASKET: 1"-600#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-6D	1
32A	12		STUD: 5/8"Ø	3 1/2"		SA-193-B7	3
32B	24		NUT: 5/8" HVY. HEX			SA-194-2H	3
33	2		GASKET: 3/4"-600#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-6C	1
33A	8		STUD: 5/8"Ø	3 3/4"		SA-193-B7	2
33B	16		NUT: 5/8" HVY. HEX			SA-194-2H	2

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

TOTAL WT.: 337

DESIGN NOTES:

1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



TYPICAL SOCKET WELD DETAIL

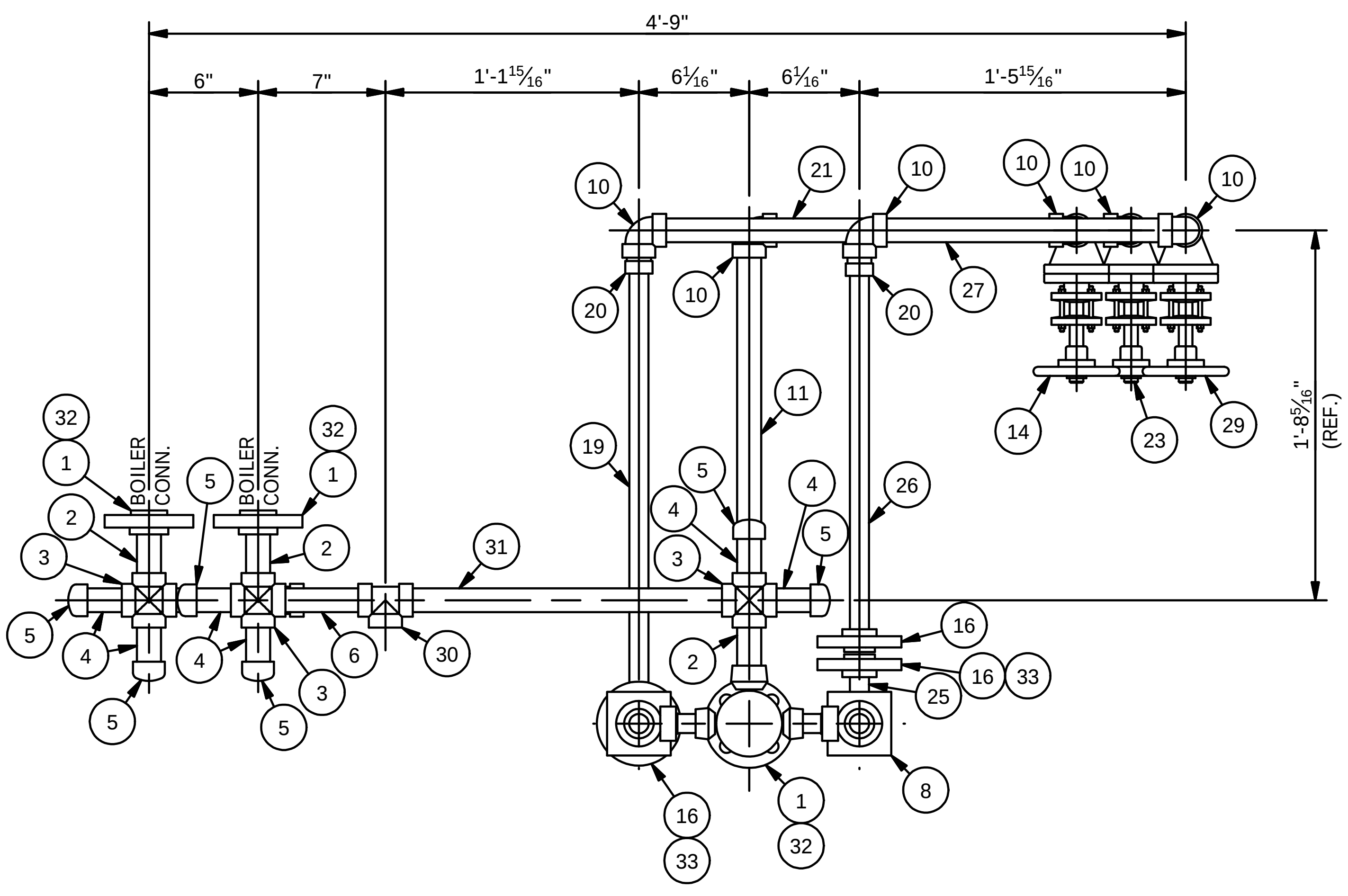
WORK THIS DRAWING WITH: 50-13288-06A

REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

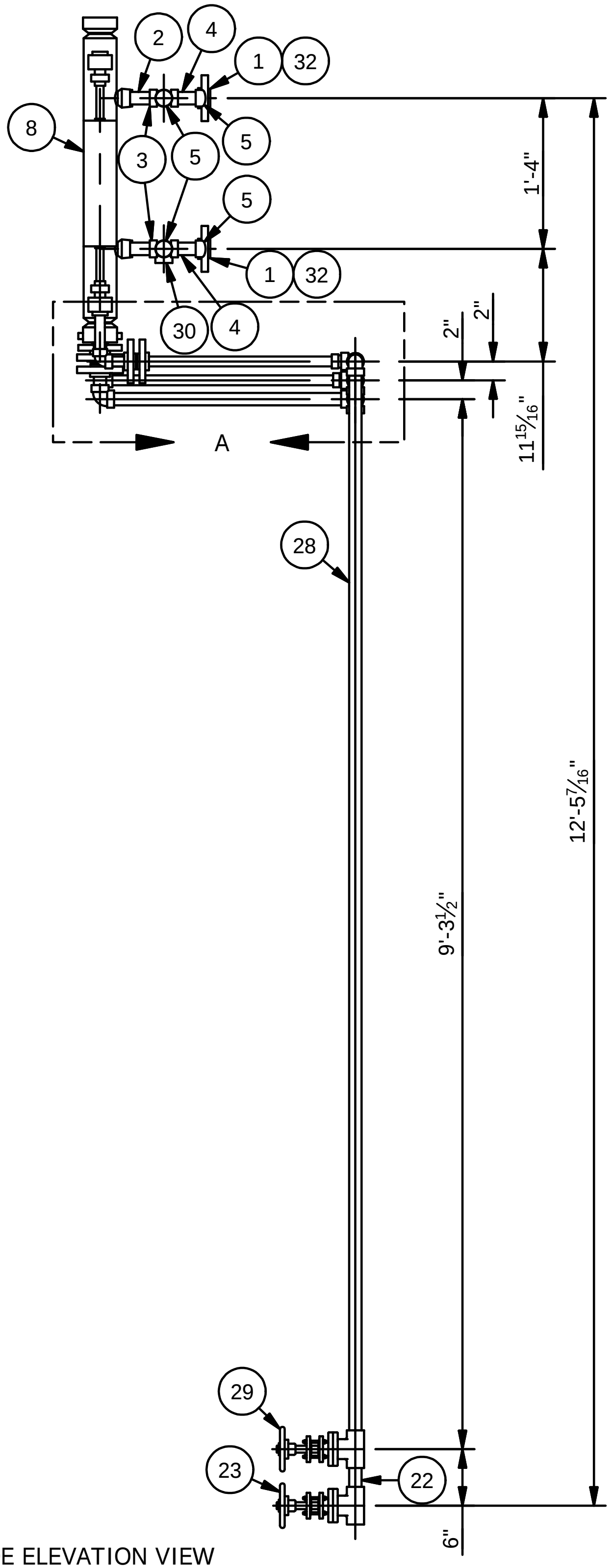
VICTORY ENERGY®
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP SH
Title: TIE BAR PIPING ASSEMBLY

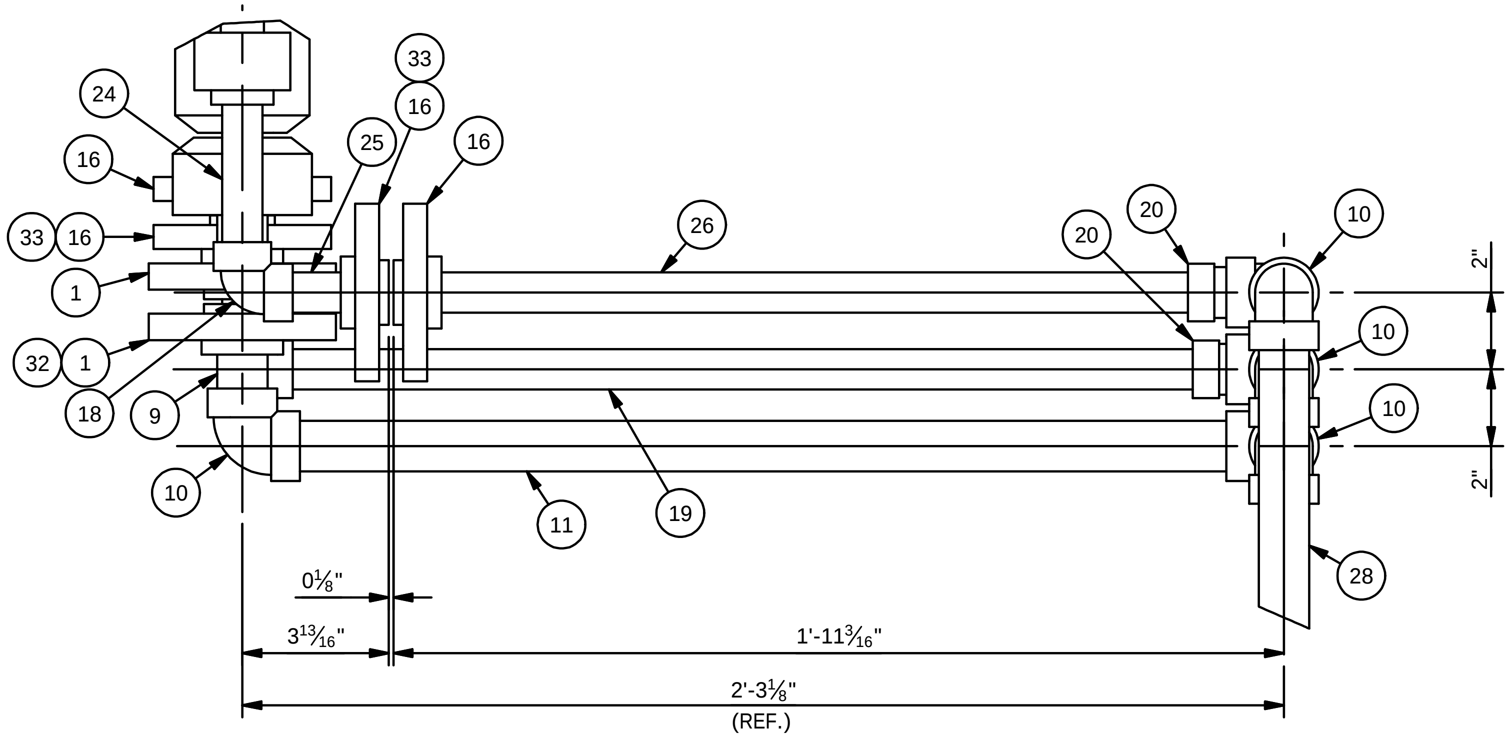
By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/26/18	Date: 1/26/18	Date: 1/26/18	NTS	50-13288-06	0



PLAN VIEW



SIDE ELEVATION VIEW



DETAIL A

WORK THIS DRAWING WITH: 50-13288-06

REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

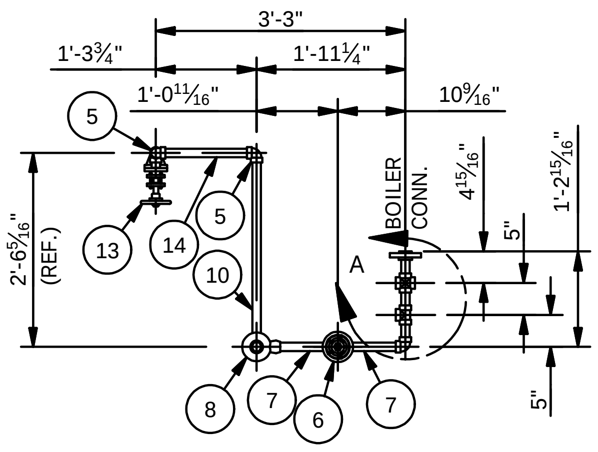
THIS DESIGN OR DRAWING IS NOT SOLD AND IS SUBJECT TO RECALL. REPRODUCTION OR COPYING RIGHTS ARE RESERVED SOLELY TO VICTORY ENERGY OPERATIONS, L.L.C. THE DRAWING HAS BEEN DELIVERED AND RECEIVED ON THE EXPRESSED CONDITIONS THAT IT IS NOT USED IN ANY WAY AGAINST THE INTERESTS AND BENEFITS OF VICTORY ENERGY OPERATIONS, L.L.C., AND THAT THIS DRAWING AND ALL COPIES OF IT WILL BE RETURNED TO VICTORY ENERGY OPERATIONS, L.L.C. IMMEDIATELY UPON DEMAND, AND THAT ALL INFORMATION DISCLOSED BY THIS DRAWING TO THE HOLDER SHALL BE HELD IN CONFIDENCE.

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

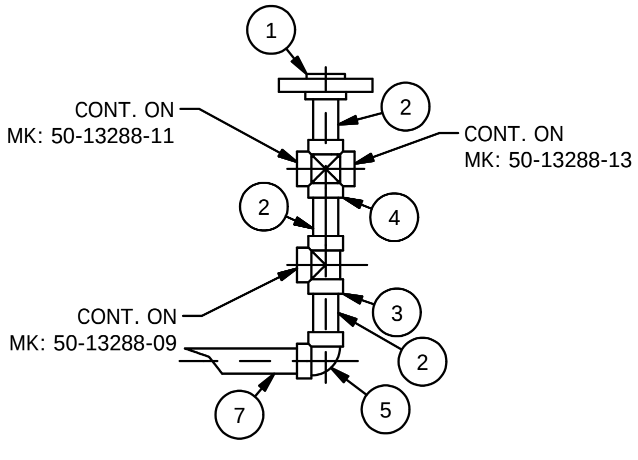
Unit Type/Cust: VS-5-78SP SH

Title: TIE BAR PIPING ASSEMBLY

By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/26/18	Date: 1/26/18	Date: 1/26/18	NTS	50-13288-06A	0



PLAN VIEW



DETAIL A

ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATI.	WT.
1	1	50-13288-07-01	FLANGE: 1"-600#, R.F.S.W., SCH 80 BORE			SA-105	4
2	3	50-13288-07-02	PIPE: 1" SCH. 80	3"	(P.B.E.)	SA-106-B	2
3	2	50-13288-07-03	TEE: 1"-3000#, S.W.			SA-105	3
4	1	50-13288-07-04	CROSS: 1"-3000#, S.W.			SA-105	2
5	4	50-13288-07-05	ELBOW: 1"-3000#, 90°, S.W.			SA-105	4
6	1	50-13288-07-06	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81001)	SA-105	8
7	2	50-13288-07-07	PIPE: 1" SCH. 80	8"	(P.B.E.)	SA-106-B	3
8	1	50-13288-07-08	OONDENSATE POT: 57-STD-003			SA-234-WPB	10
9	1	50-13288-07-09	PIPE: 1" SCH. 80	3'-4 7/16"	(P.B.E.)	SA-106-B	7
10	1	50-13288-07-10	PIPE: 1" SCH. 80	2'-4 5/16"	(P.B.E.)	SA-106-B	5
11	1	50-13288-07-11	PIPE: 1" SCH. 80	7'-5 1/2"	(P.B.E.)	SA-106-B	16
12	1	50-13288-07-12	PIPE: 1" SCH. 80	9 7/16"	(P.B.E.)	SA-106-B	2
13	1	50-13288-07-13	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81010)	SA-105	8
14	1	50-13288-07-14	PIPE: 1" SCH. 80	1'-1 3/4"	(P.B.E.)	SA-106-B	2
15	1	50-13288-07-15	REDUCING ADAPTER: 1" S.W. x 1/2" N.P.T.-3000#, S.W., (T2)			SA-105	1
16	1		GASKET: 1"-600#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-6D	1
16A	4		STUD: 5/8"Ø	3 1/2"		SA-193-B7	1
16B	8		NUT: 5/8" HVY. HEX			SA-194-2H	1

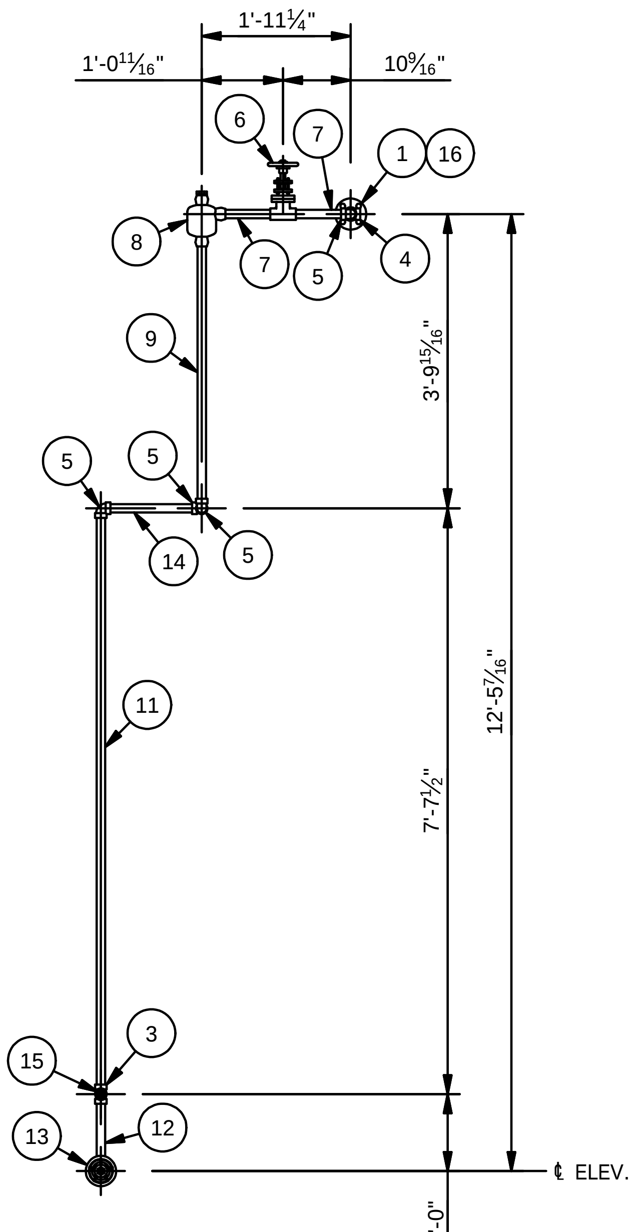
BILL OF MATERIAL

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

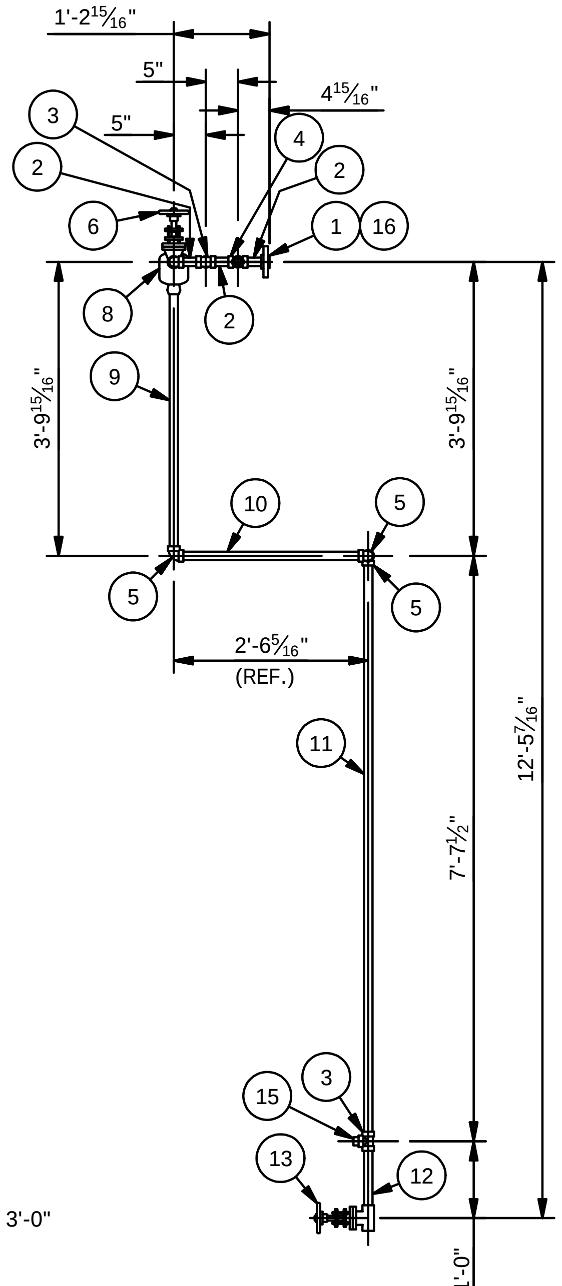
TOTAL WT.: 80

DESIGN NOTES:

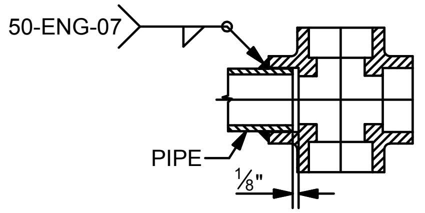
1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



ELEVATION VIEW



SIDE ELEVATION VIEW



TYPICAL SOCKET WELD DETAIL

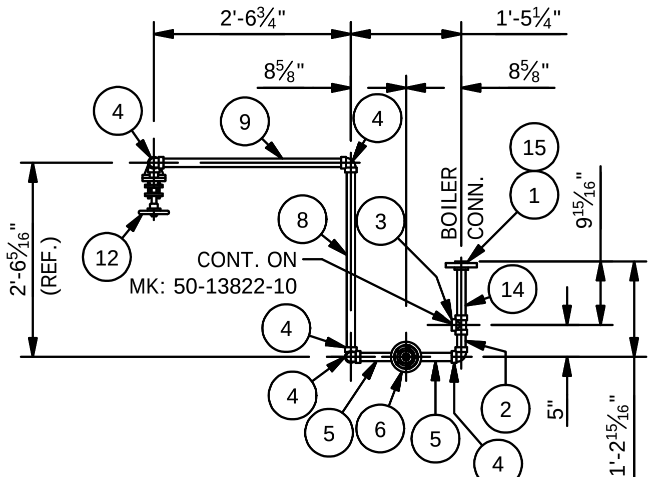
0					
REV	BY	DATE	CHK'D	DATE	DESCRIPTION

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP SH

Title: LEVEL TRANSMITTER PIPING ASSEMBLY (UPPER)

By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/29/18	Date: 1/29/18	Date: 1/29/18	NTS	50-13288-07	0



PLAN VIEW

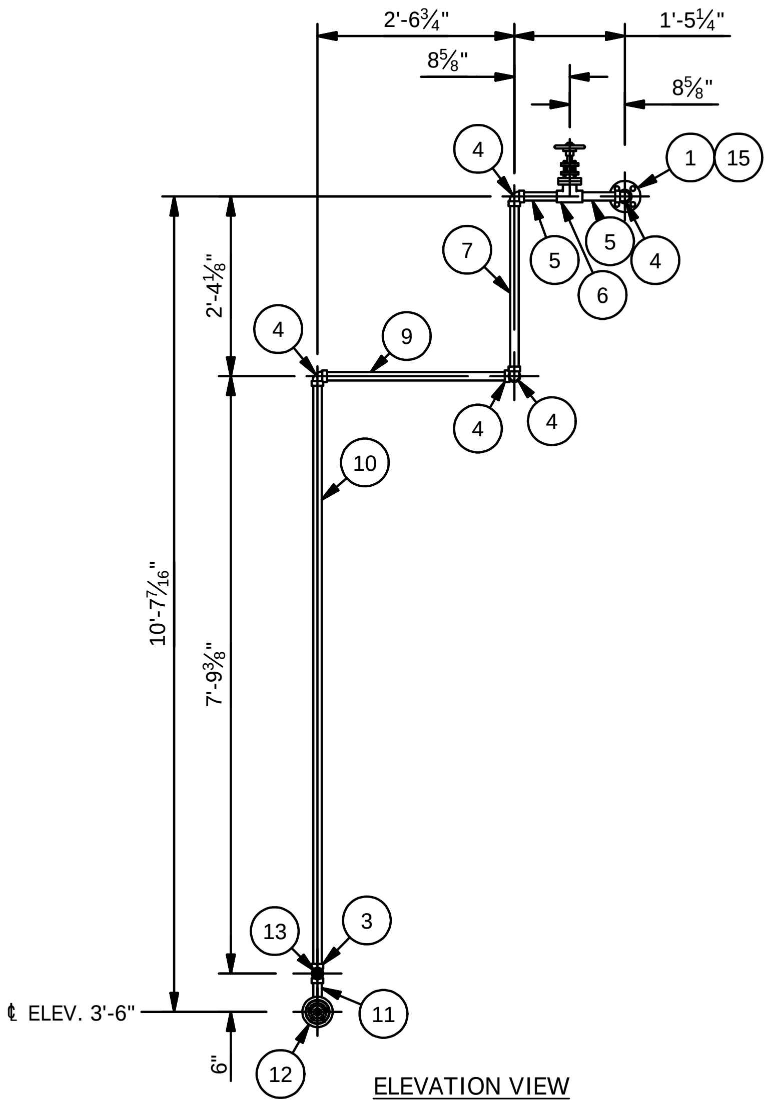
BILL OF MATERIAL							
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATI.	WT.
1	1	50-13288-08-01	FLANGE: 1"-600#, R.F.S.W., SCH 80 BORE			SA-105	4
2	1	50-13288-08-02	PIPE: 1" SCH. 80	3"	(P.B.E.)	SA-106-B	1
3	2	50-13288-08-03	TEE: 1"-3000#, S.W.			SA-105	3
4	5	50-13288-08-04	ELBOW: 1"-3000#, 90°, S.W.			SA-105	5
5	2	50-13288-08-05	PIPE: 1" SCH. 80	6 1/16"	(P.B.E.)	SA-106-B	2
6	1	50-13288-08-06	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81002)	SA-105	8
7	1	50-13288-08-07	PIPE: 1" SCH. 80	2'-2 1/8"	(P.B.E.)	SA-106-B	5
8	1	50-13288-08-08	PIPE: 1" SCH. 80	2'-4 5/16"	(P.B.E.)	SA-106-B	5
9	1	50-13288-08-09	PIPE: 1" SCH. 80	2'-4 3/4"	(P.B.E.)	SA-106-B	5
10	1	50-13288-08-10	PIPE: 1" SCH. 80	7'-7 3/8"	(P.B.E.)	SA-106-B	17
11	1	50-13288-08-11	PIPE: 1" SCH. 80	3 7/16"	(P.B.E.)	SA-106-B	1
12	1	50-13288-08-12	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81011)	SA-105	8
13	1	50-13288-08-13	REDUCING ADAPTER: 1" S.W. x 1/2" N.P.T.-3000#, S.W., (T2)			SA-105	1
14	1	50-13288-08-14	PIPE: 1" SCH. 80	8"	(P.B.E.)	SA-106-B	1
15	1		GASKET: 1"-600#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-6D	1
15A	4		STUD: 5/8"Ø	3 1/2"		SA-193-2H	1
15B	8		NUT: 5/8" HVY. HEX			SA-194-B7	1

TOTAL WT.: 69

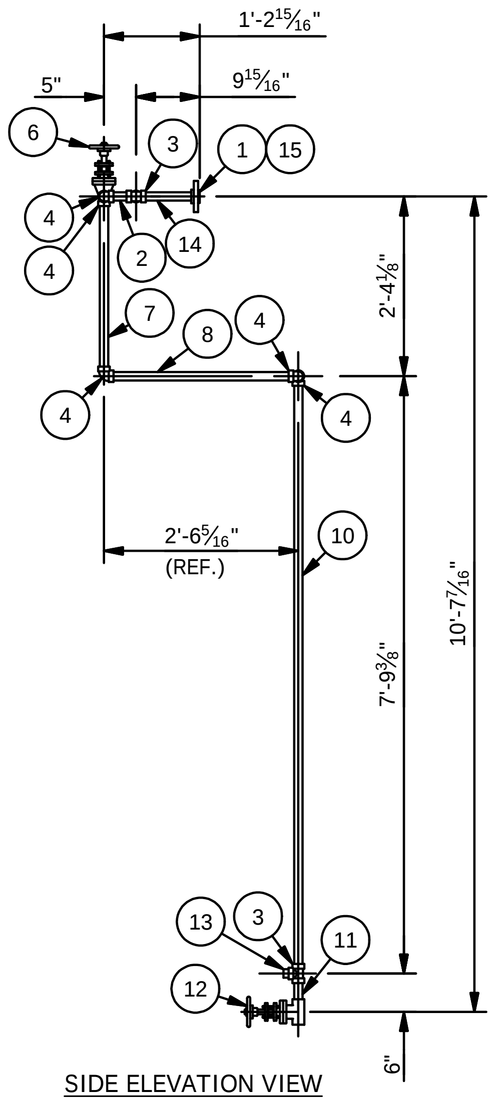
QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

DESIGN NOTES:

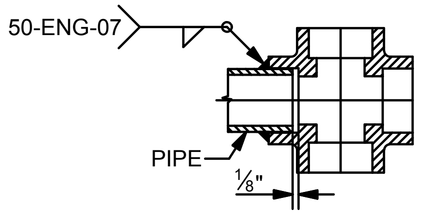
1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



ELEVATION VIEW



SIDE ELEVATION VIEW



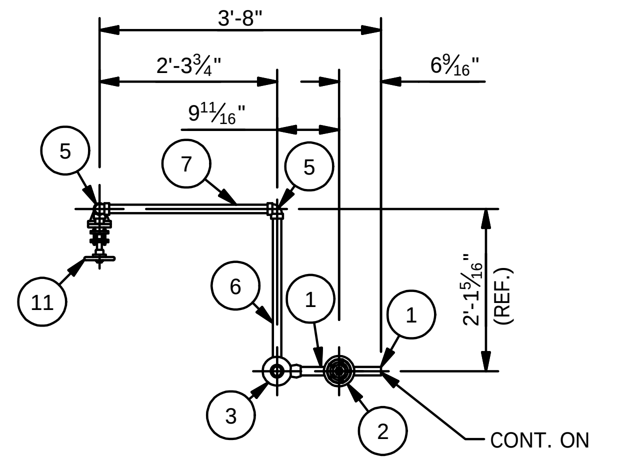
TYPICAL SOCKET WELD DETAIL

0					
REV	BY	DATE	CHK'D	DATE	DESCRIPTION

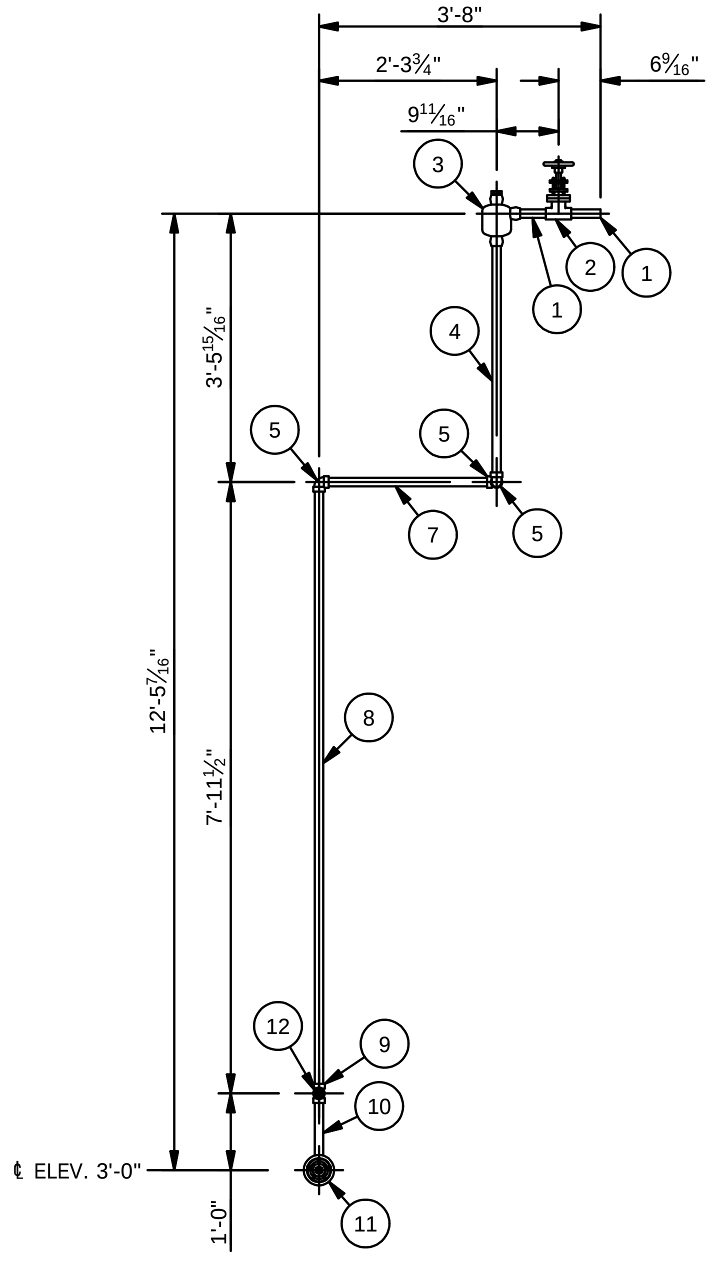
VICTORY ENERGY®
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP SH
Title: LEVEL TRANSMITTER PIPING ASSEMBLY (LOWER)

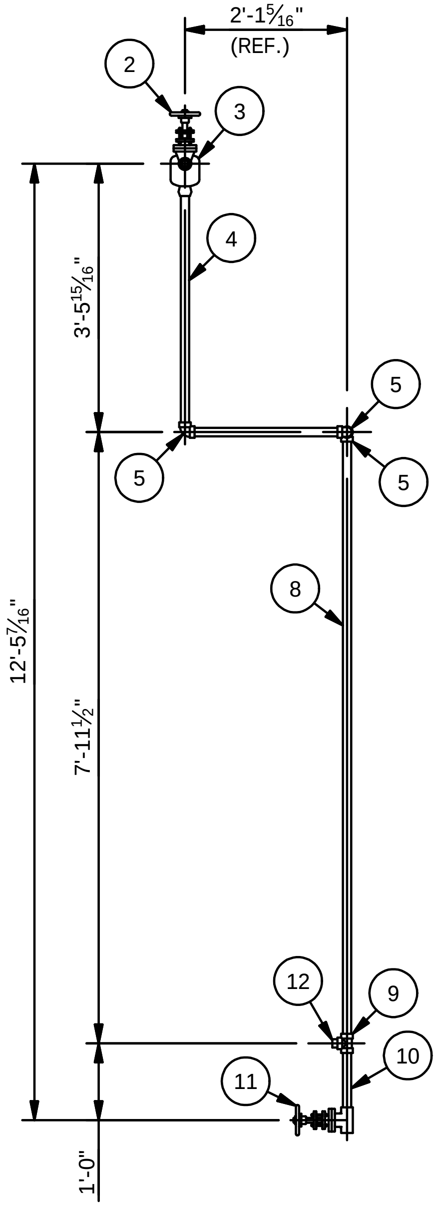
By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/29/18	Date: 1/29/18	Date: 1/29/18	NTS	50-13288-08	0



PLAN VIEW



ELEVATION VIEW



SIDE ELEVATION VIEW

BILL OF MATERIAL

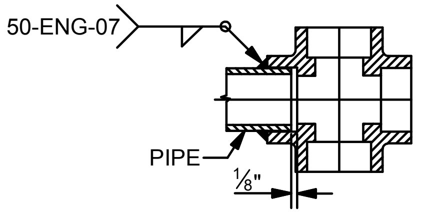
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATI.	WT.
1	2	50-13288-09-01	PIPE: 1" SCH. 80	5"	(P.B.E.)	SA-106-B	2
2	1	50-13288-09-02	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81003)	SA-105	8
3	1	50-13288-09-03	OONDENSATE POT: 57-STD-003			SA-234-WPB	10
4	1	50-13288-09-04	PIPE: 1" SCH. 80	3'-7/16"	(P.B.E.)	SA-106-B	7
5	3	50-13288-09-05	ELBOW: 1"-3000#, 90°, S.W.			SA-105	3
6	1	50-13288-09-06	PIPE: 1" SCH. 80	1'-11 5/16"	(P.B.E.)	SA-106-B	4
7	1	50-13288-09-07	PIPE: 1" SCH. 80	2'-1 3/4"	(P.B.E.)	SA-106-B	5
8	1	50-13288-09-08	PIPE: 1" SCH. 80	7'-9 1/2"	(P.B.E.)	SA-106-B	17
9	1	50-13288-09-09	TEE: 1"-3000#, S.W.			SA-105	2
10	1	50-13288-09-10	PIPE: 1" SCH. 80	9 7/16"	(P.B.E.)	SA-106-B	2
11	1	50-13288-09-11	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81012)	SA-105	8
12	1	50-13288-09-12	REDUCING ADAPTER: 1" S.W. x 1/2" N.P.T.-3000#, S.W., (T2)			SA-105	1

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

TOTAL WT.: 69

DESIGN NOTES:

1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



TYPICAL SOCKET WELD DETAIL

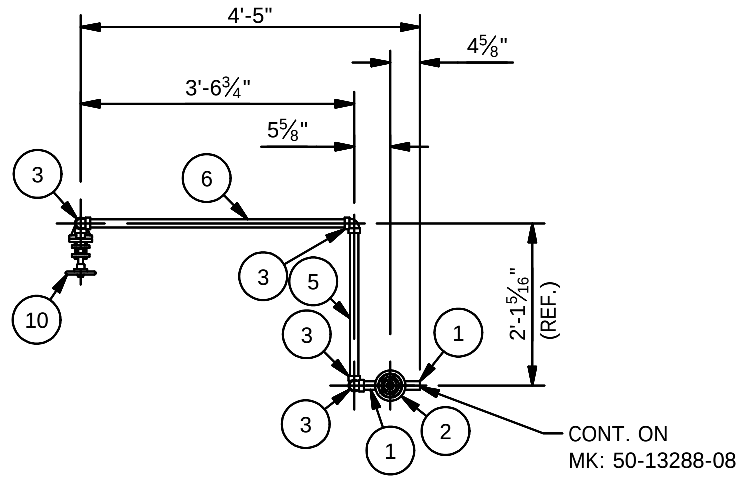
REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

VICTORY ENERGY®
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

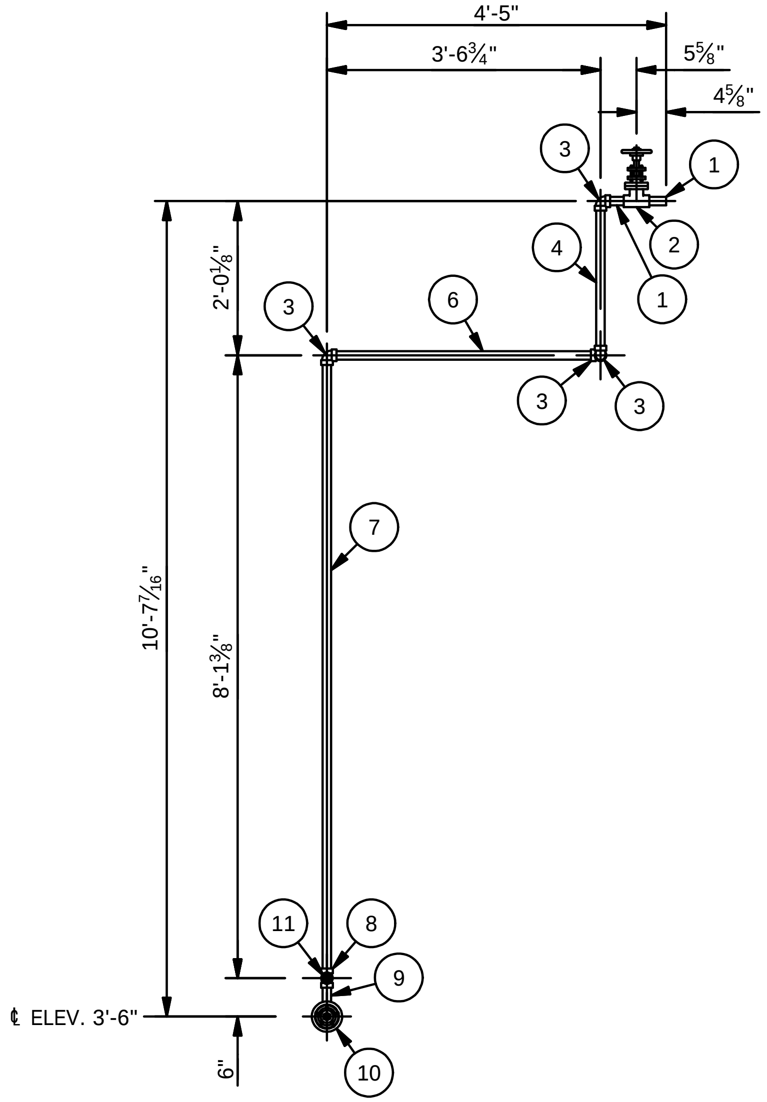
Unit Type/Cust: VS-5-78SP SH

Title: LEVEL TRANSMITTER PIPING ASSEMBLY (UPPER)

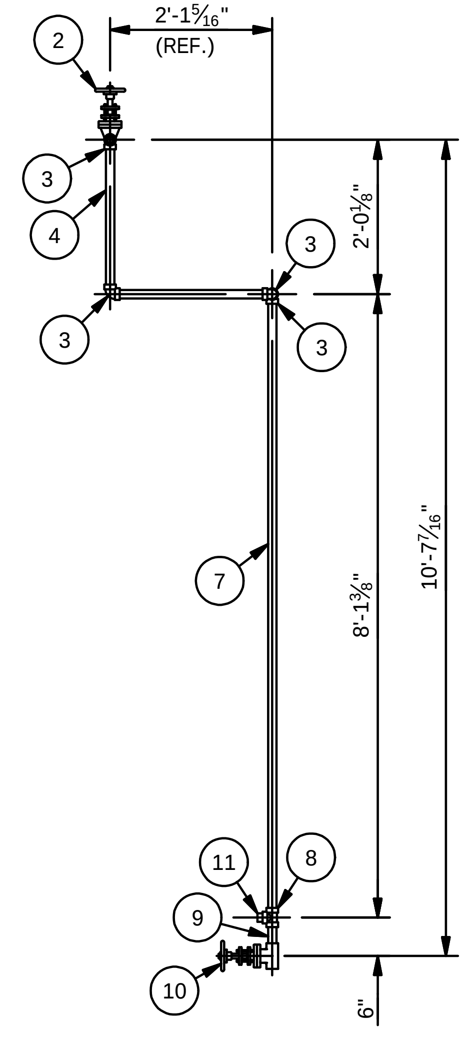
By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/29/18	Date: 1/29/18	Date: 1/29/18	NTS	50-13288-09	0



PLAN VIEW



ELEVATION VIEW



SIDE ELEVATION VIEW

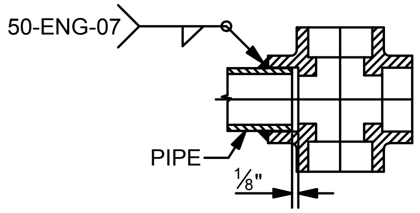
BILL OF MATERIAL							
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATI.	WT.
1	2	50-13288-10-01	PIPE: 1" SCH. 80	3 1/16"	(P.B.E.)	SA-106-B	1
2	1	50-13288-10-02	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81006)	SA-105	8
3	4	50-13288-10-03	ELBOW: 1"-3000#, 90°, S.W.			SA-105	4
4	1	50-13288-10-04	PIPE: 1" SCH. 80	1'-10 1/8"	(P.B.E.)	SA-106-B	4
5	1	50-13288-10-05	PIPE: 1" SCH. 80	1'-11 5/16"	(P.B.E.)	SA-106-B	4
6	1	50-13288-10-06	PIPE: 1" SCH. 80	3'-4 3/4"	(P.B.E.)	SA-106-B	7
7	1	50-13288-10-07	PIPE: 1" SCH. 80	7'-11 3/8"	(P.B.E.)	SA-106-B	17
8	1	50-13288-10-08	TEE: 1"-3000#, S.W.			SA-105	2
9	1	50-13288-10-09	PIPE: 1" SCH. 80	3 7/16"	(P.B.E.)	SA-106-B	1
10	1	50-13288-10-10	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81015)	SA-105	8
11	1	50-13288-10-11	REDUCING ADAPTER: 1" S.W. x 1/2" N.P.T.-3000#, S.W., (T2)			SA-105	1

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

TOTAL WT.: 57

DESIGN NOTES:

1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



TYPICAL SOCKET WELD DETAIL

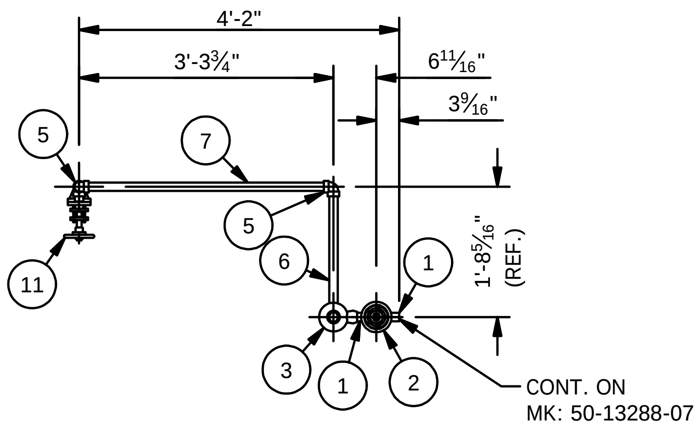
REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

VICTORY ENERGY®
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

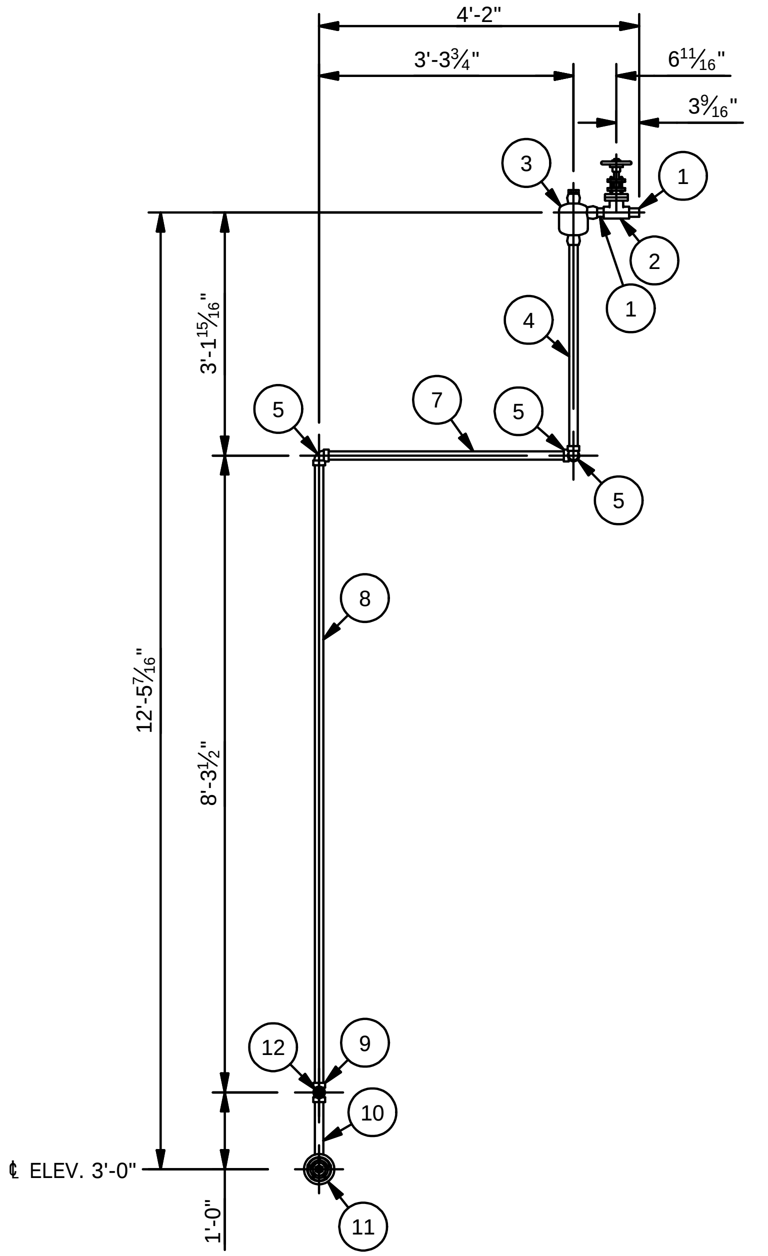
Unit Type/Cust: VS-5-78SP SH

Title: LEVEL TRANSMITTER PIPING ASSEMBLY (LOWER)

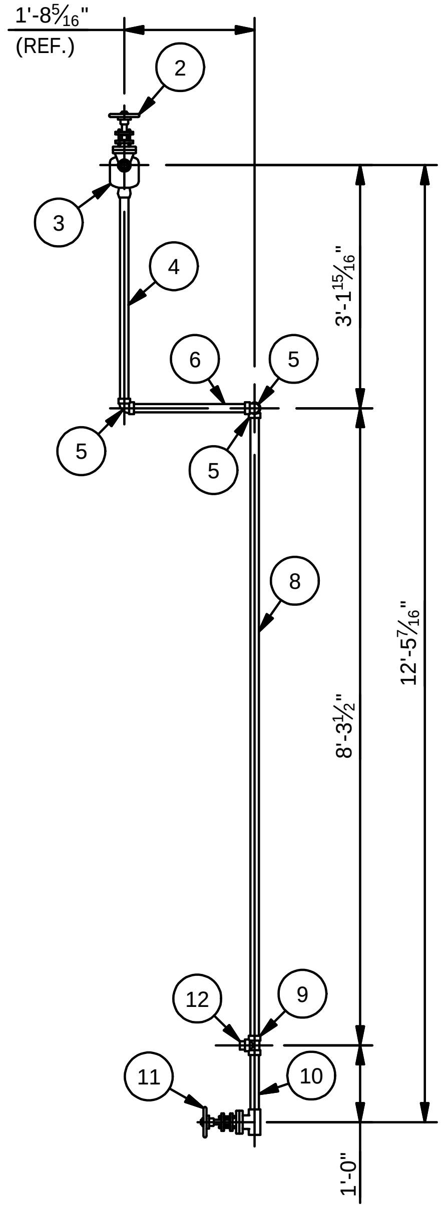
By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/29/18	Date: 1/29/18	Date: 1/29/18	NTS	50-13288-10	0



PLAN VIEW



ELEVATION VIEW



SIDE ELEVATION VIEW

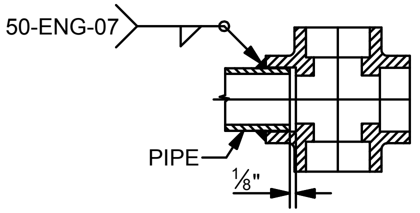
BILL OF MATERIAL							
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATl.	WT.
1	2	50-13288-11-01	PIPE: 1" SCH. 80	2"	(P.B.E.)	SA-106-B	1
2	1	50-13288-11-02	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81005)	SA-105	8
3	1	50-13288-11-03	OONDENSATE POT: 57-STD-003			SA-234-WPB	10
4	1	50-13288-11-04	PIPE: 1" SCH. 80	2'-8 7/16"	(P.B.E.)	SA-106-B	6
5	3	50-13288-11-05	ELBOW: 1"-3000#, 90°, S.W.			SA-105	3
6	1	50-13288-11-06	PIPE: 1" SCH. 80	1'-6 5/16"	(P.B.E.)	SA-106-B	3
7	1	50-13288-11-07	PIPE: 1" SCH. 80	3'-1 3/4"	(P.B.E.)	SA-106-B	7
8	1	50-13288-11-08	PIPE: 1" SCH. 80	8'-1 1/2"	(P.B.E.)	SA-106-B	18
9	1	50-13288-11-09	TEE: 1"-3000#, S.W.			SA-105	2
10	1	50-13288-11-10	PIPE: 1" SCH. 80	9 7/16"	(P.B.E.)	SA-106-B	2
11	1	50-13288-11-11	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81014)	SA-105	8
12	1	50-13288-11-12	REDUCING ADAPTER: 1" S.W. x 1/2" N.P.T.-3000#, S.W., (T2)			SA-105	1

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

TOTAL WT.: 69

DESIGN NOTES:

1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



TYPICAL SOCKET WELD DETAIL

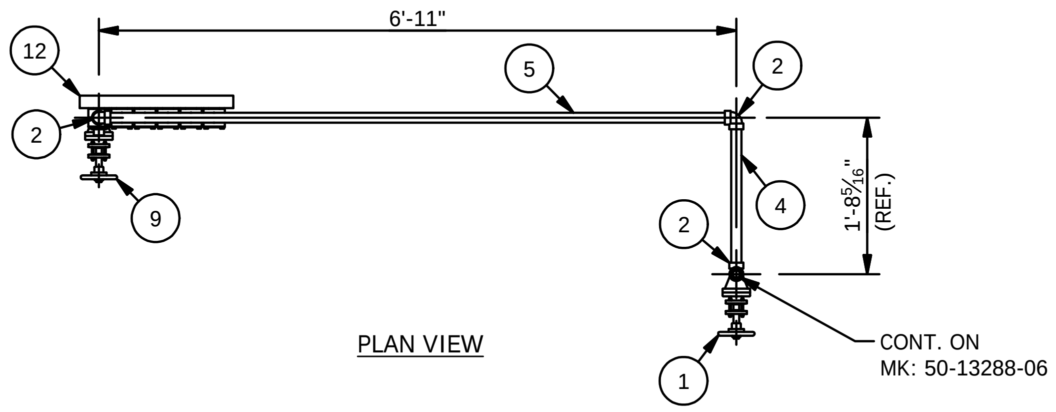
REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

VICTORY ENERGY®
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP SH

Title: LEVEL TRANSMITTER PIPING ASSEMBLY (UPPER)

By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/29/18	Date: 1/29/18	Date: 1/29/18	NTS	50-13288-11	0



PLAN VIEW

BILL OF MATERIAL

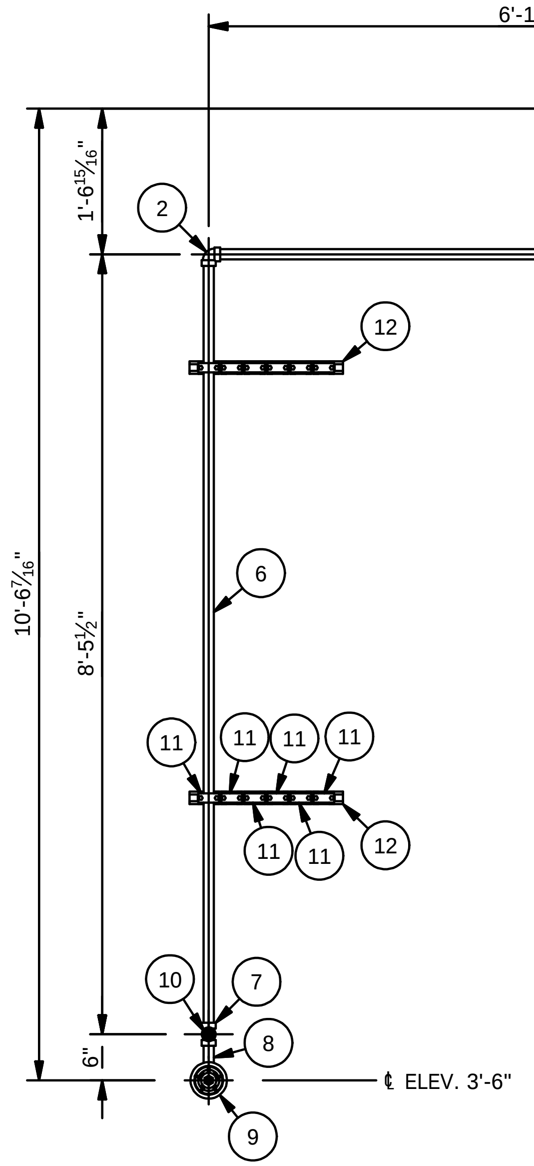
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATI.	WT.
1	1	50-13288-12-01	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81004)	SA-105	8
2	3	50-13288-12-02	ELBOW: 1"-3000#, 90°, S.W.			SA-105	3
3	1	50-13288-12-03	PIPE: 1" SCH. 80	3"	(P.B.E.)	SA-106-B	1
4	1	50-13288-12-04	PIPE: 1" SCH. 80	1'-6 5/16"	(P.B.E.)	SA-106-B	3
5	1	50-13288-12-05	PIPE: 1" SCH. 80	6'-9"	(P.B.E.)	SA-106-B	15
6	1	50-13288-12-06	PIPE: 1" SCH. 80	8'-3 3/8"	(P.B.E.)	SA-106-B	18
7	1	50-13288-12-07	TEE: 1"-3000#, S.W.			SA-105	2
8	1	50-13288-10-08	PIPE: 1" SCH. 80	3 7/16"	(P.B.E.)	SA-106-B	1
9	1	50-13288-12-09	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81013)	SA-105	8
10	1	50-13288-12-10	REDUCING ADAPTER: 1" S.W. x 1/2" N.P.T.-3000#, S.W., (T2)			SA-105	1
11	12	50-13288-12-11	CLAMP: 1" (BEHRINGER ST-CLH-05-A-132)			ALUMINUM	12
12	2	50-13288-12-12	CHANNEL: UNISTRUT B LINE, 1 5/8" x 1 5/8", NO HOLE				2
13	1	50-13288-12-13	PIPE: 1" SCH. 80	11 13/16"	(P.B.E.)	SA-106-B	2

TOTAL WT.: 76

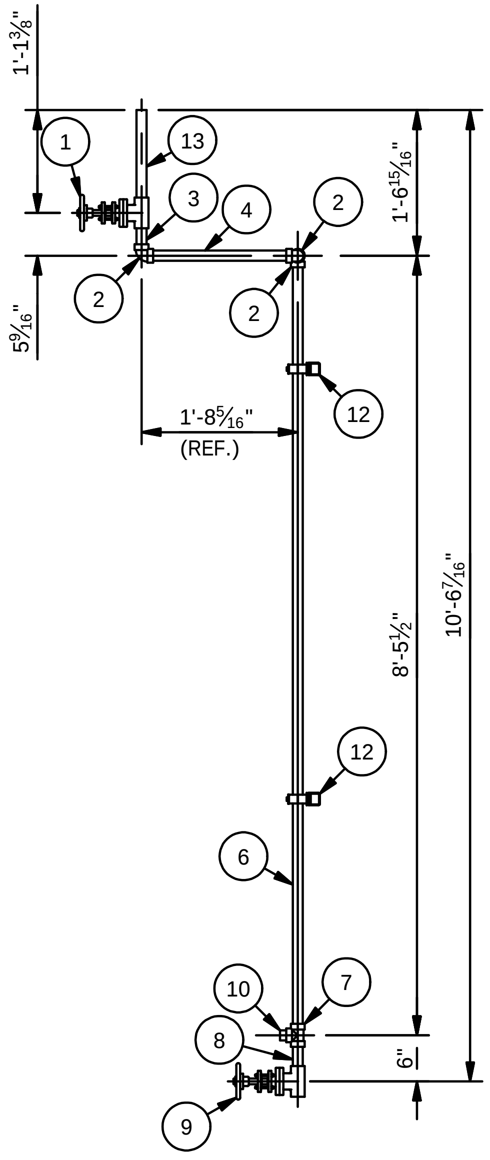
QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

DESIGN NOTES:

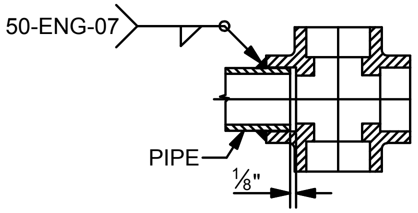
1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



ELEVATION VIEW



SUDE ELEVATION VIEW



TYPICAL SOCKET WELD DETAIL

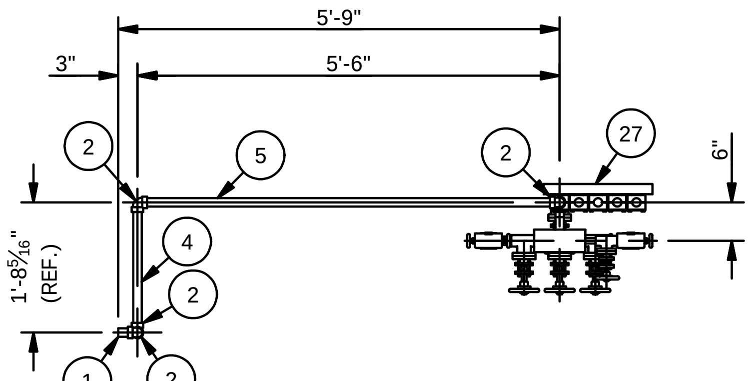
REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

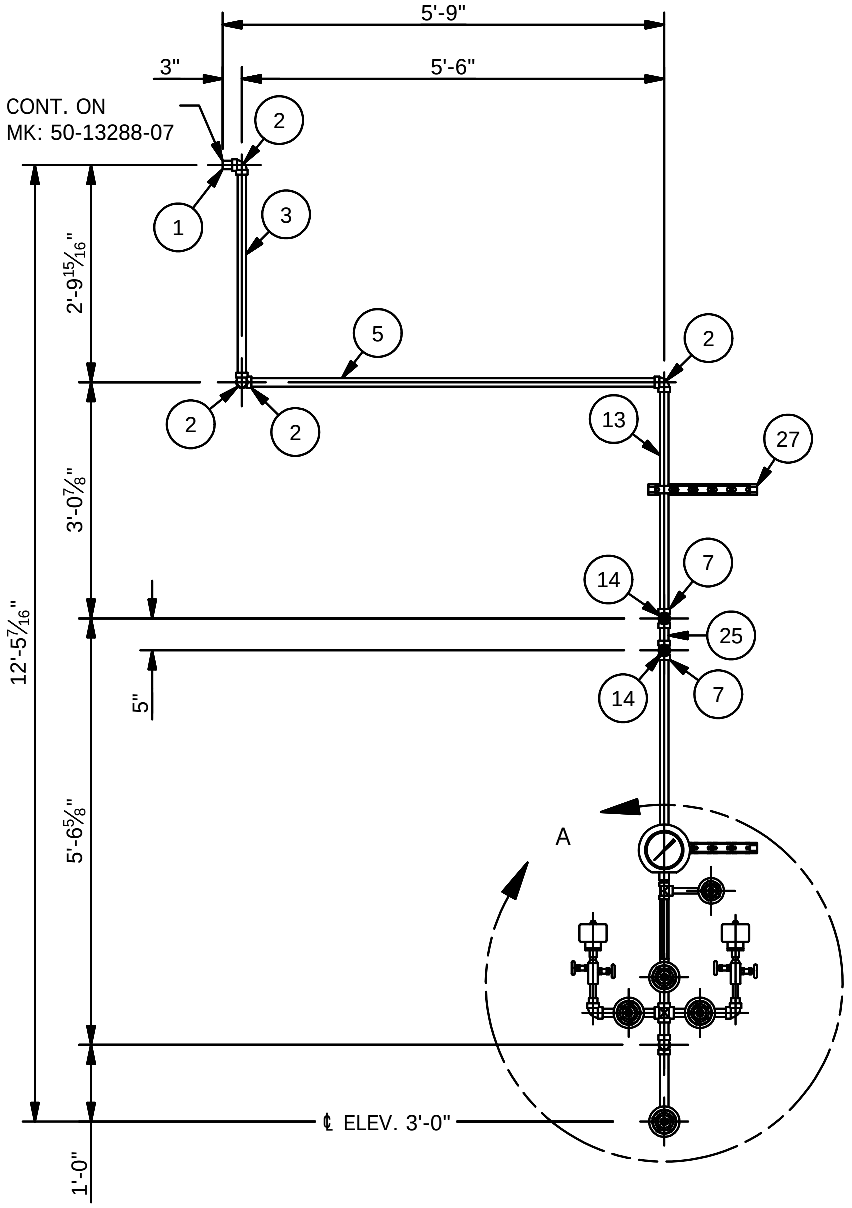
Unit Type/Cust: VS-5-78SP SH

Title: LEVEL TRANSMITTER PIPING ASSEMBLY (LOWER)

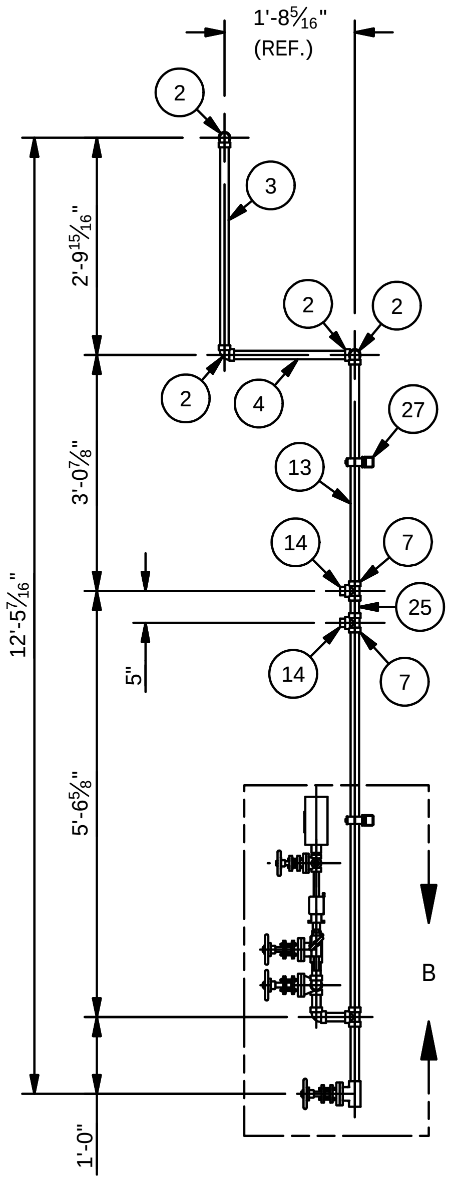
By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dug no:	Rev:
Date: 1/29/18	Date: 1/29/18	Date: 1/29/18	NTS	50-13288-12	0



PLAN VIEW



ELEVATION VIEW



SIDE ELEVATION VIEW

BILL OF MATERIAL

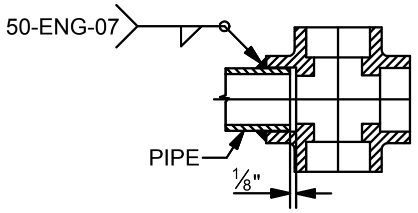
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATl.	WT.
1	1	50-13288-13-01	PIPE: 1" SCH. 80	2"	(P.B.E.)	SA-106-B	0
2	7	50-13288-13-02	ELBOW: 1"-3000#, 90°, S.W.			SA-105	7
3	1	50-13288-13-03	PIPE: 1" SCH. 80	2'-7 15/16"	(P.B.E.)	SA-106-B	6
4	1	50-13288-13-04	PIPE: 1" SCH. 80	1'-6 5/16"	(P.B.E.)	SA-106-B	3
5	1	50-13288-13-05	PIPE: 1" SCH. 80	5'-4"	(P.B.E.)	SA-106-B	12
6	1	50-13288-13-06	PIPE: 1" SCH. 80	9 7/16"	(P.B.E.)	SA-106-B	2
7	3	50-13288-13-07	TEE: 1"-3000#, S.W.			SA-105	5
8	1	50-13288-13-08	PIPE: 1" SCH. 80	4'-11 1/2"	(P.B.E.)	SA-106-B	11
9	1	50-13288-13-09	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81016)	SA-105	8
10	1	50-13288-13-10	PIPE: 1" SCH. 80	4"	(P.B.E.)	SA-106-B	1
11	6	50-13288-13-11	PIPE: 1" SCH. 80	3"	(P.B.E.)	SA-106-B	3
12	1	50-13288-13-12	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81017)	SA-105	8
13	1	50-13288-13-13	PIPE: 1" SCH. 80	2'-10 7/8"	(P.B.E.)	SA-106-B	6
14	4	50-13288-13-14	REDUCING ADAPTER: 1" S.W. x 1/2" N.P.T.-3000#, S.W., (T2)			SA-105	4
15	2	50-13288-13-15	PIPE: 1/2" SCH. 80	3"	(T.B.E.)	SA-106-B	1
16	2	50-13288-13-16	2-VLV: 1/2" N.P.T., (ROSEMOUNT 306)		(2-VLV)	SS-304	1
17	1	50-13288-13-17	PRESSURE TRANSMITTER: 1/2" N.P.T., (ASHCROFT)		(PIT-81030)	SA-105	3
18	1	50-13288-13-18	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81018)	SA-105	8
19	1	50-13288-13-19	REDUCING INSERT: 1" x 1/2"-3000#, S.W., (T2)			SA-105	1
20	1	50-13288-13-20	PIPE: 1/2" SCH. 80	10"	(T.O.E. & P.O.E.)	SA-106-B	1
21	1	50-13288-13-21	TEE: 1/2"-3000#, N.P.T.			SA-105	1
22	1	50-13288-13-22	PRESSURE GAUGE: 1/2" N.P.T., (ASHCROFT)		(PI-81035)		3
23	1	50-13288-13-23	PIPE: 1/2" SCH. 80	5"	(T.O.E. & P.O.E.)	SA-106-B	0
24	1	50-13288-13-24	GATE VALVE: 1/2"-800#, (VOGT SW12111)		(HV-81019)	SA-105	5
25	1	50-13288-13-25	PIPE: 1" SCH. 80	3"	(P.B.E.)	SA-106-B	1
26	10	50-13288-13-26	CLAMP: 1" (BEHRINGER ST-CLH-05-A-132)			ALUMINUM	10
27	2	50-13288-13-27	CHANNEL: UNISTRUT B LINE, 1 5/8" x 1 5/8", NO HOLE				2
28	1	50-13288-13-28	CROSS: 1"-3000#, S.W.			SA-105	2
29	1	50-13288-13-29	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81028)	SA-105	8
30	1	50-13288-13-30	PRESSURE TRANSMITTER: 1/2" N.P.T., (ASHCROFT)		(PIT-81032)	SA-105	3

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

TOTAL WT.: 126

DESIGN NOTES:

1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



TYPICAL SOCKET WELD DETAIL

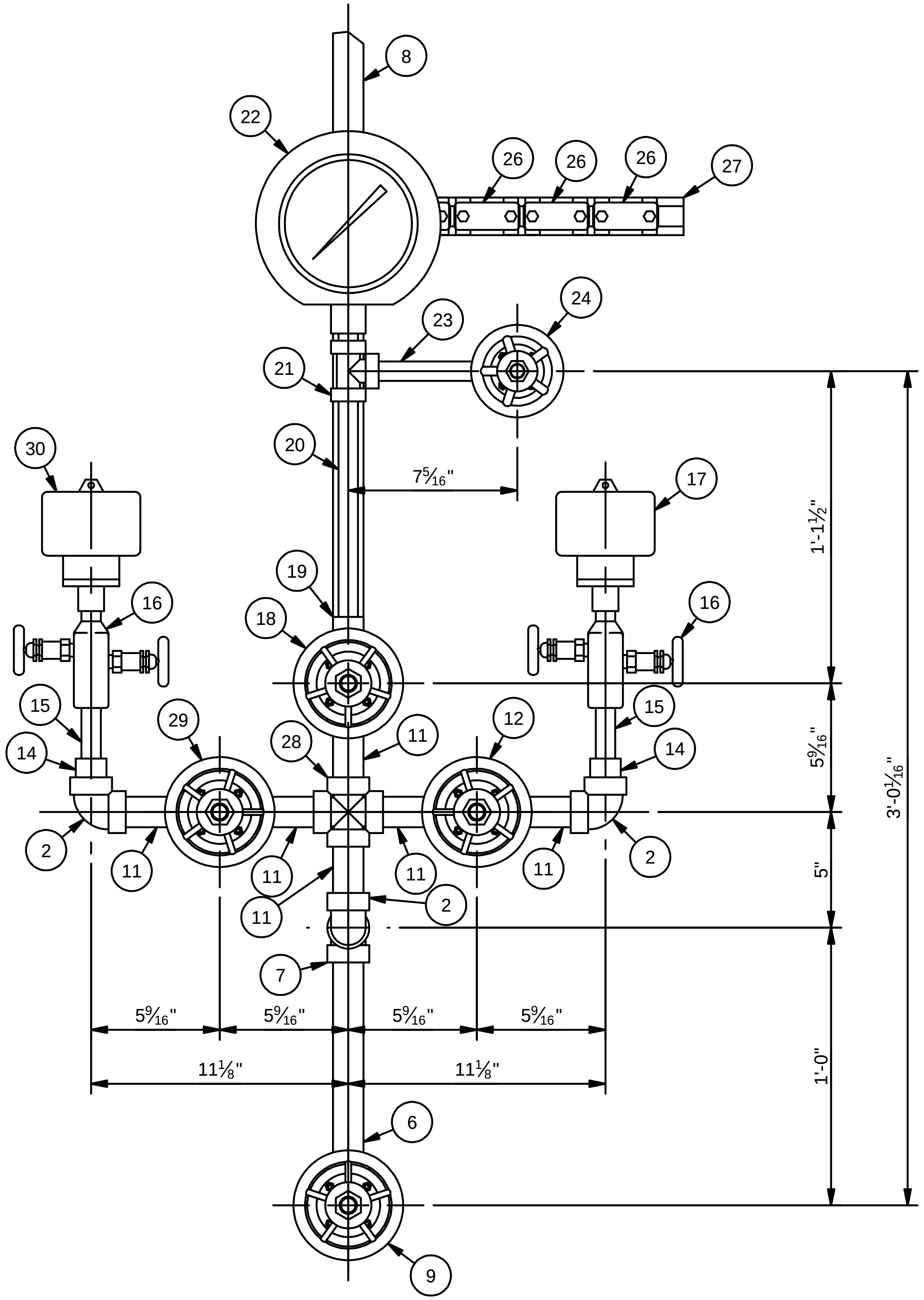
WORK THIS DRAWING WITH: 50-13288-13A

REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

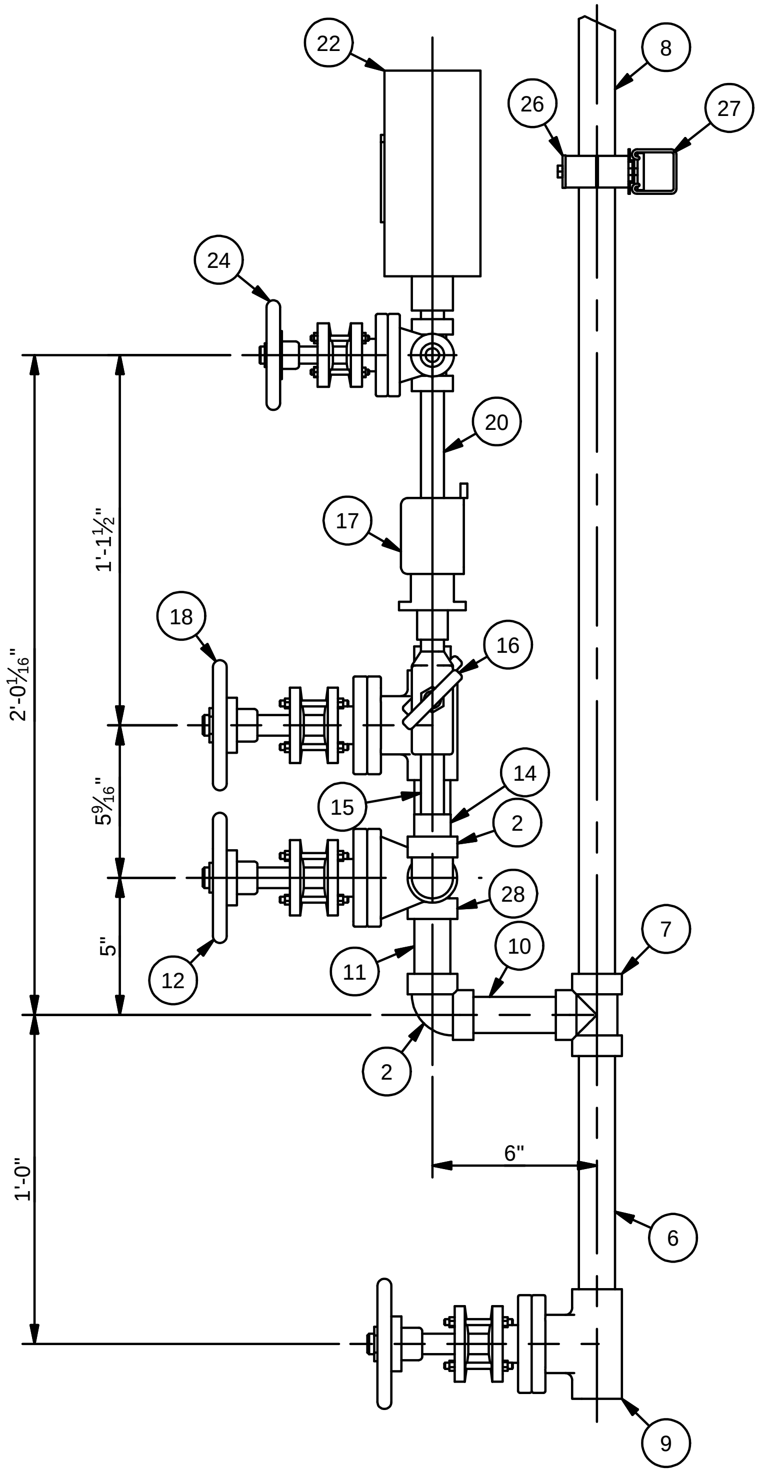
VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP SH
Title: PRESSURE INDICATOR PIPING ASSEMBLY

By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/29/18	Date: 1/29/18	Date: 1/29/18	NTS	50-13288-13	0



DETAIL A



DETAIL B

WORK THIS DRAWING WITH: 50-13288-13

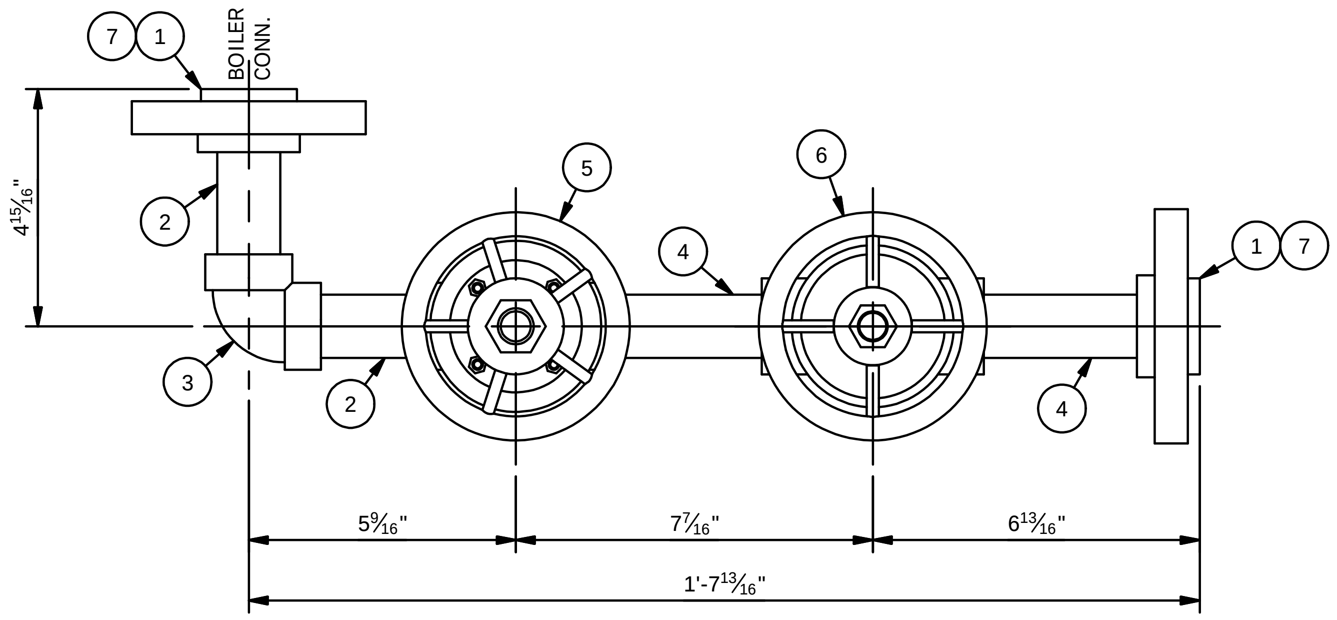
REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

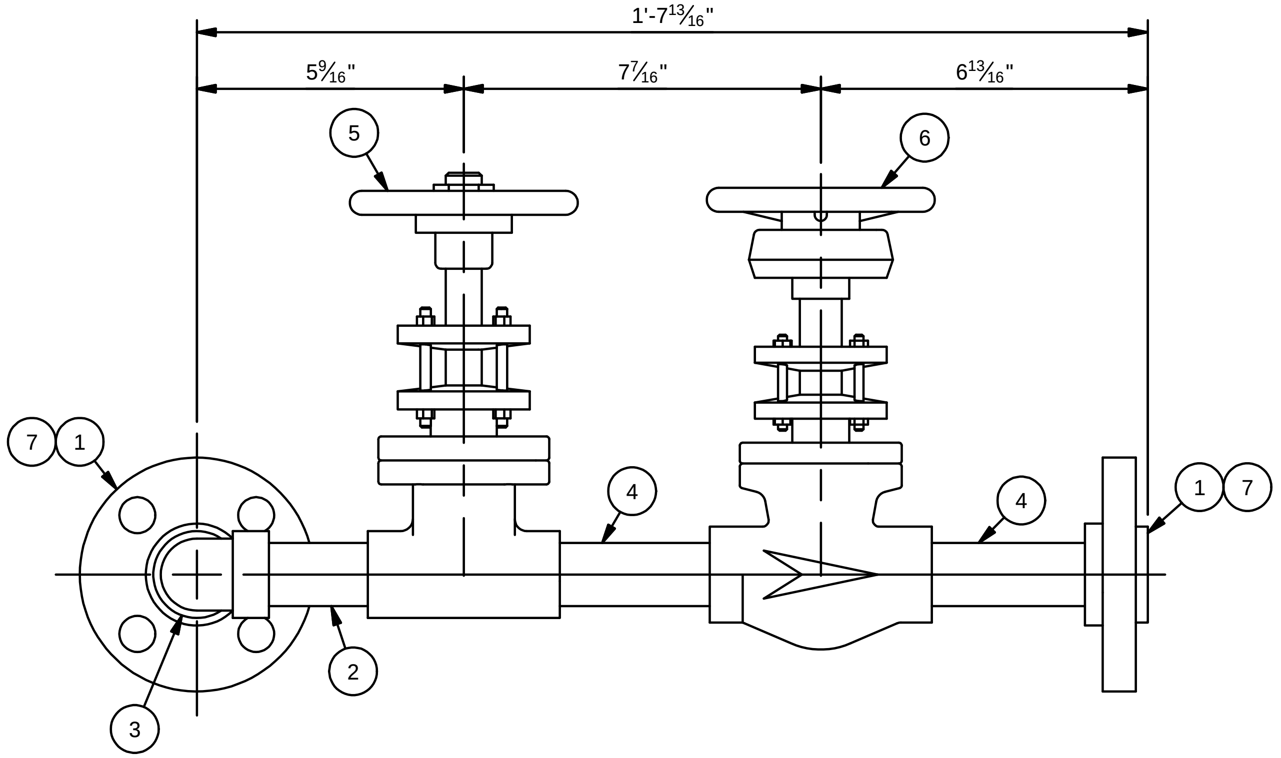
Unit Type/Cust: VS-5-78SP SH

Title: PRESSURE INDICATOR PIPING ASSEMBLY

By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/29/18	Date: 1/29/18	Date: 1/29/18	NTS	50-13288-13A	0



PLAN VIEW



ELEVATION VIEW

BILL OF MATERIAL

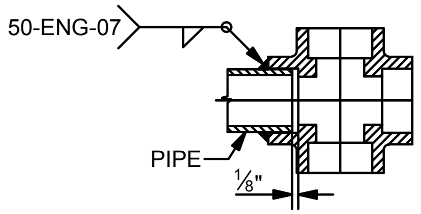
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATl.	WT.
1	2	50-13288-14-01	FLANGE: 1"-600#, R.F.S.W., SCH 80 BORE			SA-105	8
2	2	50-13288-14-02	PIPE: 1" SCH. 80	3"	(P.B.E.)	SA-106-B	1
3	1	50-13288-14-03	ELBOW: 1"-3000#, 90°, S.W.			SA-105	1
4	2	50-13288-14-04	PIPE: 1" SCH. 80	4"	(P.B.E.)	SA-106-B	1
5	1	50-13288-14-05	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81022)	SA-105	8
6	1	50-13288-14-06	GLOBE VALVE: 1"-800#, (VOGT SW12443)		(HV-81023)	SA-105	10
7	2		GASKET: 1"-600#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-6D	1
7A	8		STUD: 5/8"Ø	3 1/2"		SA-193-B7	2
7B	16		NUT: 5/8" HVY. HEX			SA-194-2H	2

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

TOTAL WT.: 34

DESIGN NOTES:

1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



TYPICAL SOCKET WELD DETAIL

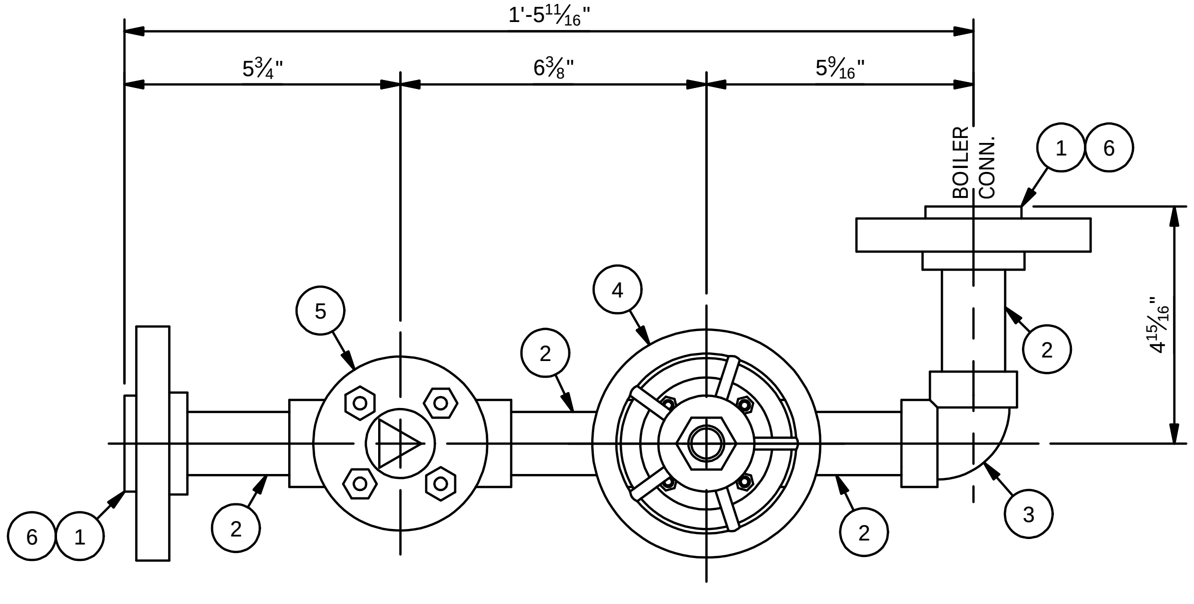
REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

VICTORY ENERGY®
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

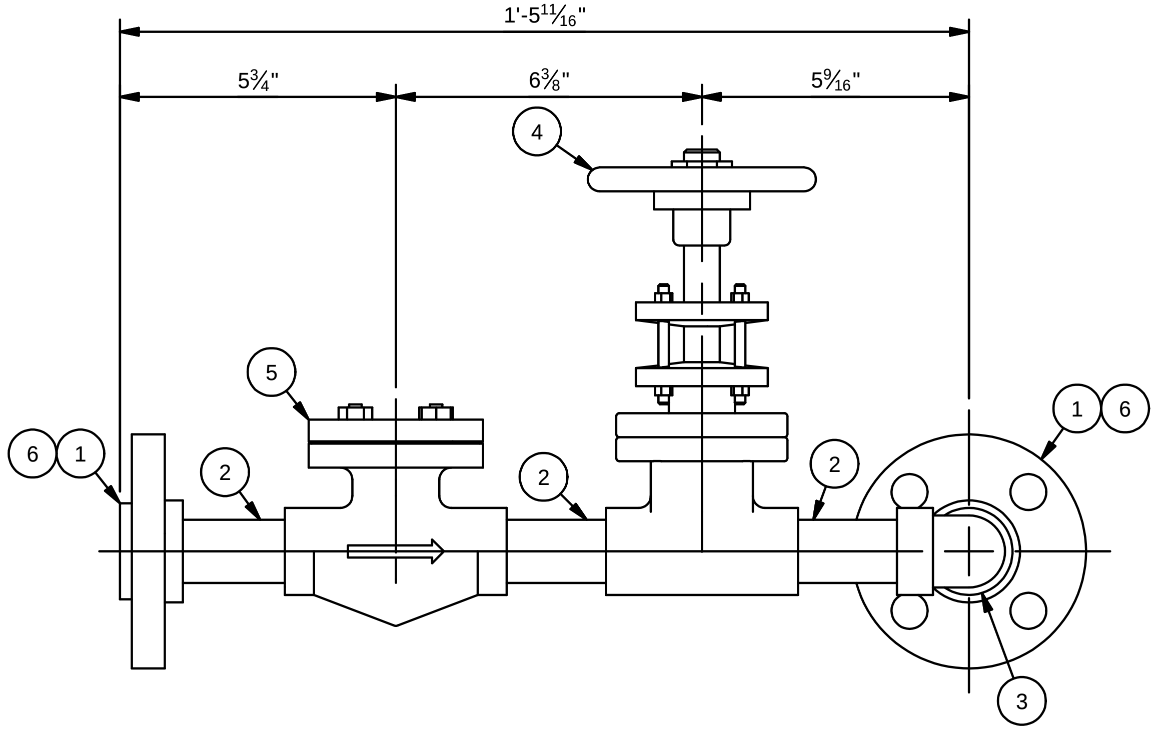
Unit Type/Cust: VS-5-78SP SH

Title: CONTINUOUS BLOWDOWN PIPING ASSEMBLY

By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/29/18	Date: 1/29/18	Date: 1/29/18	NTS	50-13288-14	0



PLAN VIEW



ELEVATION VIEW

BILL OF MATERIAL

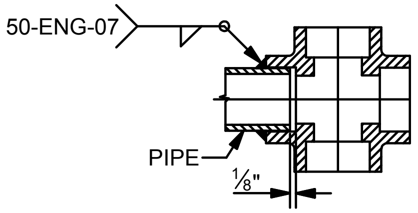
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATI.	WT.
1	2	50-13288-15-01	FLANGE: 1"-600#, R.F.S.W., SCH 80 BORE			SA-105	8
2	4	50-13288-15-02	PIPE: 1" SCH. 80	3"	(P.B.E.)	SA-106-B	2
3	1	50-13288-15-03	ELBOW: 1"-3000#, 90°, S.W.			SA-105	1
4	1	50-13288-15-04	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81020)	SA-105	8
5	1	50-13288-15-05	CHECK VALVE: 1"-800#, (VOGT SW701)		(CV-81021)	SA-105	7
6	1		GASKET: 1"-600#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-6D	1
6A	4		STUD: 5/8"Ø	3 1/2"		SA-193-B7	1
6B	8		NUT: 5/8" HVY. HEX			SA-194-2H	1

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

TOTAL WT.: 29

DESIGN NOTES:

1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



TYPICAL SOCKET WELD DETAIL

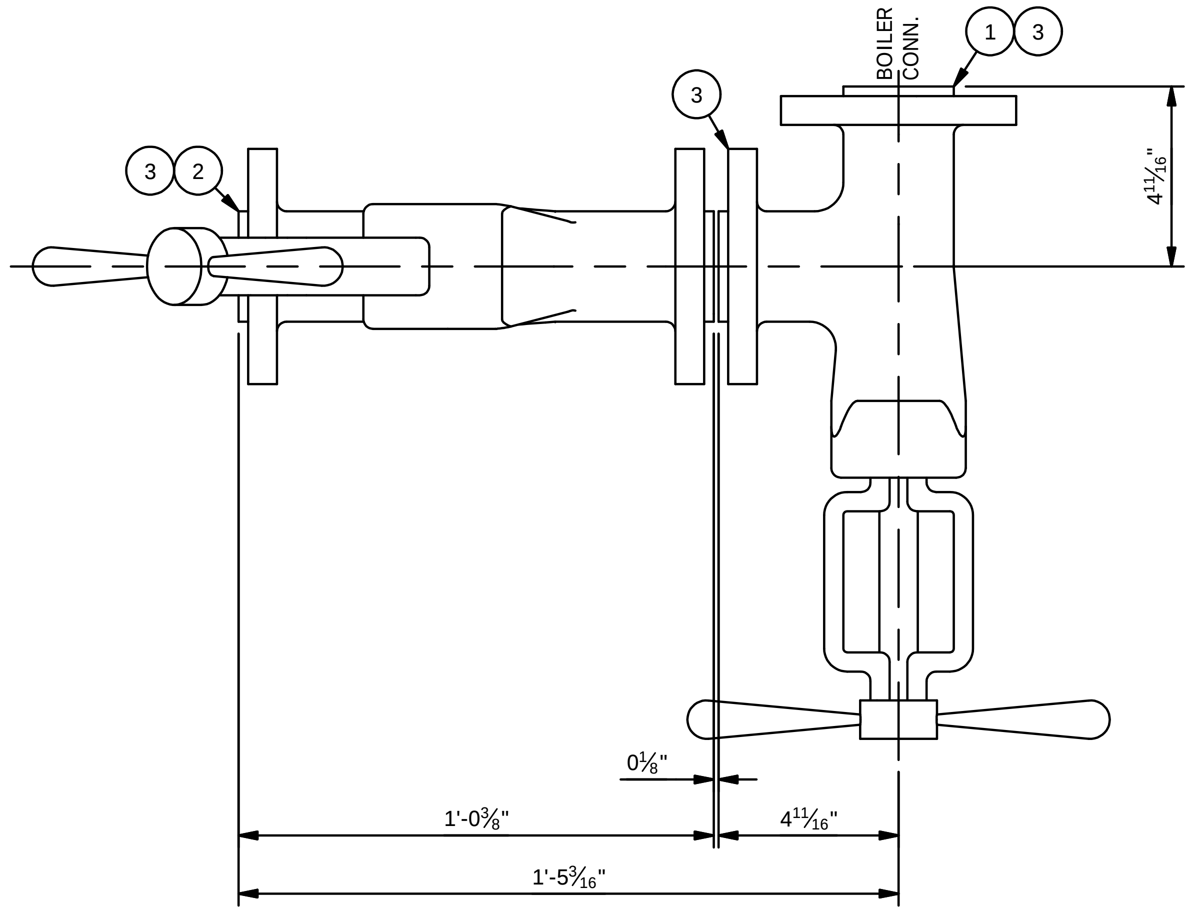
REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

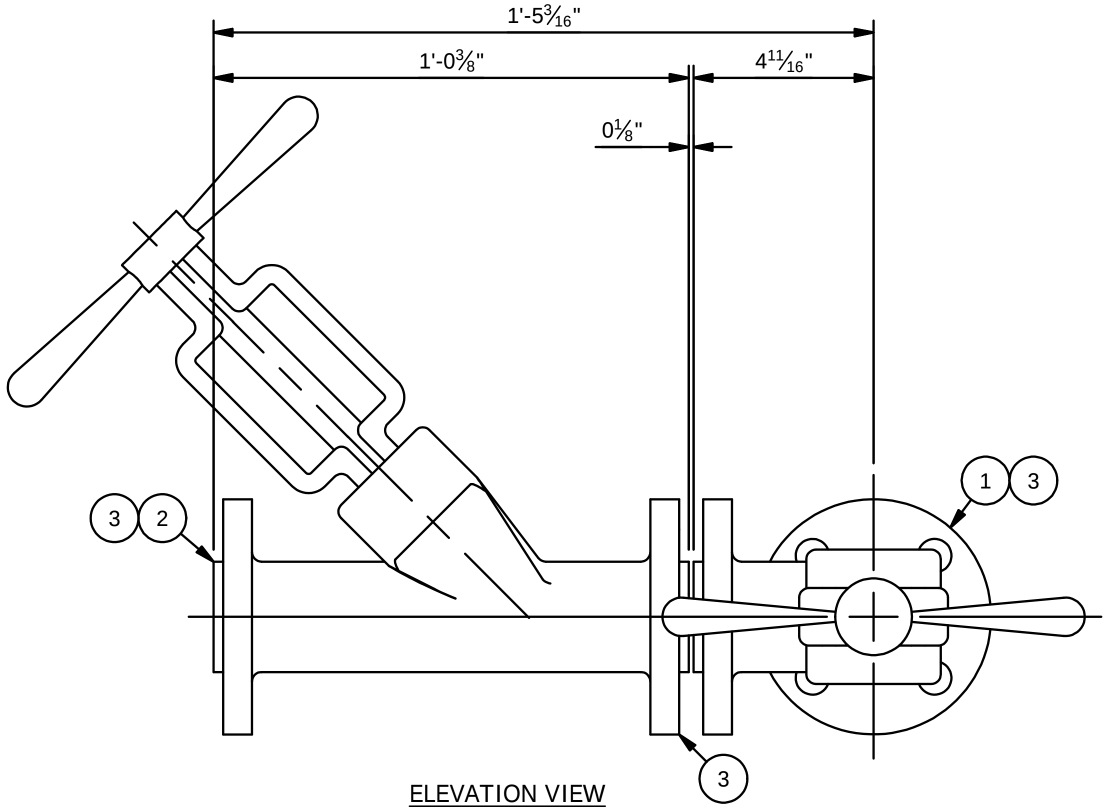
Unit Type/Cust: VS-5-78SP SH

Title: CHEMICAL FEED PIPING ASSEMBLY

By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/29/18	Date: 1/29/18	Date: 1/29/18	NTS	50-13288-15	0



PLAN VIEW



ELEVATION VIEW

BILL OF MATERIAL

ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATI.	WT.
1	1	50-13288-16-01	BLOW-OFF VALVE: 1 1/2"-600#, R.F., (EDWARDS 1643)		(HV-81024)	SA-105	41
2	1	50-13288-16-02	BLOW-OFF VALVE: 1 1/2"-600#, R.F., (EDWARDS 1641)		(HV-81025)	SA-105	44
3	3		GASKET: 1 1/2"-600#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-6F	1
3A	12		STUD: 3/4"Ø	4 1/4"		SA-193-B7	7
3B	24		NUT: 3/4" HVY. HEX			SA-194-2H	4

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

TOTAL WT.: 97

DESIGN NOTES:

1) DESIGN TEMP @ 650°
2) MAWP @ 1,175 PSIG.
3) HYDROTEST PRESSURE @ 1,763 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.

REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

VICTORY ENERGY®
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP SH

Title: INTERMITTENT BLOWDOWN PIPING ASSEMBLY

By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/30/18	Date: 1/30/18	Date: 1/30/18	NTS	50-13288-16	0

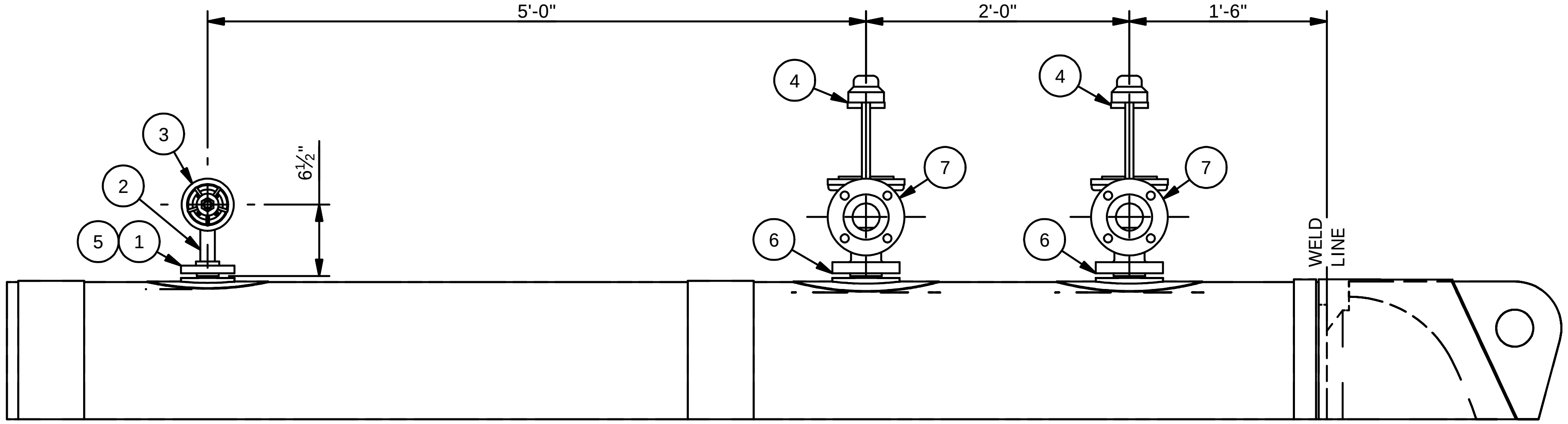
BILL OF MATERIAL							
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATI.	WT.
1	1	50-13288-17-01	FLANGE: 1"-600#, R.F.S.W., SCH 80 BORE			SA-105	4
2	1	50-13288-17-02	PIPE: 1" SCH. 80	4"	(P.B.E.)	SA-106-B	1
3	1	50-13288-17-03	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81026)	SA-105	8
4	2	50-13288-17-04	SAFETY VALVE: 1 1/2"-600# INLET x 2 1/2"-150# OUTLET, (KUNKLE 600NHG)		(PSV-81602)	SA-105	120
5	1		GASKET: 1"-600#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-6D	1
5A	4		STUD: 5/8"Ø	3 1/2"		SA-193-B7	1
5B	8		NUT: 5/8" HVY. HEX			SA-194-2H	1
6	2		GASKET: 1 1/2"-600#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-6F	1
6A	8		STUD: 3/4"Ø	4 1/4"		SA-193-B7	2
6B	16		NUT: 3/4" HVY. HEX			SA-194-2H	2
7	2		GASKET: 2 1/2"-150#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-1H	1
7A	8		STUD: 5/8"Ø	3 3/4"		SA-193-B7	2
7B	16		NUT: 5/8" HVY. HEX			SA-194-2H	2

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

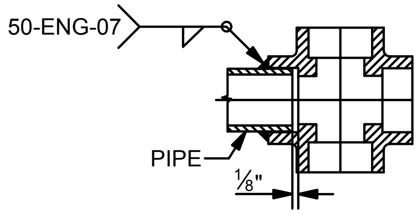
TOTAL WT.: 146

DESIGN NOTES:

1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



ELEVATION VIEW



TYPICAL SOCKET WELD DETAIL

0					
REV	BY	DATE	CHK'D	DATE	DESCRIPTION

VICTORY ENERGY®
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP SH

Title: BOILER VENT & SAFETY VALVES PIPING ASSEMBLY

By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/30/18	Date: 1/30/18	Date: 1/30/18	NTS	50-13288-17	0

BILL OF MATERIAL

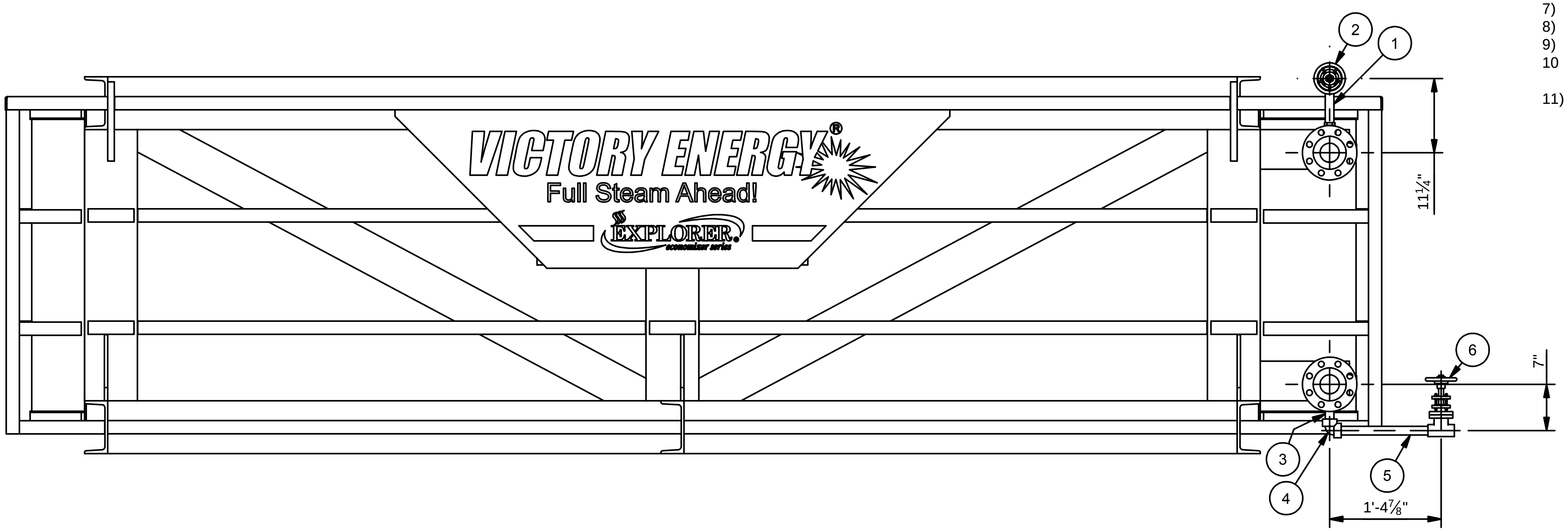
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATL.	WT.
1	1	50-13288-18-01	PIPE: 1" SCH 80	6"	(T.O.E. & P.O.E.)	SA-106-B	1
2	1	50-13288-18-02	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81401)		8
3	1	50-13288-18-03	PIPE: 1" SCH 80	4"	(T.B.E.)	SA-106-B	1
4	1	50-13288-18-04	ELBOW: 1"-3000#, 90°, N.P.T.			SA-105	1
5	1	50-13288-18-05	PIPE: 1" SCH 80	1'-0"	(T.O.E. & P.O.E.)	SA-106-B	2
6	1	50-13288-18-06	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81402)		8

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

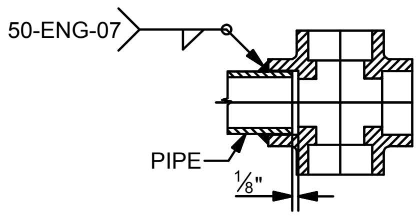
TOTAL WT.: 21

DESIGN NOTES:

1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



ELEVATION VIEW



TYPICAL SOCKET WELD DETAIL

REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

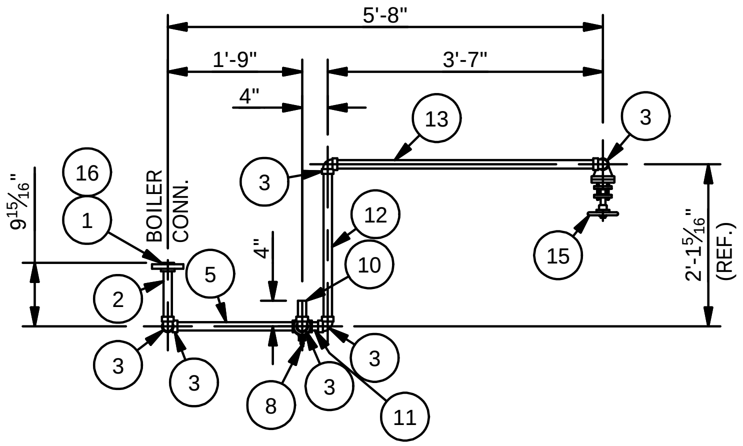
VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP SH

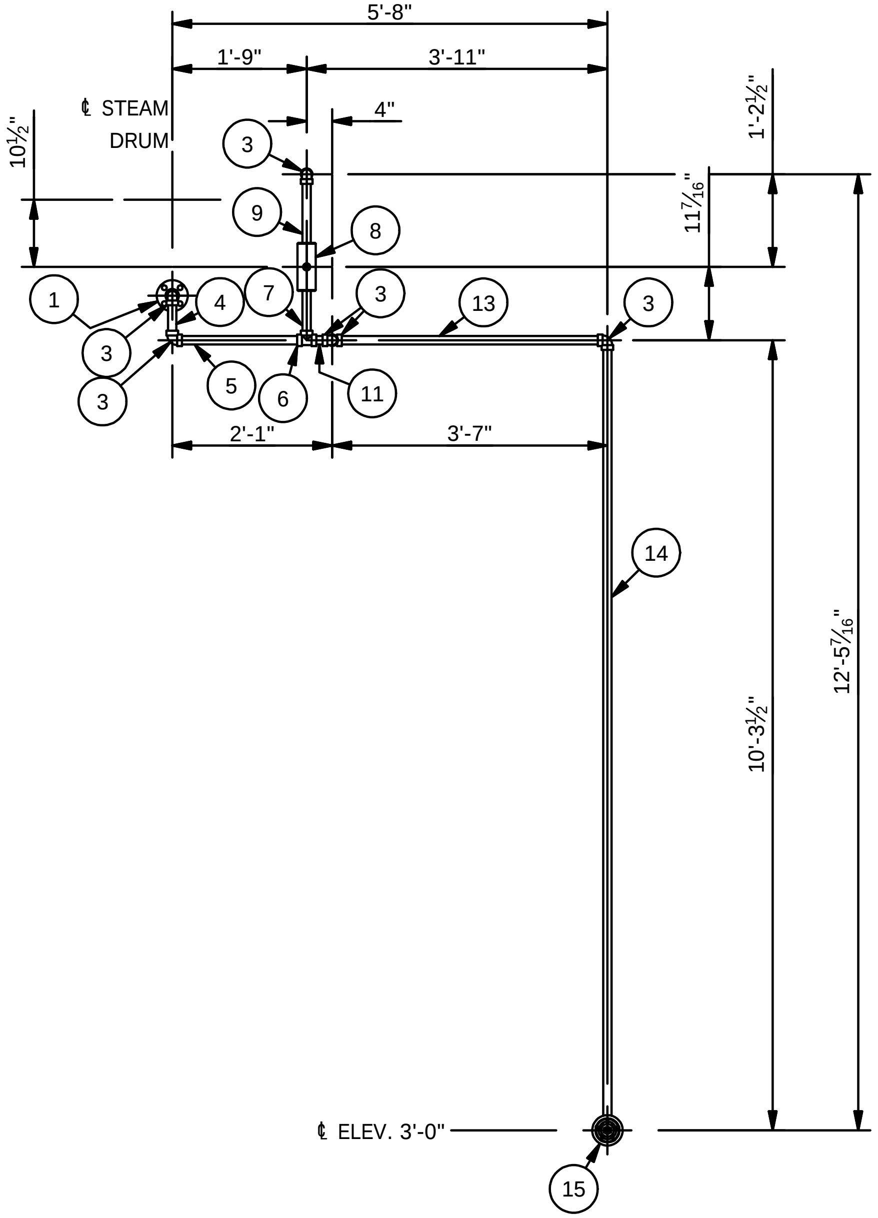
Title: ECONOMIZER VENT & DRAIN PIPING ASSEMBLY

By: TWS	Chk'd: TWS	Aprv'd: DAR	Scale:	Dwg no:	Rev:
Date: 4/03/18	Date: 4/03/18	Date: 4/03/18	NTS	50-13288-18	0

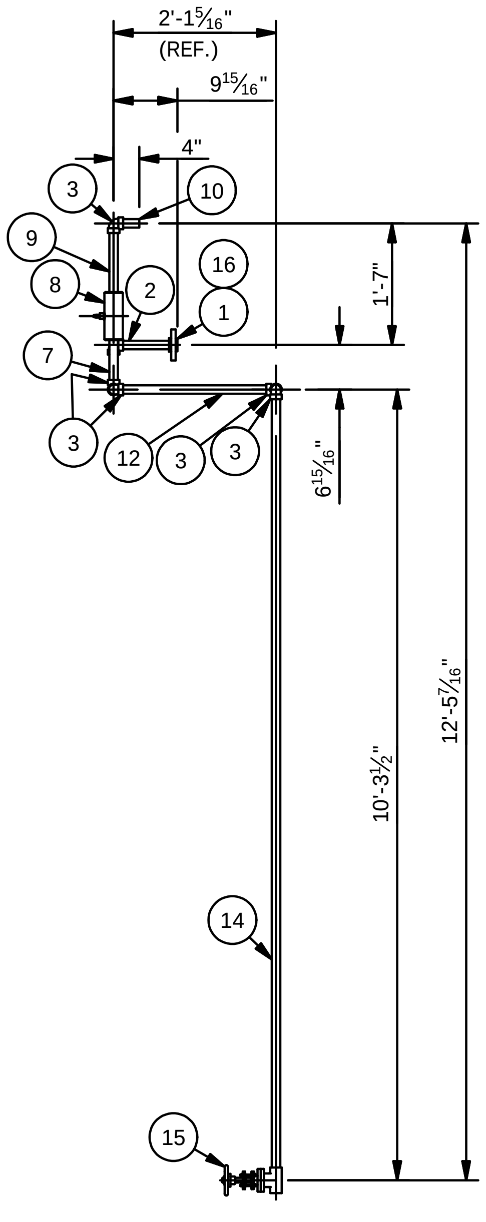
TOLERANCE: ±⅛" NON-CUMULATIVE



PLAN VIEW



ELEVATION VIEW



SIDE ELEVATION VIEW

BILL OF MATERIAL

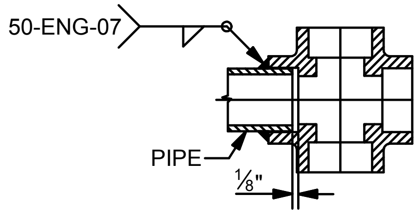
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATI.	WT.
1	1	50-13288-19-01	FLANGE: 1"-600#, R.F.S.W., SCH 80 BORE			SA-105	4
2	1	50-13288-19-02	PIPE: 1" SCH. 80	8"	(P.B.E.)	SA-106-B	1
3	6	50-13288-19-03	ELBOW: 1"-3000#, 90°, S.W.			SA-105	6
4	1	50-13288-19-04	PIPE: 1" SCH. 80	4 15/16"	(P.B.E.)	SA-106-B	1
5	1	50-13288-19-05	PIPE: 1" SCH. 80	1'-7"	(P.B.E.)	SA-106-B	3
6	1	50-13288-19-06	TEE: 1"-3000#, S.W.			SA-105	2
7	1	50-13288-19-07	PIPE: 1" SCH. 80	7 1/8"	(P.B.E.)	SA-106-B	1
8	1	50-13288-19-08	ALWCO: 1" S.W.		(LE-81009)	SA-106-B	10
9	1	50-13288-19-09	PIPE: 1" SCH. 80	10 3/16"	(P.B.E.)	SA-106-B	2
10	1	50-13288-19-10	PIPE: 1" SCH. 80	3"	(P.B.E.)	SA-106-B	1
11	1	50-13288-19-11	PIPE: 1" SCH. 80	2"	(P.B.E.)	SA-106-B	0
12	1	50-13288-19-12	PIPE: 1" SCH. 80	1'-11 5/16"	(P.B.E.)	SA-106-B	4
13	1	50-13288-19-13	PIPE: 1" SCH. 80	3'-5"	(P.B.E.)	SA-106-B	7
14	1	50-13288-19-14	PIPE: 1" SCH. 80	10'-15/16"	(P.B.E.)	SA-106-B	22
15	1	50-13288-19-15	GATE VALVE: 1"-800#, (VOGT SW12111)		(HV-81027)	SA-105	8
16	1		GASKET: 1"-600#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-6D	1
16A	4		STUD: 5/8"Ø	3 1/2"		SA-193-B7	1
16B	8		NUT: 5/8" HVY. HEX			SA-194-2H	1

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

TOTAL WT.: 75

DESIGN NOTES:

1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



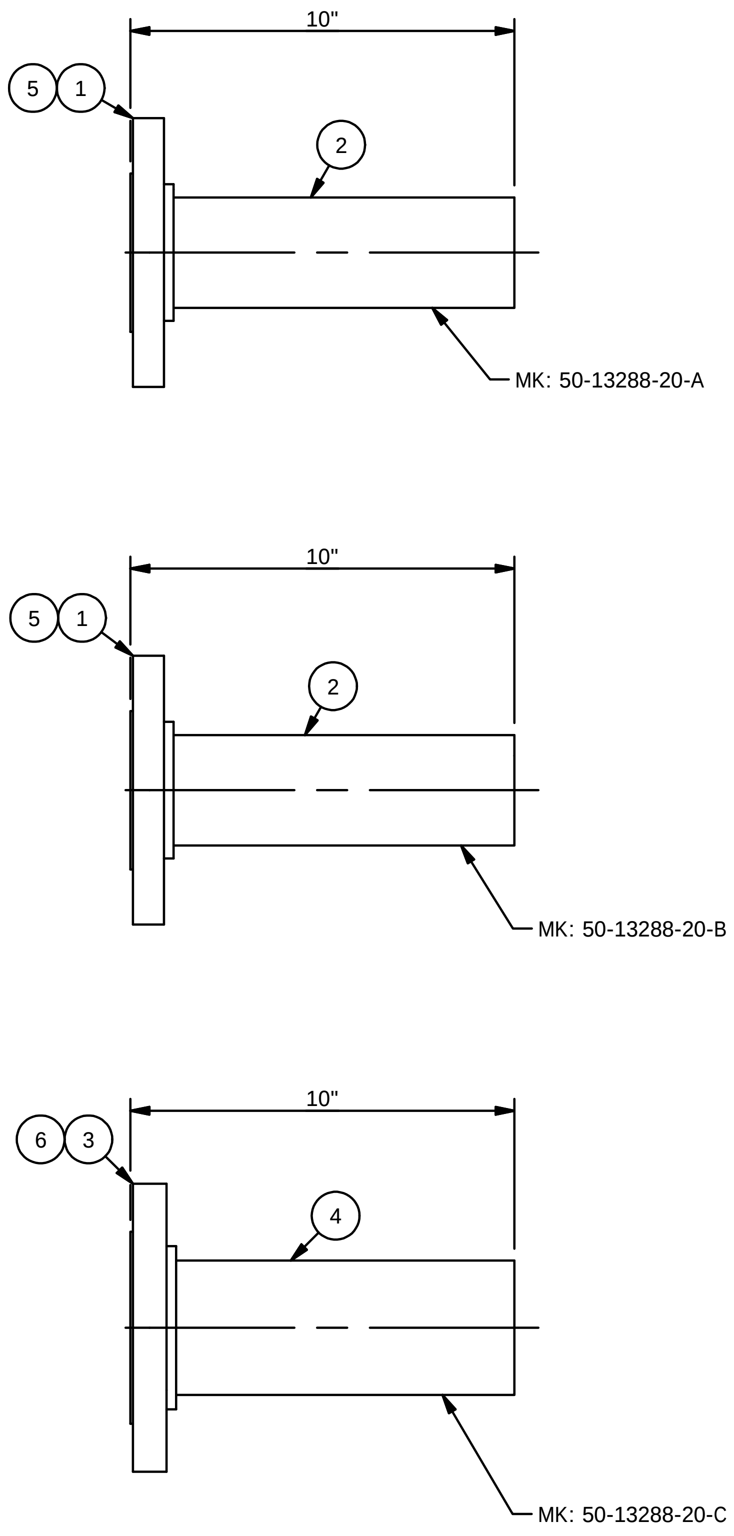
TYPICAL SOCKET WELD DETAIL

REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP SH
Title: ALWCO PIPING ASSEMBLY

By: TWS	Chk'd: TWS	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/30/18	Date: 1/30/18	Date: 1/30/18	NTS	50-13288-19	0



ELEVATION VIEW

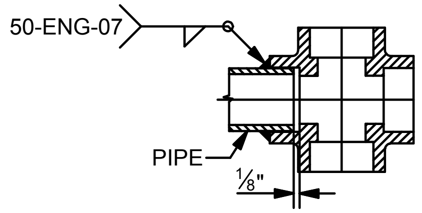
BILL OF MATERIAL							
ITEM	QTY	MK:	DESCRIPTION	LENGTH	REMARKS	MATL.	WT.
1	2	50-13288-20-01	FLANGE: 2 1/2"-150#, R.F.S.W., SCH 40 BORE			SA-105	14
2	2	50-13288-20-02	PIPE: 2 1/2" SCH. 40	9 1/2"	(T.O.E. & P.O.E.)	SA-106-B	9
3	1	50-13288-20-03	FLANGE: 3"-150#, R.F.S.W., SCH 40 BORE			SA-105	8
4	1	50-13288-20-04	PIPE: 3" SCH. 40	9 1/2"	(T.O.E. & P.O.E.)	SA-106-B	6
5	2		GASKET: 2 1/2"-150#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-1H	1
5A	8		STUD: 5/8"Ø	3 3/4"		SA-193-B7	2
5B	16		NUT: 5/8" HVY. HEX			SA-194-2H	2
6	1		GASKET: 3"-150#, 1/8" THK., (FLEXITALLIC OR EQUAL)			CG-J	1
6A	4		STUD: 5/8"Ø	3 3/4"		SA-193-B7	1
6B	8		NUT: 5/8" HVY. HEX			SA-194-2H	1

QUANTITIES ARE FOR ONE (1) UNIT; ONE (1) UNIT REQUIRED

TOTAL WT.: 45

DESIGN NOTES:

1) DESIGN TEMP @ 650°
2) MAWP @ 950 PSIG.
3) HYDROTEST PRESSURE @ 1,425 PSIG.
4) RADIOGRAPHY (NOT REQUIRED).
5) CODE STAMP AS PER ASME CODE SECTION 1 2015 EDITION.
6) CONSTRUCT TO ASME B31.1
7) ALL PIPE LENGTHS BASED ON 1/8" GAP.
8) ALL WELDS TO BE DEBURRED.
9) SHOP TO CUT PLAIN, BEVEL OR THREAD AS REQUIRED.
10 ALL FLANGE BOLT HOLES TO STRADDLE NOMINAL CENTER LINE, UNLESS OTHERWISE NOTED.
11) PIPE LENGTHS ARE THEORETICAL BASED ON THE BEST AVAILABLE STANDARDS AND DATA. DUE TO ALLOWABLE MANUFACTURERS TOLERANCE AND VARIABLE WELD SHRINK. ADJUST LENGTH AS NEEDED TO MAINTAIN OVERALL DIMENSIONS.



TYPICAL SOCKET WELD DETAIL

TOLERANCE: ±$\frac{1}{8}$" NON-CUMULATIVE

REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

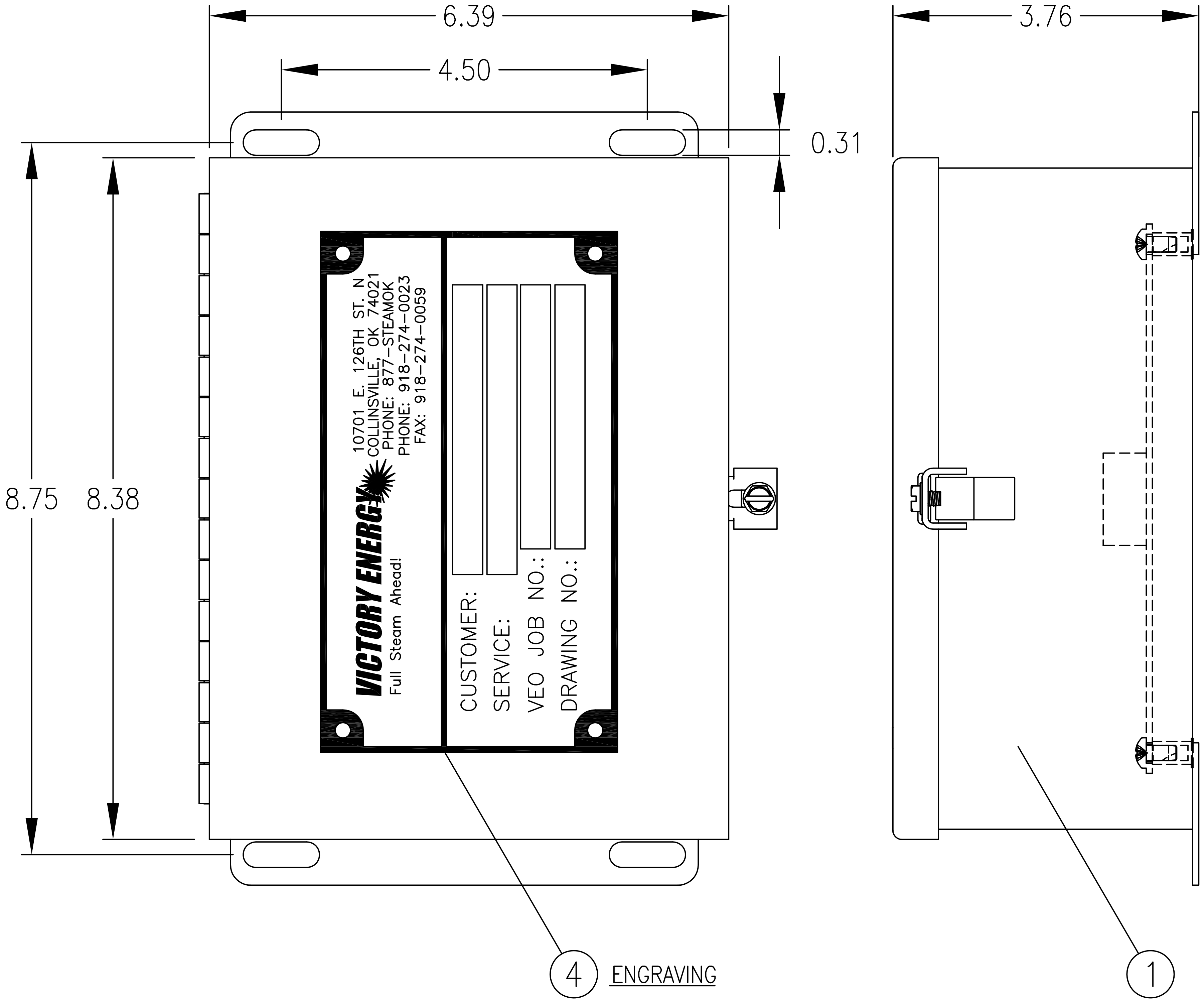
VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

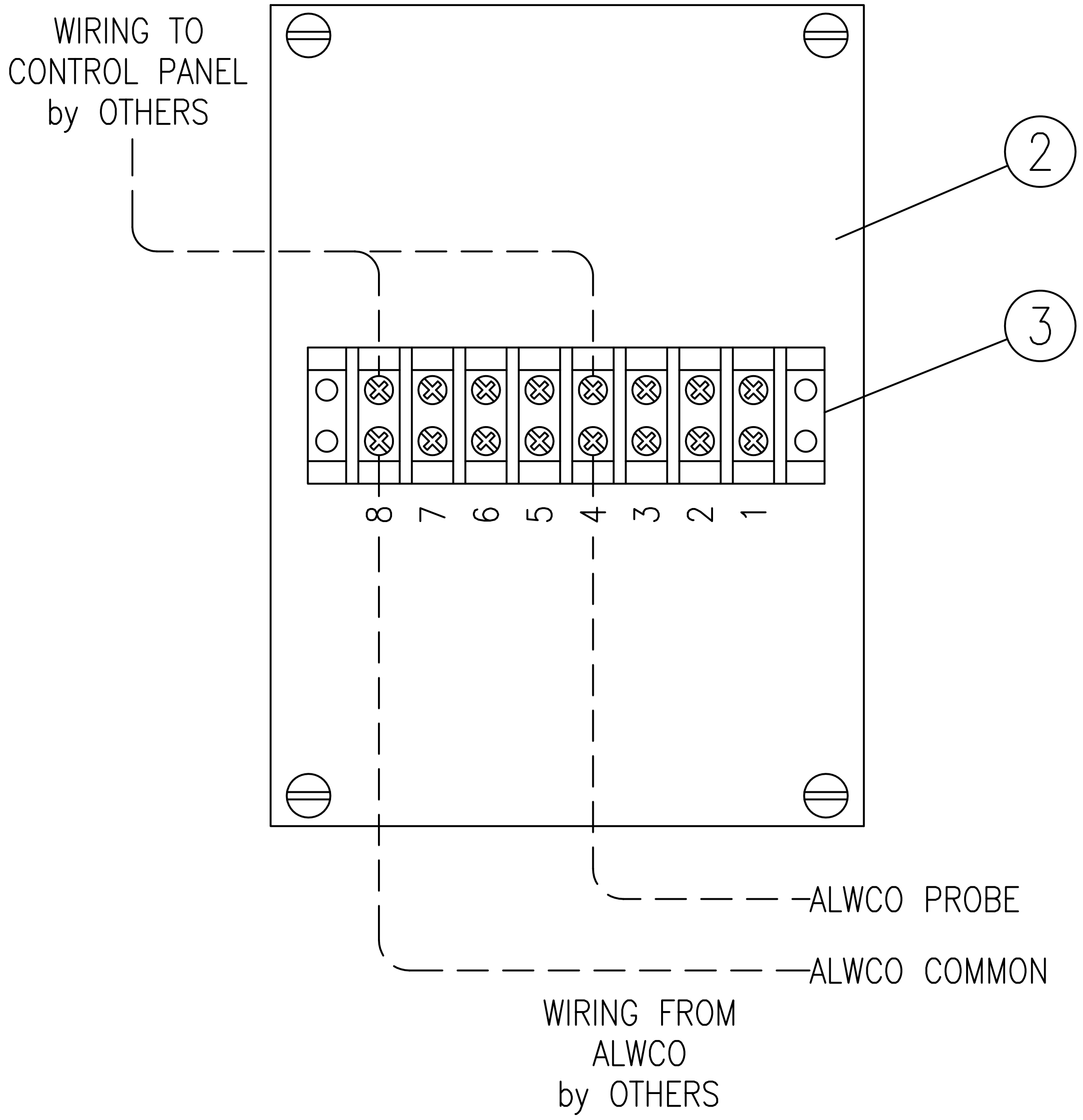
Unit Type/Cust: VS-5-78SP SH

Title: PSV TO DRIP PAN ELBOW SPOOLS

By: TWS	Chk'd: TWS	Aprv'd: DAR	Scale:	Dwg no:	Rev:
Date: 4/03/18	Date: 4/03/18	Date: 4/03/18	NTS	50-13288-20	0

MATERIAL LIST		
ITEM	QTY.	DESCRIPTION
1	1	ENCLOSURE, SCE MODEL 806CHNF NEMA 4
2	1	ENCLOSURE SUB-PANEL, MODEL 8P6
3	1	TERMINAL STRIP, MARATHON KULKA NO. 671GP08
4	1	JUNCTION BOX NAMEPLATE, REF. 62-000-02





CUSTOMER: COLUMBIA PULP
SERVICE: ALWCO JUNCTION BOX
VEO JOB NO.: VE-13288
DRAWING NO.: 60-13288-22

TAG: LE-81009

rev.	by	date	chk'd	date	description
6					
5					
4					
3					
2					
1	AWG	17JAN18	FBL	17JAN18	CHANGED ENCLOSURE SIZE

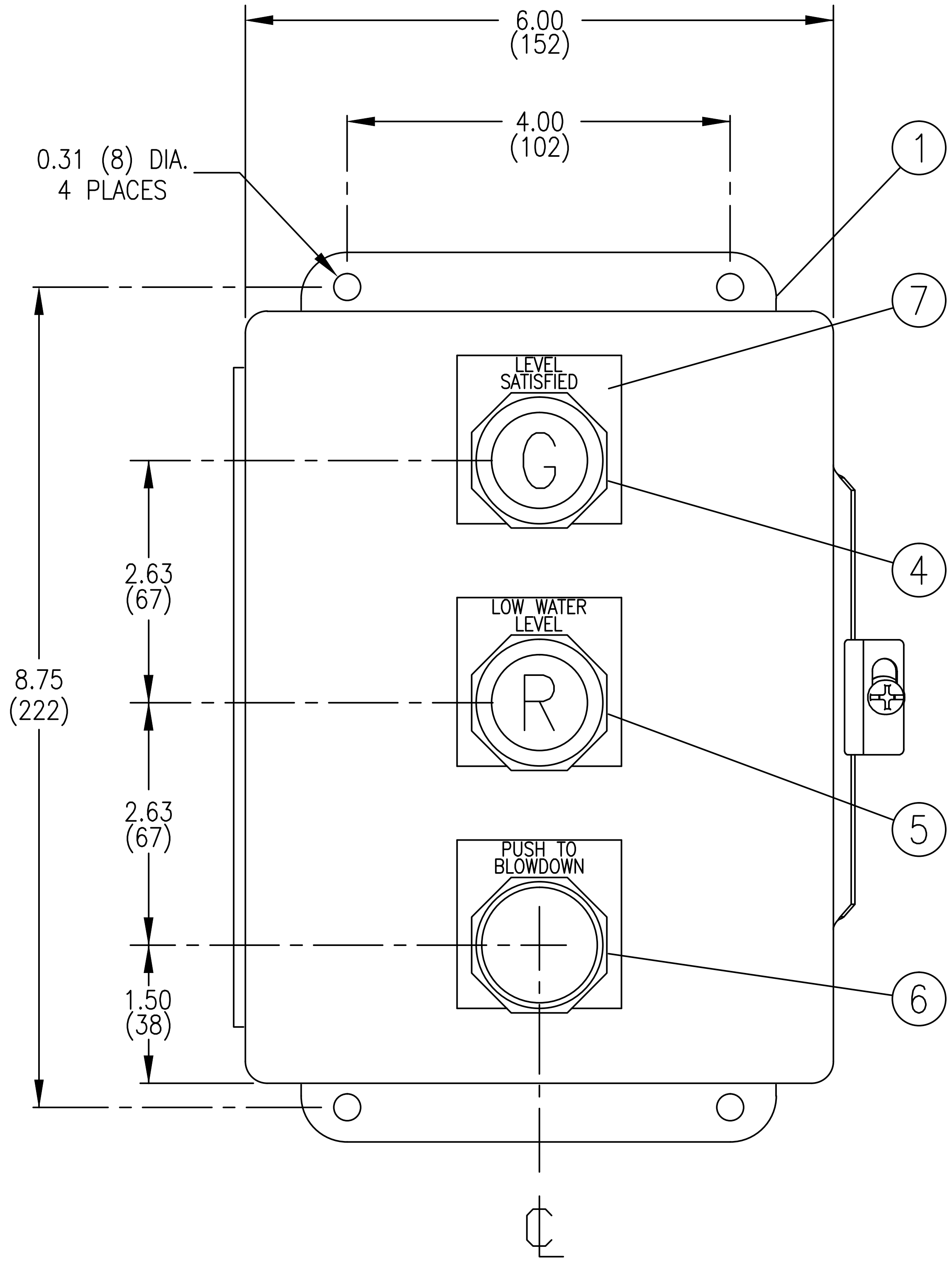
VICTORY ENERGY

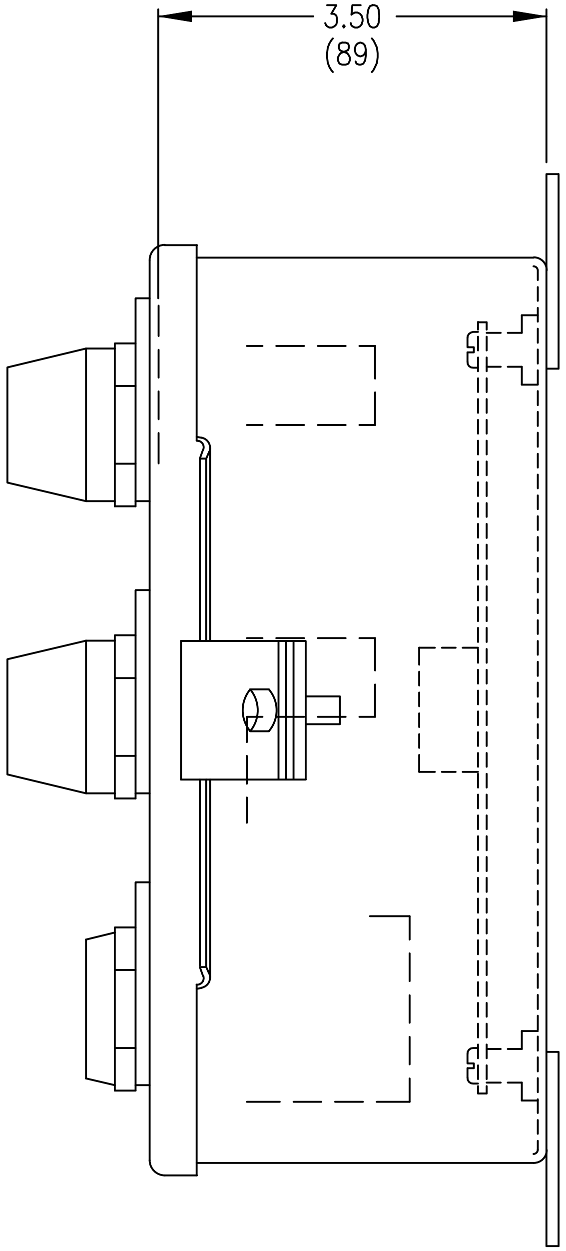
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

cust/proj.#: COLUMBIA PULP / VE-13288

title: ALWCO JUNCTION BOX

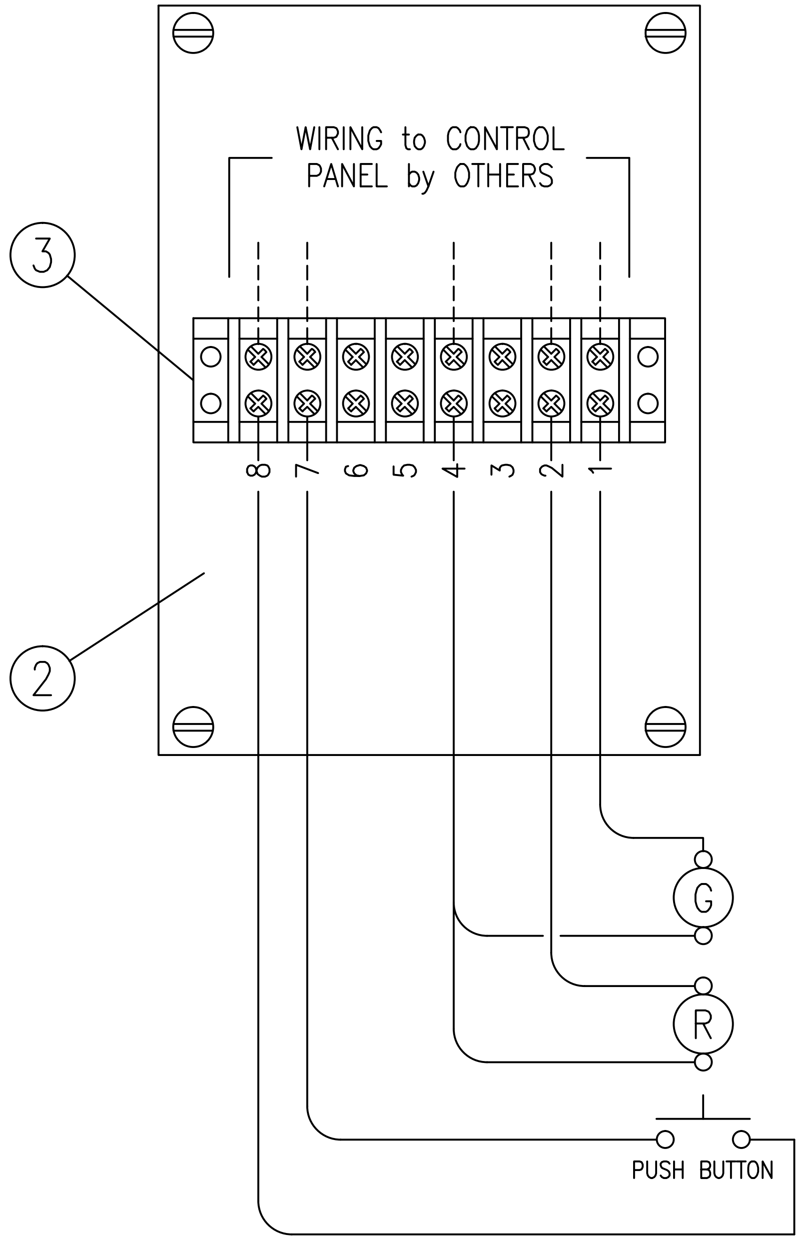
by: AWG	chk'd: FBL	aprv'd: GM	scale:	dwg. no:	rev:
date: 17JAN18	date: 17JAN18	date: 17JAN18	NTS	60-13288-22	1





MATERIAL LIST – FOR TWO UNITS

ITEM	QTY.	DESCRIPTION
1	1	ENCLOSURE, SCE MODEL 806CHNF NEMA 4
2	1	ENCLOSURE SUB–PANEL, SCE MODEL 8P6
3	1	TERMINAL STRIP, MARATHON KULKA NO. 671GP08
4	1	GREEN PILOT LIGHT, AB NO. 800H–QRH2G NEMA 4X
5	1	RED PILOT LIGHT, AB NO. 800T–QH2R NEMA 4
6	1	PUSH BUTTON 1 N.O./1 N.C., AB NO. 800T–A2A NEMA 4
7	3	LEGEND PLATE, AB NO. 800T–X559E (ENGRAVED per DRAWING)
8		



OPERATION

PUSH BUTTON
PRESS PUSH BUTTON FOR THE BLOWDOWN OPERATION WHILE THE GREEN LIGHT IS ON. AFTER THE BLOWDOWN IS COMPLETE, RELEASE THE BUTTON AFTER THE RED LIGHT GOES OUT.

GREEN LIGHT
THIS LIGHT IS ILLUMINATED AT WATER LEVELS DOWN TO THE LOW WATER ALARM POINT.

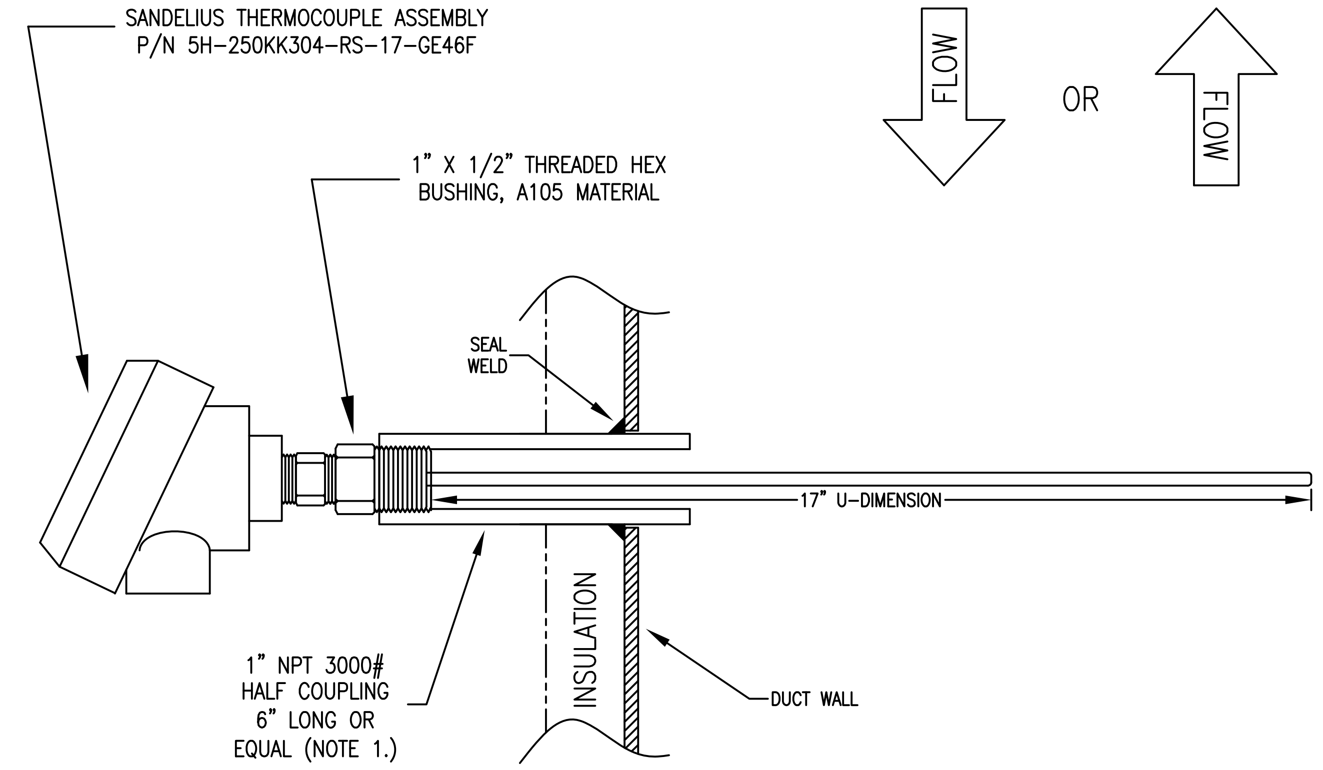
RED LIGHT
THIS LIGHT IS ILLUMINATED AT THE LOW WATER SHUT DOWN POINT AND LOWER WATER LEVELS.

rev.	by	date	chk'd	date	description
6					
5					
4					
3					
2					
1					

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918–274–0023 FAX: 918–274–0059

cust/proj.#: COLUMBIA PULP / VE–13288
title: BY–PASS PUSH BUTTON STATION

by: AWG	chk'd: FBL	aprv'd: GM	scale:	dwg. no:	rev:
date: 13JAN18	date: 13JAN18	date: 13JAN18	NTS	60–13288–23	0



INSTALL THERMOCOUPLE
PERPENDICULAR TO DUCT

FRESH AIR TEMPERATURE

TAG NUMBER: TE-81205

COMBUSTION AIR TEMPERATURE

TAG NUMBER: TE-81213

NOTES:

1. PENNSYLVANIA MACHINE WORKS
3000# THREADED HALF COUPLING
A105 MATERIAL, 6" LONG
SOURCE: INDUSTRIAL PIPING SPECIALISTS
TULSA, OK (918) 270-6346

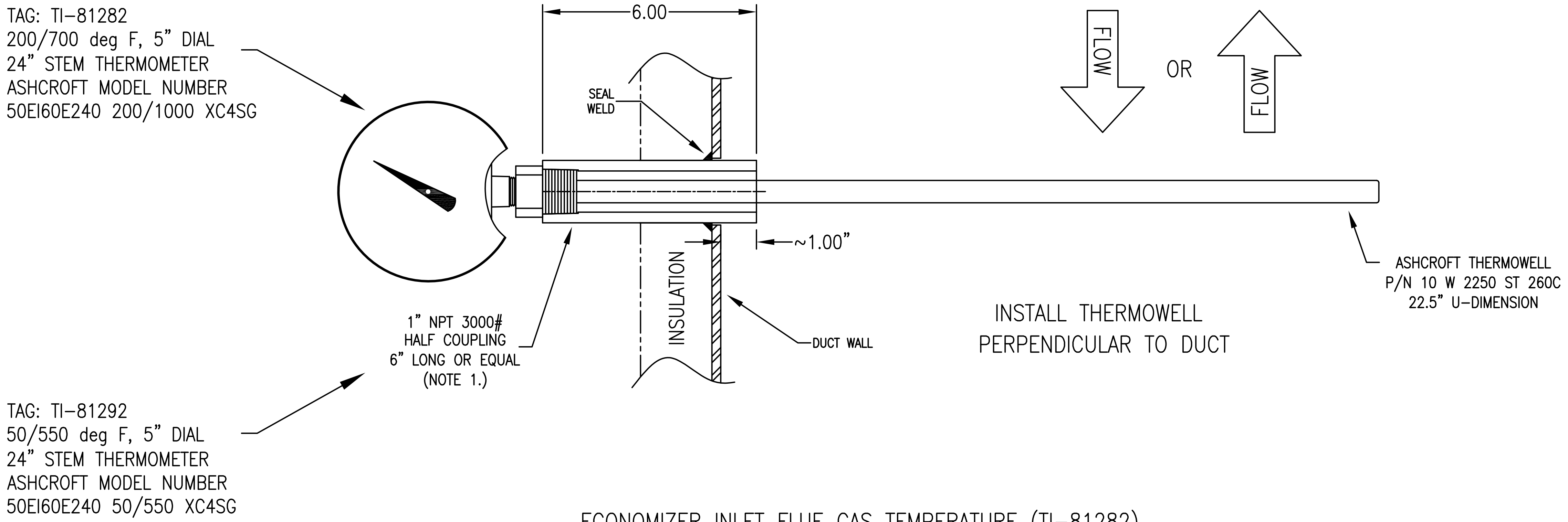
rev.	by	date	chk'd	date	description
0	FBL	19MAR18	CJP	12MAR18	FOR CONSTRUCTION

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

cust/proj.#: COLUMBIA PULP / VE-13288

title: THERMOCOUPLE INSTALLATION DETAIL - SHEET 1

by: FBL	chk'd: CJP	aprv'd: GMc	scale:	dwg. no:	rev:
date: 19MAR18	date: 19MAR18	date: 19MAR18	NTS	66-13288-01	0



ECONOMIZER INLET FLUE GAS TEMPERATURE (TI-81282)

ECONOMIZER OUTLET FLUE GAS TEMPERATURE (TI-81292)

NOTES:

1. PENNSYLVANIA MACHINE WORKS
3000# THREADED HALF COUPLING
A105 MATERIAL, 6" LONG
SOURCE: INDUSTRIAL PIPING SPECIALISTS
TULSA, OK (918) 270-6346

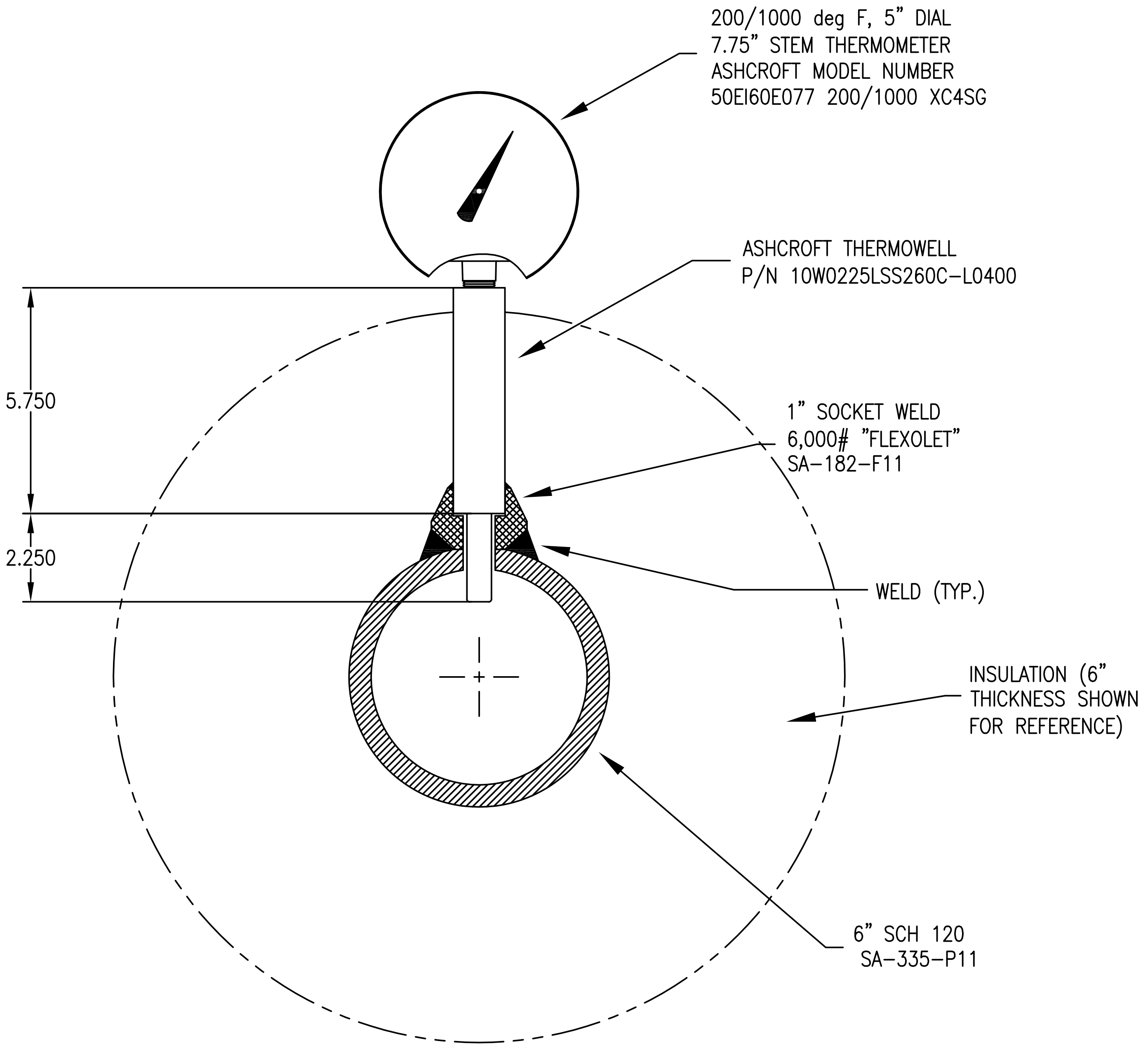
0	FBL	19MAR18	CJP	19MAR18	FOR CONSTRUCTION
rev.	by	date	chk'd	date	description

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

cust/proj.#: COLUMBIA PULP / VE-13288

title: THERMOWELL INSTALLATION DETAIL - SHEET 2

by: FBL	chk'd: CJP	aprv'd: GMc	scale:	dwg. no:	rev:
date: 19MAR18	date: 19MAR18	date: 19MAR18	NTS	66-13288-02	0



MAIN STEAM TEMPERATURE
TAG NUMBER:
TI-81610

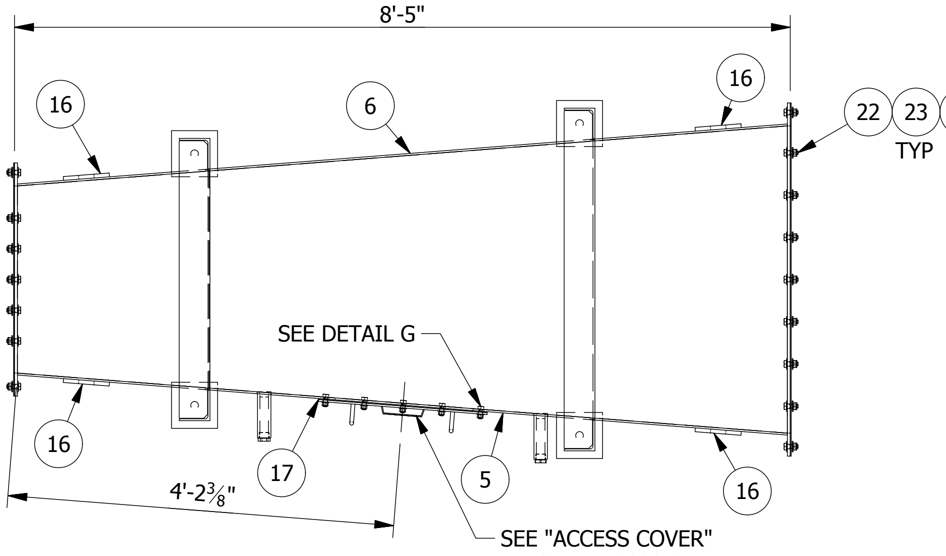
0	FBL	19MAR18	CJP	19MAR18	FOR CONSTRUCTION
rev.	by	date	chk'd	date	description

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

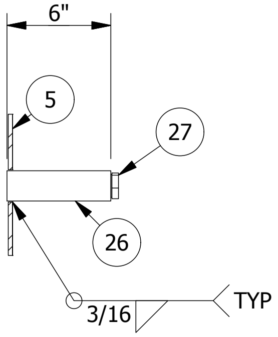
cust/proj.#: COLUMBIA PULP / VE-13288

title: THERMOWELL INSTALLATION DETAIL - SHEET 3

by: FBL	chk'd: CJP	aprv'd: GMc	scale:	dwg. no:	rev:
date: 19MAR18	date: 19MAR18	date: 19MAR18	NTS	66-13288-03	0



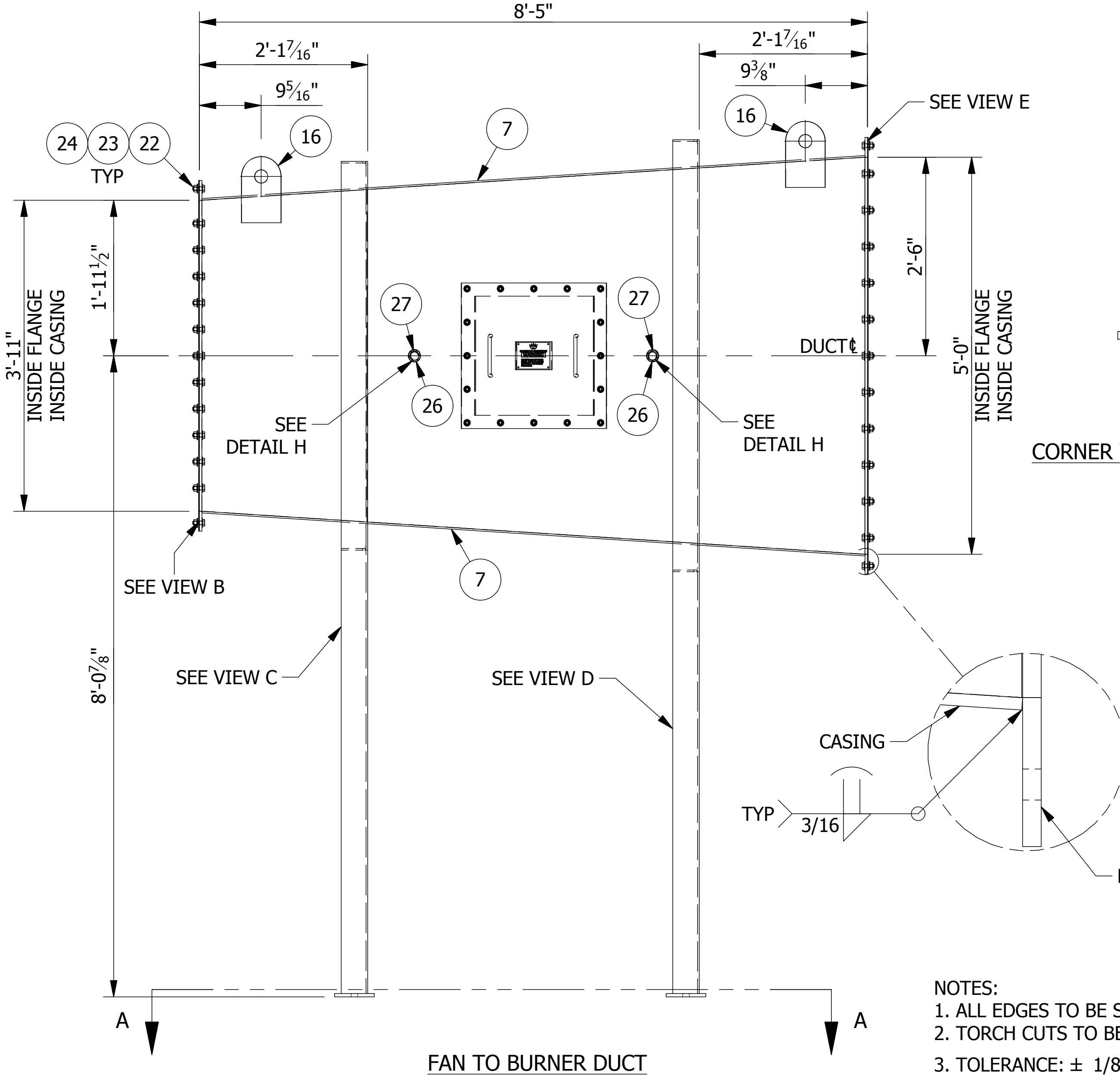
TOP VIEW



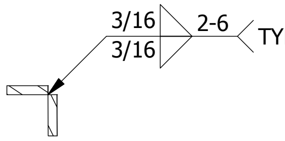
DETAIL H

BILL OF MATERIAL

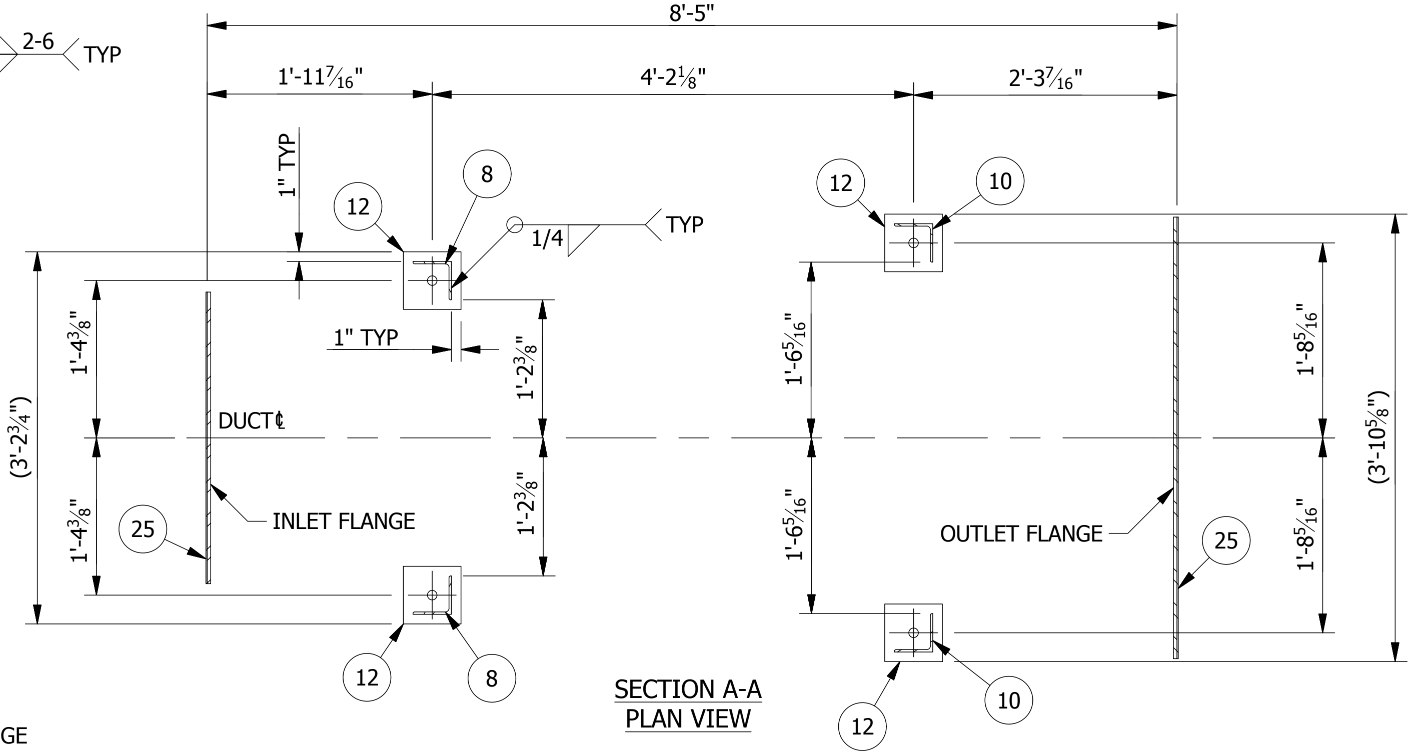
ITEM	QTY	MK:	DESCRIPTION	WIDTH	LENGTH	REMARKS	MATl.	WT.	C
71-01	1		FAN TO BURNER DUCT ASSEMBLY					1774	F
1	2	71-13288-01-1	PLATE 3/8"THK	3"	2'-6 3/8"	SEE VIEW B	SA-36	19	S
2	2	71-13288-01-2	PLATE 3/8"THK	3"	3'-11"	SEE VIEW B	SA-36	29	S
3	2	71-13288-01-3	PLATE 3/8"THK	3"	3'-10"	SEE VIEW E	SA-36	29	S
4	2	71-13288-01-4	PLATE 3/8"THK	3"	5'-0"	SEE VIEW E	SA-36	38	S
5	1	71-13288-01-5	PLATE 1/4"THK	5'-4 13/16"	8'-10 1/16"		SA-36	359	S
6	1	71-13288-01-6	PLATE 1/4"THK	5'-4 13/16"	8'-10 1/16"		SA-36	382	S
7	2	71-13288-01-7	PLATE 1/4"THK	3'-7 5/8"	8'-7 1/2"		SA-36	460	S
8	2	71-13288-01-8	ANGLE: 4" x 4" x 1/4"		10'-5 3/4"		SA-36	140	S
9	2	71-13288-01-9	ANGLE: 4" x 4" x 1/4"		3'-1/8"		SA-36	36	S
10	2	71-13288-01-10	ANGLE: 4" x 4" x 1/4"		10'-9"		SA-36	143	S
11	2	71-13288-01-11	ANGLE: 4" x 4" x 1/4"		3'-8"		SA-36	44	S
12	4	71-13288-01-12	PLATE 1/2"THK	6"	6"		SA-36	20	S
13	1	71-13288-01-13	PLATE 1/4"THK	1'-10"	1'-10"		SA-36	34	S
14	2	71-13288-01-14	BAR, ROUND: 1/2"		11"	SEE DETAIL	SA-36	1	S
15	1	71-13288-01-15	SHEET: 10 GA. THK. x 4 1/4'	4 1/4"	6 11/16"	SEE DETAIL	SA-36	1	S
16	4	71-13288-01-16	PLATE 1/2"THK	6"	10"		SA-36	30	S
17	1		L.F. DROP WARP GASKET, 2" WIDE x 1/8" THK.				C.F.	1	S
18	1		ACCESS DOOR WARNING LABEL (SUPPLIED BY VEO)					0	S
19	16		HEAVY HEX BOLT: Ø1/2		1 1/4"		A-325 PLAIN	2	S
20	16		WASHER: Ø1/2				F-436 HDG	0	F
21	16		HEAVY HEX NUT: Ø1/2				A-563 HDG	1	F
22	76		HEAVY HEX BOLT: Ø1/2		1 1/2"		A-325 HDG	11	F
23	152		WASHER: Ø1/2				F-436 HDG	6	F
24	76		HEAVY HEX NUT: Ø1/2				A-563 HDG	5	F
25	1		L.F. DROP WARP GASKET: 3" WIDE x 1/8" THK.		32'-6 3/4"		C.F.	2	F
26	2		COUPLING, FULL: 1"-3000# THRD		6"		SA-105	5	S
27	2		PIPE PLUG: 1"-3000# THRD				SA-105	1	S



FAN TO BURNER DUCT
MK: 71-13288-01



CORNER WELD DETAIL



SECTION A-A
PLAN VIEW

NOTES:
1. ALL EDGES TO BE SMOOTHED AN DEBURRED
2. TORCH CUTS TO BE GROUND SMOOTH
3. TOLERANCE: ± 1/8" UNLESS NOTED OTHERWISE
4. ALL WELDS TO BE 3/16" FILLET UNLESS NOTED OTHERWISE
5. WORK THIS DRAWING WITH: 71-13288-01A, 01B

REV	BY	DATE	CHK'D	DATE	DESCRIPTION
0					

VICTORY ENERGY®
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP-SH / COLUMBIA PULP
Title: FAN TO BURNER DUCT ASSEMBLY

By: ADM	Chk'd: AM	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 1/8/18	Date: 1/8/18	Date: 1/8/18	NTS	71-13288-01	0

TOTAL DEAD LOAD EMPTY (KIPS)				HYDRO LOAD ONLY (KIPS)				LIVE LOAD (KIPS)				WIND X (KIPS)			
NODE #	Fx	Fy	Fz	NODE #	Fx	Fy	Fz	NODE #	Fx	Fy	Fz	NODE #	Fx	Fy	Fz
N1	0.00	3.86	0.00	N1	0.00	0.48	0.00	N1	0.00	0.09	0.00	N1	0.00	0.97	0.00
N2	0.00	18.73	0.00	N2	0.00	2.36	0.00	N2	0.00	0.52	0.00	N2	0.00	-0.93	0.00
N3	0.00	4.00	0.00	N3	0.00	0.47	0.00	N3	0.00	0.55	0.00	N3	0.00	-0.73	0.00
N4	0.00	5.23	0.00	N4	0.00	0.64	0.00	N4	0.00	0.08	0.00	N4	1.69	1.10	0.00
N5	0.00	18.35	0.00	N5	0.00	2.31	0.00	N5	0.00	0.48	0.00	N5	0.00	-0.36	0.00
N6	0.00	5.36	0.00	N6	0.00	0.64	0.00	N6	0.00	0.56	0.00	N6	0.00	-0.65	0.06
N7	0.00	5.57	0.00	N7	0.00	0.68	0.00	N7	0.00	0.03	0.00	N7	1.70	1.18	-0.03
N8	0.00	17.61	0.00	N8	0.00	2.22	0.00	N8	0.00	0.40	0.00	N8	0.00	-0.28	0.00
N9	0.00	5.74	0.00	N9	0.00	0.68	0.00	N9	0.00	0.55	0.00	N9	0.00	-0.60	0.05
N10	0.00	5.25	0.00	N10	0.00	0.64	0.00	N10	0.00	0.01	0.00	N10	1.73	1.17	-0.04
N11	0.00	16.87	0.00	N11	0.00	2.13	0.00	N11	0.00	0.31	0.00	N11	0.00	-0.21	0.00
N12	0.00	5.39	0.00	N12	0.00	0.64	0.00	N12	0.00	0.45	0.00	N12	0.00	-0.55	0.07
N13	0.00	4.93	0.00	N13	0.00	0.60	0.00	N13	0.00	0.01	0.00	N13	1.76	1.16	-0.04
N14	0.00	16.13	0.00	N14	0.00	2.04	0.00	N14	0.00	0.14	0.00	N14	0.00	-0.13	0.00
N15	0.00	4.97	0.00	N15	0.00	0.60	0.00	N15	0.00	0.12	0.00	N15	0.00	-0.47	0.06
N16	0.00	5.37	0.00	N16	0.00	0.67	0.00	N16	0.00	-0.02	0.00	N16	1.63	1.61	0.15
N17	0.00	15.38	0.00	N17	0.00	1.95	0.00	N17	0.00	0.04	0.00	N17	0.00	-0.09	0.00
N18	0.00	5.43	0.00	N18	0.00	0.67	0.00	N18	0.00	0.02	0.00	N18	0.00	-1.28	-0.28
N19	0.00	7.02	0.00	N19	0.00	0.89	0.00	N19	0.00	-0.05	0.00	N19	0.00	2.60	0.00
N20	0.00	14.99	0.00	N20	0.00	1.90	0.00	N20	0.00	-0.02	0.00	N20	0.00	-0.52	0.00
N21	0.00	7.09	0.00	N21	0.00	0.89	0.00	N21	0.00	0.03	0.00	N21	0.00	-3.00	0.00
Totals:	0.00	193.27	0.00	Totals:	0.00	24.11	0.00	Totals:	0.00	4.28	0.00	Totals:	8.51	0.00	0.00

WIND Z (KIPS)				SEISMIC X (KIPS)				SEISMIC Z (KIPS)			
NODE #	Fx	Fy	Fz	NODE #	Fx	Fy	Fz	NODE #	Fx	Fy	Fz
N1	0.00	0.13	0.00	N1	0.00	1.25	0.00	N1	0.00	0.31	0.00
N2	0.00	0.31	0.00	N2	0.00	-4.47	0.00	N2	0.00	3.80	0.00
N3	0.00	0.12	0.00	N3	0.00	-1.07	0.00	N3	0.00	0.31	0.00
N4	0.01	0.09	0.39	N4	6.64	8.80	-1.45	N4	0.02	1.64	3.95
N5	0.00	0.25	0.00	N5	0.00	-1.37	0.00	N5	0.00	2.98	0.00
N6	0.00	0.08	0.38	N6	0.00	-6.44	1.66	N6	0.00	1.59	3.86
N7	0.00	0.04	0.38	N7	7.82	5.86	-0.16	N7	0.16	0.19	4.07
N8	0.00	0.12	0.00	N8	0.00	-0.85	0.00	N8	0.00	1.38	0.00
N9	0.00	0.03	0.37	N9	0.00	-3.12	0.37	N9	0.00	0.15	3.99
N10	-0.01	-0.01	0.36	N10	7.89	5.96	-0.28	N10	-0.04	-0.15	3.82
N11	0.00	0.00	0.00	N11	0.00	-0.63	0.00	N11	0.00	-0.16	0.00
N12	0.00	-0.01	0.35	N12	0.00	-2.90	0.57	N12	0.00	-0.13	3.76
N13	-0.01	-0.03	0.34	N13	8.15	5.53	-0.28	N13	-0.15	-0.13	3.55
N14	0.00	-0.10	0.00	N14	0.00	-0.36	0.00	N14	0.00	-1.47	0.00
N15	0.00	-0.02	0.33	N15	0.00	-2.17	0.49	N15	0.00	-0.06	3.48
N16	0.00	-0.07	0.31	N16	5.91	12.03	2.56	N16	0.01	-1.35	3.00
N17	0.00	-0.21	0.00	N17	0.00	-0.77	0.00	N17	0.00	-2.77	0.00
N18	0.00	-0.07	0.30	N18	0.00	-11.63	-3.47	N18	0.00	-1.34	2.93
N19	0.00	-0.17	0.00	N19	0.00	2.14	0.00	N19	0.00	-0.30	0.00
N20	0.00	-0.32	0.00	N20	0.00	-3.26	0.00	N20	0.00	-4.19	0.00
N21	0.00	-0.17	0.00	N21	0.00	-2.52	0.00	N21	0.00	-0.30	0.00
Totals:	0.00	0.00	3.51	Totals:	36.42	0.00	0.00	Totals:	0.00	0.00	36.42

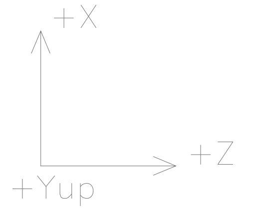
UNFACTORED LOADS

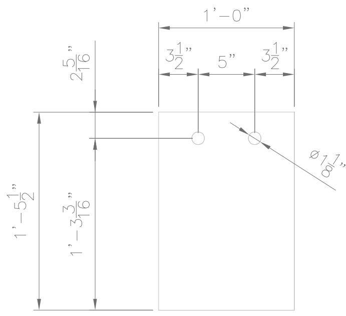
GENERAL NOTES:

1. THE DESIGN AND INSTALLATION OF FOUNDATIONS ARE NOT THE RESPONSIBILITY OF VEO. FOUNDATIONS, ITS DESIGN, GROUTING, LEVELING PLATES, ETC. ARE NOT PROVIDED.
2. ALL BOILER BASE DIMENSIONS SHOWN ARE FOR BOILER IN COLD POSITION.
3. ALL BOILER & STRUCTURE ANCHOR BOLTS AS NOTED THREADED ROD (NF BY VEO).
4. TBD = DIMESIONS TO BE PROVIDED LATER.

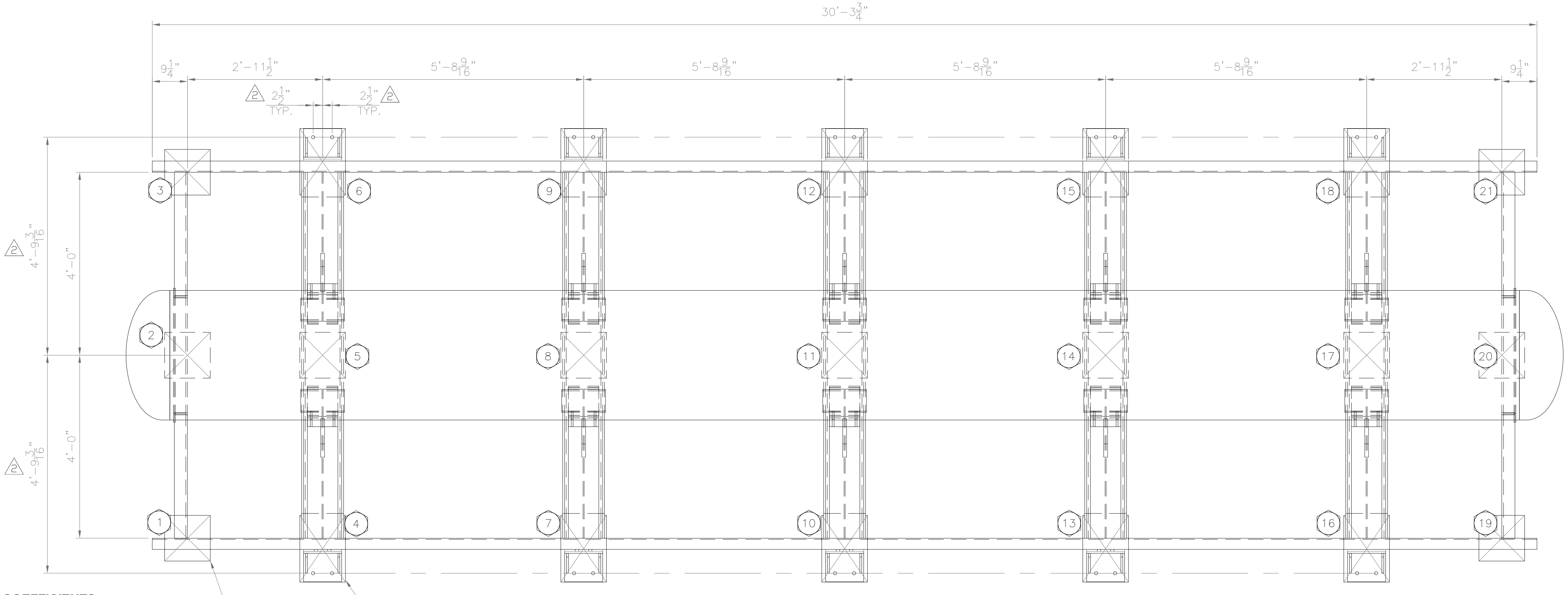
STRUCTURAL NOTES:

1. THERMAL FRICTION LOADS ARE NEGLIGIBLE. PRESSURE PARTS EXPAND RELATIVE TO BASE ASSEMBLY.





DETAIL "A"
10 PLCS.



PLAN VIEW

12"x12"x2" PL.
(11 PLCS.)

12"x1'-5 1/2"x2" PL.
(10 PLCS.) SEE DETAIL "A"

ASCE 7-10

SEISMIC DESIGN CATEGORY = C
SITE CLASS = D
OCCUPANCY CATEGORY = III
USE GROUP = II
IMPORTANCE FACTOR (I)= 1.25
Ss = 0.328
S1 = 0.121
Fa = 1.538
Fv = 2.314
SMS = 0.504
SM1 = 0.280
SDS = 0.336
SDI = 0.187

WIND COEFFICIENTS

BASIC WIND SPEED = 115
EXPOSURE CATEGORY = C
IMPORTANCE FACTOR = 1

2	JMP	6-11/18	GM	6-11-18	REVISED ANCHOR HOLE DIMENSIONS
1	DEG	6-6-18	GM	6-6-18	ADDED SHIM PLATES
0	DEG	4-26-18	GM	4-26-18	REVISED LOADS
Rev.	*By*	*Date*	*Checked*	*Date*	*Description*

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

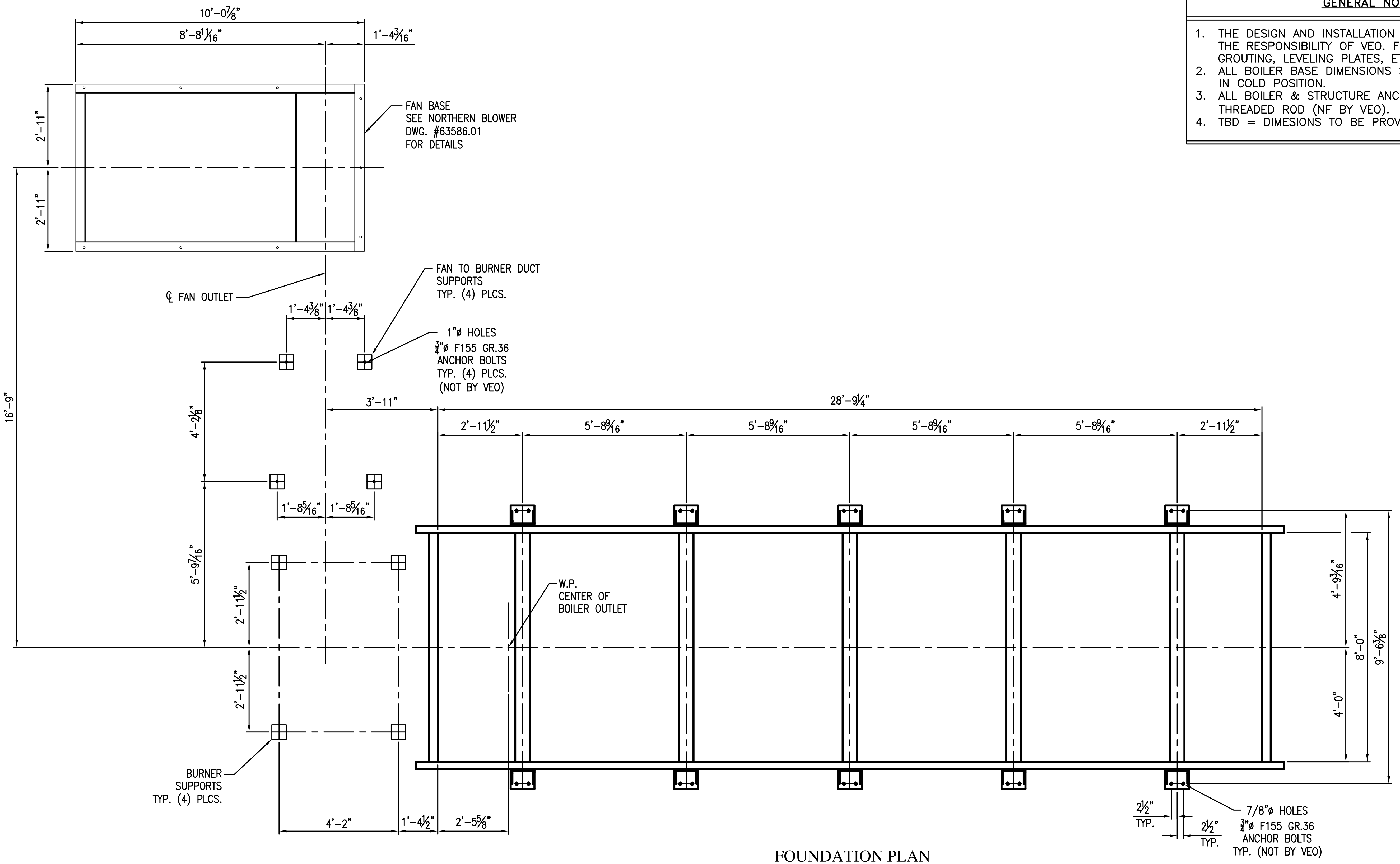
Unit Type/Cust: VS-5-78-SP SH / COLUMBIA PULP

Title: BOILER FOUNDATION AND REACTIONS

By: SU | *Chk'd: DG* | *Aprv'd: -* | *Scale: NONE* | *Dwg. no: 90-13288-00* | *Rev: 2*
Date: 01/15/16 | *Date: -* | *Date: -*

GENERAL NOTES:

1. THE DESIGN AND INSTALLATION OF FOUNDATIONS ARE NOT THE RESPONSIBILITY OF VEO. FOUNDATIONS, ITS DESIGN, GROUTING, LEVELING PLATES, ETC. ARE NOT PROVIDED.
2. ALL BOILER BASE DIMENSIONS SHOWN ARE FOR BOILER IN COLD POSITION.
3. ALL BOILER & STRUCTURE ANCHOR BOLTS AS NOTED THREADED ROD (NF BY VEO).
4. TBD = DIMESIONS TO BE PROVIDED LATER.



FOUNDATION PLAN

Rev.	By	Date	Checked	Date	Description
0	JMP	5/31/18	GM	5/31/18	RELEASED FOR CONSTRUCTION

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

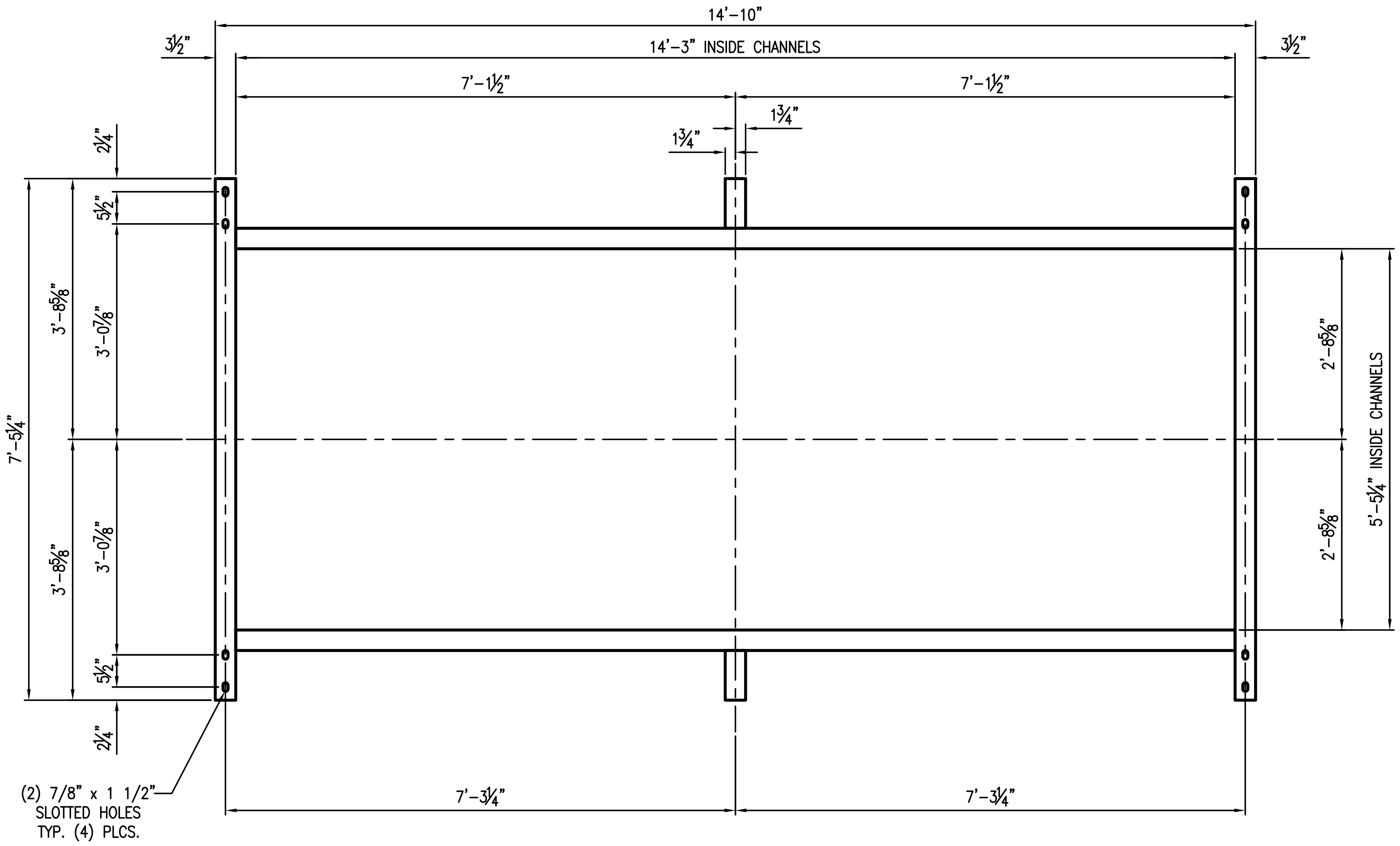
Unit Type/Cust: VS-5-78SP-SH / COLUMBIA PULP

Title: FOUNDATION PLAN

By: JMP	Chk'd: DG	Aprv'd: GM	Scale:	Dwg. no:	Rev:
Date: 1/15/2016	Date: 5/31/18	Date: 5/31/18	NTS	90-13288-01	0

GENERAL NOTES:

1. THE DESIGN AND INSTALLATION OF FOUNDATIONS ARE NOT THE RESPONSIBILITY OF VEO. FOUNDATIONS, ITS DESIGN, GROUTING, LEVELING PLATES, ETC. ARE NOT PROVIDED.
2. ALL BOILER BASE DIMENSIONS SHOWN ARE FOR BOILER IN COLD POSITION.
3. ALL BOILER & STRUCTURE ANCHOR BOLTS AS NOTED THREADED ROD (NF BY VEO).
4. TBD = DIMESIONS TO BE PROVIDED LATER.



ECONOMIZER BASE

0	JMP	5/31/18	GM	5/31/18	RELEASED FOR CONSTRUCTION
Rev.	**By**	**Date**	**Checked**	**Date**	**Description**

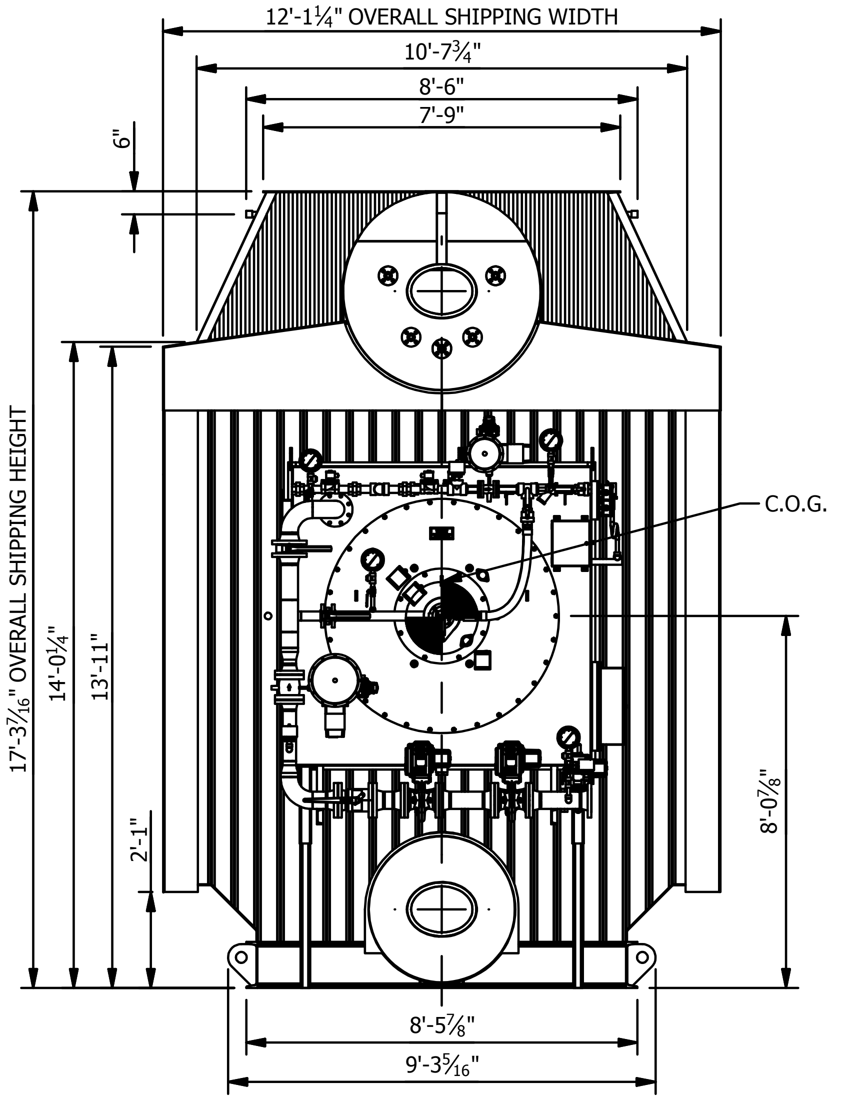
VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP-SH / COLUMBIA PULP

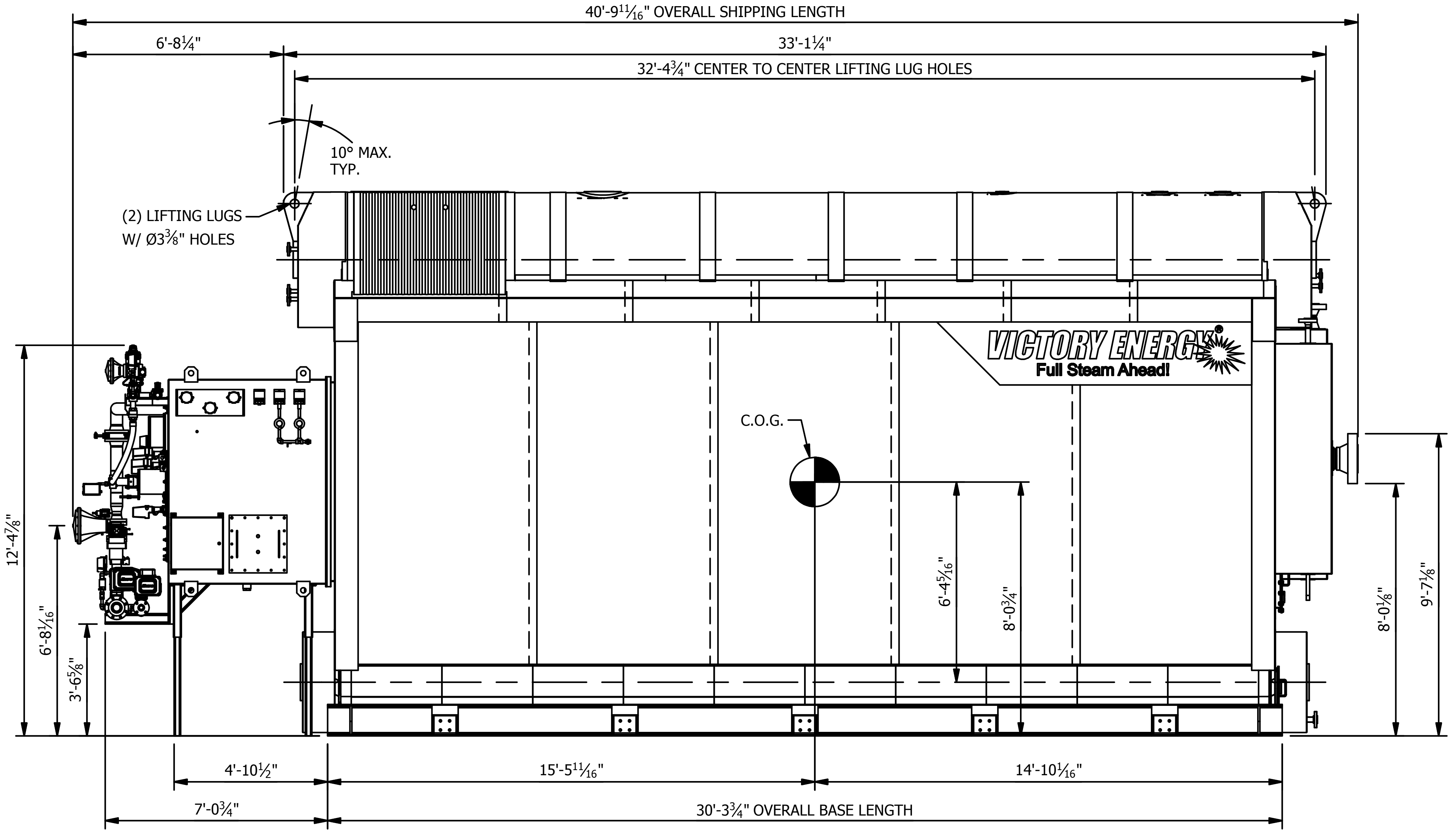
Title: ECONOMIZER BASE

By: JMP	Chk'd: DG	Aprv'd: GM	Scale:	Dwg. no:	Rev:
Date: 11/13/17	Date: 11/13/17	Date: 5/31/18	NTS	90-13288-02	0

CUSTOMER NAME:	COLUMBIA PULP
BOILER MODEL:	VS-5-78SP-SH
DESTINATION:	STARBUCK, WA.
BOILER OVERALL WIDTH:	12'-1 1/4"
BOILER OVERALL LENGTH:	44-9 11/16"
BOILER OVERALL HEIGHT:	17'-3 7/16"
TOTAL SHIPPING WEIGHT:	185,400



FRONT VIEW



SIDE VIEW

REV	BY	DATE	CHK'D	DATE	DESCRIPTION
1	GMc	5/23/18	JP	5/23/18	Added GMc to the Approval Box

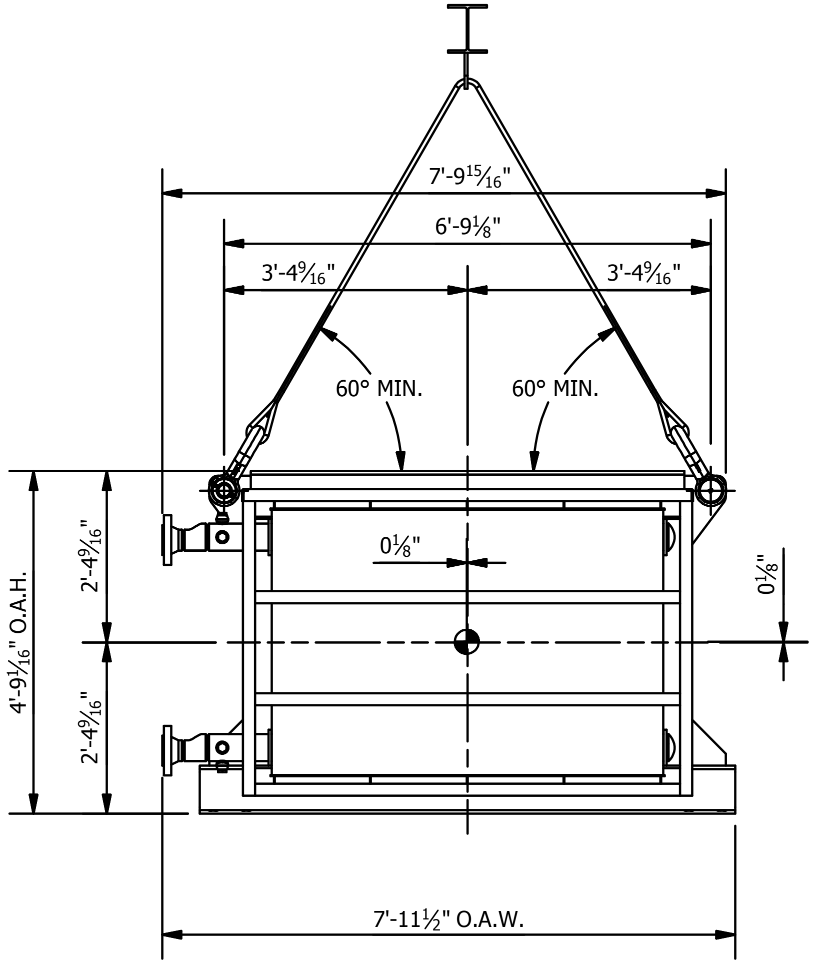
VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: VS-5-78SP-SH / COLUMBIA PULP

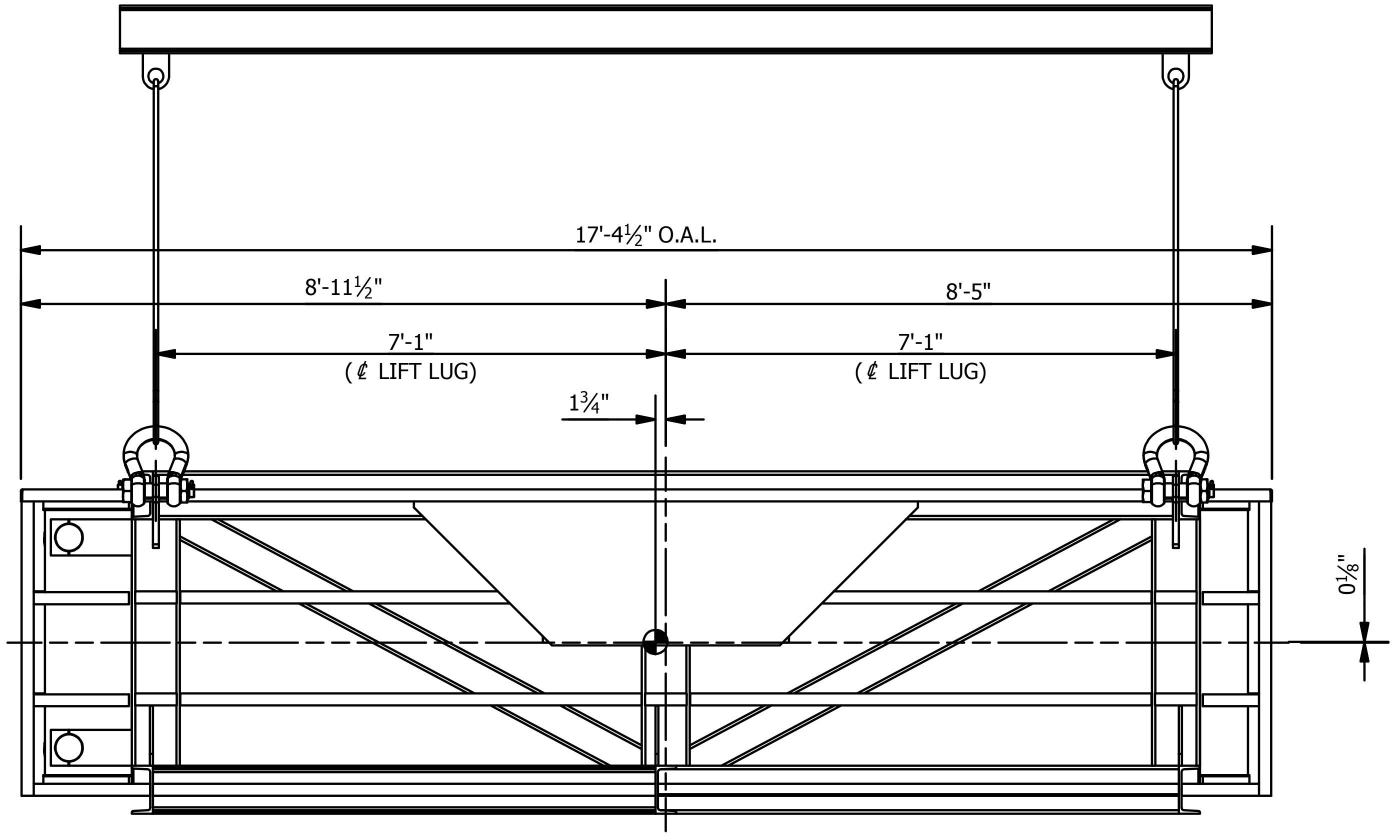
Title: BOILER SHIPPING ARRANGEMENT

By: JMP	Chk'd: JP	Aprv'd: GMc	Scale:	Dwg no:	Rev:
Date: 11/22/2017	Date: 11/22/2017	Date: 5/23/2018	NTS	90-13288-10	1

TOTAL DRY WEIGHT: 30,015 LBS



TERMINAL END VIEW



ELEVATION VIEW

REV	BY	DATE	CHK'D	DATE	DESCRIPTION
1	JMP	5/31/18	GM	5/31/18	ADDED APPROVED INITIALS

VICTORY ENERGY
10701 E. 126th St. North, Collinsville, OK 74021
PH: 918-274-0023 FAX: 918-274-0059

Unit Type/Cust: COLUMBIA PULP, SEATTLE WA / VEO-13288

Title: LIFTING DIAGRAM

By:	Chk'd:	Aprv'd:	Scale:	Dwg no:	Rev:
ED	ED	GM	NTS	90-13288-30	1
Date: 9/1/2017	Date: 9/7/2017	Date: 5/23/2018			

SECTION F

PRE-OPERATION

SECTION F-1
PRE-START UP INSPECTION

TABLE OF CONTENTS

RESPONSIBILITY

Prior to placing steam generator equipment in service, a complete inspection should be made to determine the condition of the equipment. This applies to existing equipment as well as to newly installed equipment. This inspection should ensure that the unit has been correctly completed.

Responsibility for the completion of construction normally rests with the customer's construction engineer.

BOILER SETTING

Inspection of the unit should begin with a check of the boiler setting, both inside and outside, noting the construction details and whether specifications have been complied with. It is assumed that the pressure parts have been checked and that a hydrostatic test has proven satisfactory.

EXPANSION JOINTS

Check all expansion joints carefully. Insure that no obstructions exists which would prevent free movement of drums, headers, or other applicable parts of the boiler setting. Also, check expansion joints with respect to gas seals so as to prevent the possibility of gas leakage out of the setting or air leakage into the setting. Where doubt exists, candle joints to check for leakage.

FURNACE AREAS

Furnace areas should be carefully checked for debris or remaining construction materials. Refractory must be checked to verify that the installation complies with specifications. .

ACCESS OPENINGS

At the completion of the furnace inspection, all access openings not used in operation should be suitably bricked to protect doors from high furnace temperatures. Refer to **DWG 14-STD-10, TYP. ACCESS DOOR BRICK INSTALLATION** for Discovery and Voyager style boilers.

CASING

Externally check all joints in the boiler casing, duct, and refractory for air or gas leakage. Operating forced or induced draft fans and noting air infiltration at joints normally can do this. Particularly note leakage through any external expansion joints.

DRUM AND TUBES

Prior to closing drums and headers, visually check for foreign materials, such as tools and dirt. Foreign materials in the drum can prevent proper circulation, with resulting failure, or can lodge in blow-off valves, preventing their proper operation. In the case of a field erected boiler, tubes should be "balled" out to be sure they are clean. This consists of dropping light sponge rubber balls through each boiler tube. It is usually not necessary to do this if the boiler was shipped assembled. Also, note all drum internals, feed piping, continuous blowdown piping, and chemical feed piping. Be sure that these items are correctly installed (outlet holes in proper direction of flow) and that feedholes are free of obstructions. Check tightness of joints, particularly in the dry steam chamber to be sure correct and free passage for steam is provided.

FEEDWATER AND WATER COLUMN PIPING

It is also important, when checking drums, to check for free passage of steam and water through feedwater regulator and water column piping. Where doubt exists, these lines should be checked by injecting water with hose and noting flow.

AUXILIARY EQUIPMENT

Included in an inspection of a boiler prior to service should be an inspection of all auxiliary equipment operated in conjunction with the boiler. This includes fans, fuel burning equipment, controls, soot blowing equipment, feed pumps, etc. It is advisable to refer to equipment manufacturers' bulletins concerning start-up, operation, and maintenance. To assist the operator, the following paragraphs are offered as a guide in checking auxiliary equipment. It should be remembered that the following rules are only general and that, in each case, the equipment manufacturers' service recommendations should be complied with.

Fans

In checking the forced and/or draft fans, it should be first noted that the bearing surfaces are clear of dirt and grime and that a proper grade and amount of lubricating oil is added. Where water-cooled bearings are furnished, a sufficient supply of cooling water should be insured. Also, check couplings on fan drives for alignment and grease fans to manufacturer's specifications. Initially turn fans over by hand or with a web wrench to see that they are free to rotate and that there is no foreign material in the fan scroll.

The fan should then be run under power to check rotation, fan drives and for any excessive vibration due to improper construction or alignment. Never operate fans with cold air unless dampers are partially closed to prevent overloading. When checking fans, also check operation of fan dampers and drive linkage. After linkage is set, insure that no linkage slip can occur during operation. Drilling and pinning the lever arms to the damper shaft can do this.

Oil Burners

Fuel burning equipment should be carefully checked in accordance with manufacturer's recommendations, bearing in mind the rules of safety applying to the fuel to be used. In the case of oil firing equipment, burners should be checked to insure proper alignment of burners with respect to the setting and all piping to and from the burner should be checked for proper installation. It is advisable to blow out all newly installed piping with steam or air to rid the system of foreign matter. Make an inspection of the piping system, noting valves, bypasses, and, in general, how the system works. It is also advisable to circulate oil through the system and check for leaks that may exist, particularly on the suction side of the fuel pumps. A check should also be made of the oil storage, heating, and pumping system.

Gas Burners

Where gas-firing equipment is utilized, all valves and piping should be checked for leaks under pressure with soap solution. When possible, gas lines should be purged of air to insure positive ignition when lighting off. Initially, automatic positioning type valves should be bypassed to allow lines to clear of foreign materials. Stop valves located in the system piping should be checked with extreme care to insure against gas leakage into the furnace prior to light off. A good policy is to blank off gas lines at the burner prior to placing burners in actual operation. Also check burner gas rings and gas spuds for any obstruction in the orifice openings.

Safety Interlocks

Most modern boilers contain electrical safety interlocks in the operating control system. Interlocks are utilized as a safety measure and are only good as the maintenance they receive. Prior to placing a boiler in service, these controls should be checked for proper operation and adjustments made where necessary. Here again, as with all auxiliary equipment in service, it is essential that all operators thoroughly know and understand the function and operation of safety controls.

Combustion Controls

Along with the check of electrical safety interlocks, a preliminary check should be made of all controls used in conjunction with boiler operation and indicating instruments such as draft gages, pressure gages, and flow meters. Normally, the controls manufacturer provides service in setting the control system and calibrating indicating instruments. Operators should never attempt operating power boilers on automatic controls until they are thoroughly acquainted with the system in regard to operation. Operators also should be versed in procedures to take in case of control failure.

Soot Blowers

Where soot-blowing equipment is incorporated in the boiler design, it is desirable to obtain the services of a manufacturer's representative to make a preliminary check of the installation. In general, it is important to check alignment of the blower elements with respect to the steam jets. Improper soot blower alignment can cause serious cutting of boiler tubes and result in tube failure. Operation of retractable soot blowers should be observed to insure against retract failure and resulting damage. The start and stop positions of the blower elements (the sweep) also should be checked for compliance with manufacturer's operation instructions.

Stop-Check Valve

Prior to placing a unit in operation, the main steam stop-check valve should be checked for tight seating. Admitting steam into the steam header from another source, if available, and noting the operation of the valve can do this.

SECTION F-2

PREPARATION FOR SERVICE

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CLOSING HEADERS AND DRUMS

After agreement has been reached that a boiler and auxiliary equipment are ready for firing, the next step in the procedure for a newly installed unit is to dry out the refractory. All manway covers and gaskets should be installed in the headers; and the upper and lower drums closed.

When inserting manway covers and gaskets refer to section **F-4 Drum Manway Gasket Installation Procedure**. Be careful to snug up the gasket without allowing it to shift. Tighten down on the yoke, being careful that the plate and gasket are seated evenly on all sides. A good seal is not necessarily obtained by exerting too much force on the yoke. It is best to tighten the plates snugly and complete the tightening after a slight amount of water pressure has been applied to the boiler. Complete tightening when the boiler pressure reaches 50 psig.

VALVES AND VALVE SETTINGS

Prior to filling the boiler with water, a check should be made of all valves. All drain valves, blow off valves, continuous blowdown valves and water column drain valves should be closed. Also, close the stop-check valve. Valves around the feedwater regulator should be so positioned that feedwater is controlled by hand through the bypass around the feedwater regulator valve. Valves between drum and water column, if used, and the drum vent should be opened. When the unit contains a superheater, the vents and drains on the outlet header should be opened fully to assure steam flow through the superheater. Lack of flow through the superheater can cause overheating of the superheater elements and result in tube failure.

FILLING WITH WATER

After all pressure part access openings have been closed, fill the boiler with water and apply a hydrostatic test to note leaks around handholes and manholes. In filling the boiler with water, avoid the use of hot water, as this sets up too rapid stress changes in tubes and drums. It is advisable to fill the boiler with water at about 60° F. In some cases, where it is necessary to place a boiler into operation in a short period of time, it is permissible to fill with hot water, provided that the water initially is tempered and the degree of heat slowly increased with filling.

HYDROSTATIC TEST

Refer to section **F-5** entitled **HYDROSTATIC TEST** for specific instructions and procedure.

BOILING OUT

Refer to section **F-6** entitled **BOIL OUT** for specific instructions and procedures.

SECTION F-3

ACCESS DOORS

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SAFETY WARNINGS

The following safety warnings should be observed while operating and servicing a boiler.

WARNING: DO NOT ENTER A CONFINED SPACE WHERE THE TEMPERATURE INSIDE IS 120° F OR HIGHER. (PAGE 21)

WARNING: WHEN OPENING AN ACCESS DOOR, OBSERVE ALL CAUTIONS. (PAGE 21)

WARNING: AIR MISSING WITH HOT ASH ACCUMULATIONS IN A HOPPER OR WITH HOT ASH FLOWING OUT OF HOPPER CAN BE EXTREMELY DANGEROUS. HOT ASH CAN CAUSE A FIRE OR AN EXPLOSION, WHICH COULD RESULT IN INJURY, DEATH, AND EQUIPMENT DAMAGE. (PAGE 23)

WARNING: WATER SHOULD NOT BE SPRAYED ON HOT ASH BECAUSE WATER WILL REACT WITH HOT ASH, FORMING COMBUSTIBLE GASES THAT COULD BE EXPLOSIVE. (PAGE 23)

WARNING: NEVER SPRAY WATER INSIDE A HOPPER ONTO ASH ACCUMULATIONS. (PAGE 23)

WARNING: DO NOT COMPLETELY REMOVE AN ACCESS DOOR UNTIL IT IS KNOWN THAT ASH FLOW OUT OF THE HOPPER DOOR CAN BE CONTROLLED. (PAGE 24)

INTRODUCTION

Access doors are provided on VEO boiler systems to provide access to boiler furnace, superheaters, burner windboxes, boiler ash hoppers, boiler convection passes, economizers, flues, and ducts.

Personnel using access doors must remain aware of the hazards of opening and using the doors and must exercise caution. Inside boiler system equipment there can be hot ash, hot metal surfaces and/or hot refractory that can cause serious burns. Also, there can be combustible gases that can burn or explode, and there may be noxious gases that will not allow breathing.

If it is necessary to have personnel enter the equipment using the access doors, the components of the boiler system and all flues and ducts should be ventilated to remove combustible or noxious gases. Before opening access doors, air flow through the equipment should be established using the combustion air, forced draft, and induced draft.

Where there is the possibility of an inert gas atmosphere (nitrogen or water vapor) instead of air in steam or water drums or water storage tanks, special care must be taken to insure that there is enough air to breathe. Before entering any confined space, use an oxygen analyzer as required to ensure the confined space is safe to enter. Ventilate as needed using a portable fan to force air into the confined space.

Some components of a boiler system, a steam drum for example, will cool slowly. Cooler air flowing through an access door from stack draft or from forced ventilation will make it difficult to tell how hot it is inside, away from the door and the cooler air stream. If there is any question about the temperature inside, position a thermometer inside away from the door.

WARNING: DO NOT ENTER A CONFINED SPACE WHERE THE TEMPERATURE INSIDE IS 120° F OR HIGHER

OPENING PROCEDURE

When the boiler system has been shut down to allow access there are certain guidelines that should be followed before opening access doors and entering confined spaces inside the equipment.

WARNING: WHEN OPENING AN ACCESS DOOR, OBSERVE ALL CAUTIONS.

Cool Equipment

- Operate combustion air fans to produce air flow through the equipment

- For systems where it may not be possible to use system fans for ventilation and cooling, it may be necessary to open access doors to establish cooling air flow either by stack draft or by portable fans or air movers

- **DO NOT** enter confined space where the temperature inside is 120° F or greater.

Ventilate Equipment

- Operate combustion air fans at a suitable air flow and duration prior to opening access doors.

- For systems where it may not be possible to use system fans for ventilation and cooling, it may be necessary to open access doors to establish cooling air flow either by stack draft or by portable fans or air movers.

Isolation Equipment

Lock out or “tag out” system interconnections as required. Examples include:

Electrical supplies to:
- Boiler controls
- Motor operated valves
- Combustion air fans
- Sootblowers
- Damp operators
- Ash conveying systems
- Fuel pumps
- Fuel feeders
- Chemical feed pumps
- Burner augmenting air fans

Burner fuel system, close:
- Main fuel shutoff valves
- Burner fuel and atomizing steam valves

Steam supplies, close or shutoff:
- Steam header – steam stop valve
- Feedwater header
- Inert gas supply
- Chemical feed system
- Blowdown system
- Boiler drain tank
- Deaerator pegging steam

Flue connection to common stack, close;
- Isolation damper

Insure clear access into and out of access door and secure footing

- Inspect area outside of access doors to make sure that there is minimum hindrance entering or getting out of the door. Check for fuel, compressed air, steam water lines, and electrical conduit near the door. Check for valves in the vicinity of the door that could be opened accidentally.

- Make sure that platforms ladders, grating, steps, planking, or scaffolding required to reach the access door is stable and anchored in place.

- Secure ladders or steps to prevent them from being knocked over when being used.

- Secure hinged access doors open. If there is a self-latching mechanism on the door, wire or fasten the latch to defeat the self-latching mechanism.

- Inspect inside the access door before entering to know where there is sound footing inside. Make sure that planking, scaffolding, or other temporary supports that have been positioned inside are secure.

SPECIAL PRECAUTIONS FOR ASH HOPPERS

Special precautions are required when opening ash hopper access doors because of the possibility that hot combustible material is being retained on the inside. Ash inside the hopper may be free flowing or could be bridged across the door opening and will easily break loose when disturbed.

Ash will be self-insulating. Outside surfaces of an accumulation of ash inside the door of a hopper can feel and appear to be cool even though, beneath the surface, ash will be hot enough to glow and burn when exposed to air. Because of insulating qualities, hot ash can exist for several days after a boiler has been shut down.

Extremely hazardous conditions can occur if a hopper access door is opened and hot ash flows out and mixes with air. To help prevent his, it is better to have a solid surface under the ash hopper access door to contain ash flowing out of the hopper so that there will not be free air flow through the ash flow. Grating or other open platforms under hopper access doors will allow ash to disperse and mix with air. If the ash is hot there is risk that there will be a fire or an explosion.

WARNING: AIR MIXING WITH HOT ASH ACCUMULATIONS IN A HOPPER OR WITH HOT ASH FLOWING OUT OF A HOPPER CAN BE EXTREMELY DANGEROUS. HOT ASH CAN CAUSE A FIRE OR AN EXPLOSION, WHICH COULD RESULT IN INJURY, DEATH, AND EQUIPMENT DAMAGE.

Before opening an ash hopper access door, as a minimum:

- Turn off combustion air and forced draft fans. Leave induced draft fans running to prevent pressurized conditions inside the hopper. Draft conditions inside will help prevent ash from flowing out of the access door.
- Wear protective clothing that provides total body protection.
- Work in pairs. Make sure a supervisor knows where you are working.
- Make sure that footing, platforms, walkways, ladders, steps, or scaffolding is secure and will allow quick escape.
- Have a fire extinguisher at hand, ready to control small fires.
- Have a water deluge fire hose ready to control large fires outside the hopper. Water should not be used to cool hot ash, because it reacts with hot ash, forming combustible gas that could be explosive.

WARNING: WATER SHOULD NOT BE SPRAYED ON HOT ASH BECAUSE WATER WILL REACT WITH HOT ASH, FORMING COMBUSTIBLE GASES THAT COULD BE EXPLOSIVE.

WARNING: NEVER SPRAY WATER INSIDE A HOPPER ONTO ASH ACCUMULATIONS.

Opening an ash hopper access door:

- Loosen access door bolts.
- Pull door open slightly to detect whether there are ash or gases inside and whether the hopper is pressurized.

WARNING: DO NOT COMPLETELY REMOVE AN ACCESS DOOR UNTIL IT IS KNOWN THAT ASH FLOW OUT OF THE HOPPER DOOR CAN BE CONTROLLED.

- Continue to loosen the door as conditions inside become known.
- If there is a safety chain across the door, do not remove the chain until the access door is ajar and conditions inside are known.
- When door has been removed completely, cautiously survey conditions inside.
- If ash is bridged across the door opening or in the hopper cautiously probe from the outside to determine whether ash is still hot.
- Remove as much ash as possible from the outside preferably using the ash handling system.
- When it is decided that it is safe to enter the hopper through the access door there must be extreme care in disturbing ash accumulations that may be hot beneath the surface. Carefully probe any ash accumulations.
- When work is complete and the ash hopper access door is closed, reinstall the safety chain and any other safety devices.

SECTION F-4

DRUM MANWAY GASKET INSTALLATION PROCEDURES

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SAFETY WARNINGS

CAUTION: SHIPMENT GASKETS MUST BE REMOVED AND REPLACED BEFORE HYDRO AND AFTER BOIL-OUT. (PAGE 28)

WARNING: INSTALLING AND TRYING TO SEAL BENT OR BROKEN GASKETS CAN RESULT IN BLOWOUT, WHICH CAN LEAD TO SERIOUS INJURY. MANWAY GASKETS SHOULD NEVER BE REUSED. (PAGE 28)

WARNING: ATTEMPTING TO STOP A STEAM OR WATER LEAK THROUGH THE GASKET IS NOT SAFE. A LEAK UNDER PRESSURE COULD SIGNAL THAT A BLOWOUT IS POSSIBLE. DO NOT ATTEMPT TO TIGHTEN THE MANWAY WHEN THE UNIT IS UNDER PRESSURE AND A LEAK EXISTS. THE GASKET COULD BLOWOUT, SPRAYING HOT WATER AND STEAM, POSSIBLY CAUSING SERIUOS INJURY. INSTEAD, THE AREA AROUND THE GASKET SHOULD BE EVACUATED, STEAM PRESSURE SHOULD BE REDUCED, THE UNIT COOLED, AND THE GASKET REPOSITIONED OR REPLACED. (PAGE 30)

FOR PRESSURES BELOW 850 PSI

Please follow the recommended steps below to avoid hazardous conditions resulting from defective installation.

CAUTION: SHIPMENT GASKETS MUST BE REMOVED AND REPLACED BEFORE HYDRO AND AFTER BOIL-OUT

1. Clean and Inspect the Gasket Surfaces and Manway Hardware

Thoroughly clean the gasket surfaces on the drum head bar ring and manway cover plate. To remove remnants of old gaskets use a putty knife, wire brush, or emery cloth being careful not to mar the gasket surfaces. DO NOT use grinder. Manway cover gasket surface should be flat, smooth to the touch, and free of deep pits and gouges. If small dents, surrounded by raised metal are found in the seating surfaces, the raised portion may be removed, using great care, by using a sanding block with medium emery cloth or a medium hone. Deep dents or gouges in the gasket-seating surface must be weld repaired and resurfaced. If deep dents or gouges are found in the manway yokes, bolts or nuts should be replaced.

2. Inspect New Gasket

Carefully inspect the new replacement gasket for any signs of damage. Gaskets that are cracked, bent, or do not have smooth surfaces should be discarded.

WARNING: INSTALLING AND TRYING TO SEAL BENT OR BROKEN GASKETS CAN RESULT IN BLOWOUT, WHICH CAN LEAD TO SERIOUS INJURY. MANWAY GASKETS SHOULD NEVER BE REUSED.

3. Install the Manway Gasket

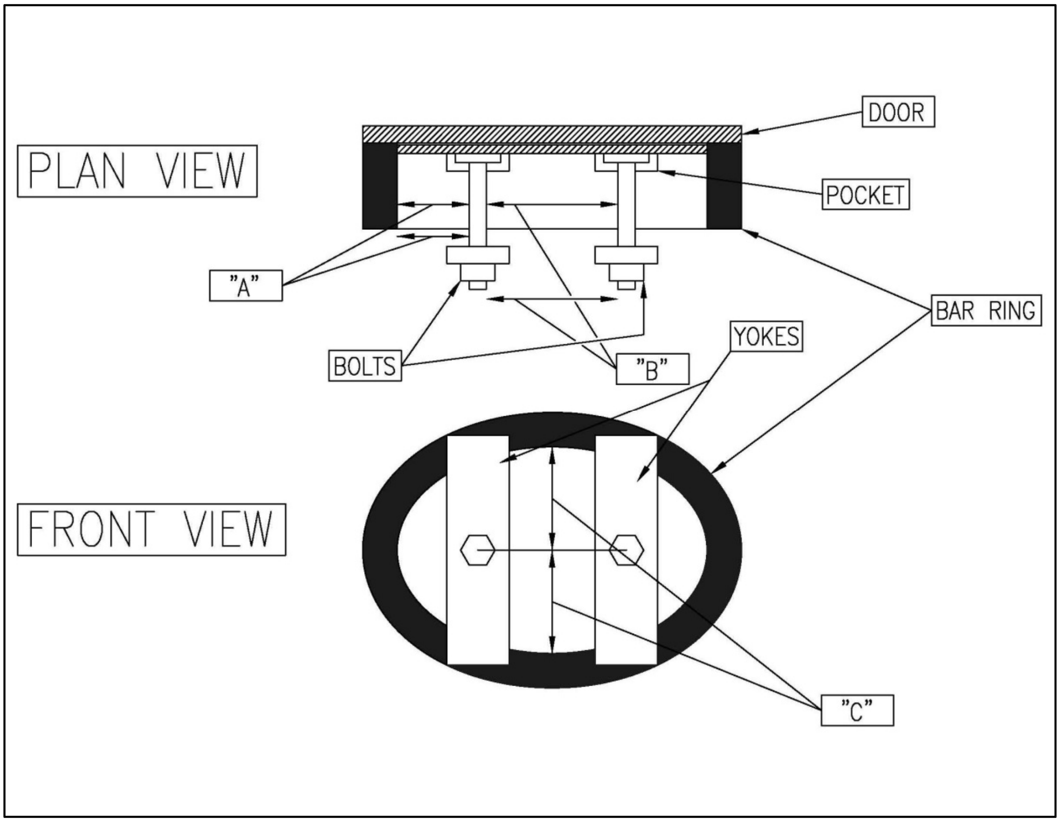
The gasket must be centered on the manway cover-seating surface. For domed manway covers, the gasket must fit over the domed portion without interference. Forcing the gasket over the domed portion of the manway can fracture the gasket and result in gasket blowout. Careful trimming of the inside edge of the gasket to accommodate the manway cover dome can be done by sanding with medium or fine emery cloth. Do not trim more than 3mm (1/8”) from the gasket width and do not sand across the gasket width. If more than 3mm (1/8”) is required to be removed to fit, the gasket must be replaced with a new gasket cut to fit the domed portion of the manway cover. For adhesive backed gaskets, peal the protective paper from the adhesive coated side of the gasket and attach the gasket to the manway cover, centering the gasket on the seating surface. For gasket without adhesive backing, a small piece of rolled paper may be used as a spacer between the inside edge of the gasket and the domed portionof the manway cover to center the gasket on the seating surface.

4. Clean and Lubricate Cover Plate Yoke Bolts

Threads on the manway plate yoke bolts should be cleaned and lubricated with anti-seizing lubricant each time a gasket is replaced. Tightening procedures recommended in Step 6 are for clean, lubricated bolts.

5. Install Manway Plate

Carefully center and pull the manway cover plate firmly against the bar ring gasket surface. You may pry against the domed portion of the manway cover or against the bolt head pockets to help center the manway cover. Hand-tighten the yoke nuts to hold the manway cover in place. Center the manway cover plate in the drum opening. If manway cover cannot be perfectly centered, insure that manway cover flat sealing surface is discernible around the entire perimeter. Evenly tighten the yoke nuts with wrench to secure the manway bolt. Heads must be firmly secured and bottomed out in the slotted portion of the bolt head pockets. Manway bolts must be perpendicular to the manway cover and yokes and equal distance from the top and bottom opening at “A” and “C” of the following diagram. The manway yokes should be parallel to each other.



6. Initial Tightening

Tighten nuts alternating back and forth between the two yoke nuts until the gasket makes contact all around both seating surfaces. Match mark the nut and yoke. Using a wrench, turn each nut no more than one turn for the Topog E Series 2000 gasket. If you use a different drum manway cover gasket refer to the manufacturer's recommended tightening procedure.

7. Check for Leaks

After the unit is filled with water, check for leaks around the manway opening. It is not uncommon for the manway to leak at this time as the two yoke assemblies are generally not capable of compressing the gasket. If a leak is discovered, use a wrench to tighten the yoke nuts no more than ¼ turn. DO NOT tighten more as this can damage the yoke assembly or the yoke bolt head clips on the manway cover. The gaskets will seal with internal drum pressure. This can be achieved by a hydrostatic test with a hydro pump, boiler feedwater pumps, or by heating the boiler to develop steam pressure.

WARNING: ATTEMPTING TO STOP A STEAM OR WATER LEAK THROUGH THE GASKET IS NOT SAFE. A LEAK UNDER PRESSURE COULD SIGNAL THAT A BLOWOUT IS POSSIBLE. DO NOT ATTEMPT TO TIGHTEN THE MANWAY WHEN THE UNIT IS UNDER PRESSURE AND A LEAK EXISTS. THE GASKET COULD BLOWOUT, SPRAYING HOT WATER AND STEAM, POSSIBLY CAUSING SERIOUS INJURY. INSTEAD, THE AREA AROUND THE GASKET SHOULD BE EVACUATED, STEAM PRESSURE SHOULD BE REDUCED, THE UNIT COOLED, AND THE GASKET REPOSITIONED OR REPLACED

8. Retighten Yoke Nuts as Pressure Increases

As the pressure inside the boiler increases, the drum manway cover gaskets compress. If the yoke assembly nuts are not properly tightened, the manway could slip and leak when the boiler pressure decreases. After the nuts are finger tight, turn each no more than ½ turn.

9. Retighten Yoke Nuts After First Boiler Off Cycle

When the boiler has been shut down for the first time after new gaskets have been installed, the yoke nuts should be retightened as in Step 6.

SECTION F-5

HYDROSTATIC TEST

TABLE OF CONTENTS

SAFETY WARNINGS

The following personnel WARNINGS and equipment CAUTIONS are to be followed when operating or servicing this steam generator. The page number following the warnings gives their location in this section of the manual.

WARNING: FAILURE OF A PART UNDER PRESSURE CAN CAUSE HAZARDOUS CONDITIONS THAT COULD RESULT IN SERIOUS BODILY INJURY. (PAGE 34)

WARNING: FAILURE TO PROPERLY DESIGN CONNECTING PIPING COULD RESULT IN SERIOUS INJURY OR DEATH. (PAGE 34)

CAUTION: DO NOT APPLY PRESSURE IF THE TEMPERATURE OF THE UNIT IS LESS THAN 60° F AFTER BEING FILLED WITH WATER TO PREVENT OVERSTRESS TO PRESSURE PART MATERIALS. (PAGE 35)

CAUTION: DO NOT LEAVE HYDROSTATIC TEST PUMPS RUNNING UNATTENDED AS EXCESSIVE PRESSURE CAN BUILD UP AND CAUSE DAMAGE TO THE EQUIPMENT (PAGE 36)

CAUTION: CHANGES IN AMBIENT TEMPERATURE COULD CAUSE A PRESSURE BUILD UP OR A VACUUM THAT COULD DAMAGE THE EQUIPMENT IF THE BOILER OR TESTED COMPONENT IS FULL OF WATER AND SEALED OFF. COMPLETELY OPEN VENTS BEFORE DRAINING. (PAGE 36)

INTRODUCTION

The American Society of Mechanical Engineers (ASME) Boiler Code requires that the completed boiler pressure system be hydrostatically tested as proof of proper design for the steam generator equipment, piping, tube welds, or other connections. A hydrostatic test is also useful to find pressure part leaks that could affect proper operation.

The state boiler inspector and owner's insurance company inspector must witness the hydrostatic test. Contact both agencies to discuss procedures and any particular requirements that they may have.

VEO performs a test on the shop-assembled boiler at the factory prior to installation of piping. An approved National Board Pressure Vessel Inspector does this testing with proper witness documentation. Field-assembled units with shop-assembled components and the systems interconnecting with shop-assembled boilers or components must be hydrostatically tested in the field.

GENERAL SAFETY PRECAUTIONS

WARNING: FAILURE OF A PART UNDER PRESSURE CAN CAUSE HAZARDOUS CONDITIONS THAT COULD RESULT IN SERIOUS BODILY INJURY.

- Display suitable warnings on the equipment and in the test area concerning the hydrostatic test.
- Permit only required personnel near equipment to be tested.
- Give special attention and care for the safety and protection of anyone inside the boiler.
- Assign one trained person to be in charge of conducting the test.
- Make certain the equipment operators and person in charge know the test procedures, how to shut off pumps, and how to vent off excessive pressure.

WARNING: FAILURE TO PROPERLY DESIGN CONNECTING PIPING COULD RESULT IN SERIOUS INJURY OR DEATH.

- Make certain that temporary connections are designed to withstand test pressures.
- Be sure piping between pumps and drain valve connections is in accord with pressure piping code requirements.
- Fully purge piping between pumps and drain valve connections before testing.

WATER TO BE USED

The following hydrostatic test fill-water conditions must be followed:

- Water temperature must not be less than the ambient temperature but in no case less than 70° F. The metal temperature of pressure parts during the hydrostatic test shall not exceed 120° F.
- Water must be filtered to remove suspended materials; water should not be oily or contain slime that could remain on boiler surfaces.
- Water must have pH of 9 or higher.

Internal heat transfer surfaces must be protected against corrosion during hydrostatic testing. Treat water used to fill the boiler or component to be tested with oxygen scavengers such as hydrazine or sodium sulfite. Inject treatment chemicals into the water as it flows into the boiler. Proper water treatment can reduce corrosion or pitting of internal surfaces of tubes and headers. Contact a water treatment specialist for the correct amount of chemicals to be used.

TEST PROCEDURE

1. Follow all safety precautions listed on Page 33.

2. Install a recently calibrated pressure gage.

    - Have maximum reading of not more that 50% and not less than 25% greater than test pressure.

    - Install in a location directly visible by the operator.

3. Remove safety valves and blind off the connections on the boiler. **(preferred method)**

OR

Install hydrostatic test clamps (sometimes called gags) on the safety valves to prevent their opening during the test procedure. (Talk to your inspector before doing this method)

4. Open the boiler or component vent valves to expel air while unit is being filled.

5. Be sure hydrostatic test water conditions are in accordance with requirements listed on previous page.

6. Fill boiler and auxiliary equipment that are to be hydrostatically tested as follows. Use a separate filling pump.

    - Make certain valves between drum and water column and gage glass are open.

    - Inspect all valve positions. Refer to Table I for correct position for hydrostatic testing.

    - Introduce water slowly into the boiler to prevent thermal shocking of the equipment. Temperature for initial filling must not be less than the ambient temperature but in no case less than 70° F. If temperature is above or below these values, fill the unit in a step-wise manner. Introduce water in sufficient quantities so that after 5 to 10 steps the boiler will be full. Wait 20-30 minutes between additions of water.

7. Fill equipment with water until all air has been expelled and water flows through the vents.

8. Close vents.

9. Isolate all valves except those connected to the hydrostatic test pump.

CAUTION: DO NOT APPLY PRESSURE IF THE TEMPERATURE OF THE UNIT IS LESS THAN 60° F AFTER BEING FILLED WITH WATER TO PREVENT OVERSTRESS TO PRESSURE PART MATERIALS.

TABLE I
VALVE POSITION CHECKLIST

Valve	*Position*
Main Steam Shutoff	Closed
Feedwater Regulator	Closed
Feedwater Regulator Isolation	Closed
Feedwater Regulator Bypass[2]	Open
Drum Vent[1]	Open/Closed
Safety Valve(s)	Remove and Blank off
Blowoff	Closed
Continuous Blowdown	Closed
Superheater Vent	Open/Closed
Superheater Drain	Closed
Economizer Vent[1]	Open/Closed
Economizer Drain	Closed
Economizer Bypass	Closed
Chemical Feed	Closed
Water Column Drain	Closed
Water Gage Drain	Closed
Steam Gage Shutoff	Closed

(¹) Valves should be open until the steam generator is full of water.

(²) Valve should be open as needed to fill the boiler.

10. Start hydrostatic test pump or, if there is sufficient discharge pressure capability, leave the fill pumps operating to pressurize unit.

CAUTION: DO NOT LEAVE HYDROSTATIC TEST PUMPS RUNNING UNATTENDED, AS EXCESSIVE PRESSURE CAN BUILD UP AND CAUSE DAMAGE TO THE EQUIPMENT.

11. Gradually raise the pressure to the required hydrostatic test pressure (normally 1.5 times design pressure). No part of the boiler shall be subjected to a general membrane stress greater than 90% of its yield strength at test temperature.

Pressure should be under control at all times. If there is a question regarding test pressure, refer to the ASME Boiler Code or ask the National Board Inspector.

12. Hold equipment at test pressure for 10 to 15 minutes at 1.5 times the design pressure. Lower pressure to the design pressure and hold as required by local authorities.

13. Reduce pressure to normal operating pressure. Make a thorough inspection of piping connections, field welds, tubes, headers, and other pressure parts for leaks.

    Cycling the hydrostatic test pressure can be useful to confirm the absence of leaks. After allowing the pressure to decrease, raise the pressure to some pressure above the design but less than 1.5 times design pressure. Cycle three times and then repeat the inspection for leaks.

14. Shut off pump once the hydrostatic test is complete and operating pressure is achieved. It may be necessary to vent equipment, since it is possible that water contained in the steam generator will be heated by natural means. As water temperature rises the pressure will increase and some water may have to be vented.

15. If a leak or defect is found when testing is complete:

    - Shut off pressurizing pump.
    - Relieve pressure by opening a vent valve.
    - Drain equipment by opening a drain valve.
    - Repair any leak or defect found.
    - Refill equipment as stated above.
    - Raise to hydrostatic pressure for a short period.
    - Inspect components again.

When testing is complete, it may not be necessary to completely drain the equipment. Refer to next section - **STORAGE.**

STORAGE

When the hydrostatic test is complete, it is necessary to protect the internal surfaces against pitting damage due to oxygen corrosion. If startup operations are to continue within less than one week the boiler can be left full of water with the vents closed.

CAUTION: CHANGES IN AMBIENT TEMPERATURE COULD CAUSE A PRESSURE BUILD UP OR A VACUUM THAT COULD DAMAGE THE EQUIPMENT IF THE BOILER OR TESTED COMPONENT IS FULL OF WATER AND SEALED OFF. COMPLETELY OPEN VENTS BEFORE DRAINING.

If startup operations will not continue within a week, the boiler should be drained. Leave vents, manheads, handholes, and other openings closed as much as possible to keep air flowing into the boiler. Refer to **Storage Procedures** located elsewhere in this manual.

It is very important to make special provisions to prevent damage due to freezing for components such as non-drainable pendant type superheaters or piping systems which cannot be drained after testing when there is a chance of freezing temperatures.

Once a non-drainable component is filled, temporary heaters or other heating means can be used to maintain the temperature above freezing. Another alternative would be to add antifreeze solution to the hydrostatic fill water to lower the freezing temperature. This technique is not recommended, however, as it is indefinite and cannot be well controlled.

SECTION F-6

BOIL OUT

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SAFETY WARNINGS

CAUTION: PERFORM ACID CLEANING ONLY UNDER THE CLOSE SUPERVISION OF AN EXPERIENCED CLEANING SPECIALIST, SINCE THIS OPERATION REQUIRES HANDLING CHEMICALS THAT COULD CAUSE DAMAGE TO THE BOILER. (PAGE 41)

WARNING: TEMPORARY PIPING SYSTEMS MUST BE PROPERLY DESIGNED FOR BOIL-OUT PRESSURE AND TEMPERTURE CONDITIONS AND PROPERLY SUPPORTED AND SECURE TO PREVENT FAILURE THAT COULD CAUSE INJURY OR DEATH. (PAGE 42)

CAUTION: IF A TEMPORARY WATER GAGE GLASS IS USED, MAKE CERTAIN IT IS CONNNECTED TO SHOW THE WATER LEVEL IN THE DRUM DURING THE BOIL-OUT OPERATION AND THAT IT IS ADEQUEATE FOR BOIL-OUT PRESSURE. IMPROPER CONNECTIONS OR GAGE CAN RESULT IN PROPERTY DAMAGE OR SEVERE INJURY TO PERSONNEL. (PAGE 42)

WARNING: AVOID OPERATING CONDITIONS THAT COULD CAUSE A RELIEF VALVE TO OPERATE DURING BOIL-OUT. HIGHLY ALKALINE SOLUTIONS COULD CAUSE PERSONNEL INJURY OR DAMAGE TO VALVE PARTS. (PAGE 42)

WARNING: DO NOT LEAVE HYDROSTATIC TEST PUMPS RUNNING UNATTENDED, AS EXCESSIVE PRESSURE CAN BUILD UP AND CAUSE DAMAGE TO THE EQUIPMENT. (PAGE 43)

WARNING: DO NOT PUT THE BOILER INTO NORMAL OPERATION WITH A TEMPORARY WATER GAGE GLASS. THE GLASS COULD BREAK, RESULTING IN INJURY TO PERSONNEL OR DAMAGE TO THE EQUIPMENT. (PAGE 43)

CAUTION: IF THE DRUM VENT OR A BOILER DRAIN VALVE IS OPENED DURING BOIL-OUT, BE CERTAIN THE DISCHARGE IS PIPED TO A SAFE LOCATION TO AVOID INJURY TO PERSONS AND DAMAGE TO PROPERY. THE BOIL-OUT SOLUTION IS HIGHLY CAUSTIC AND COULD CAUSE BURNS AND DAMAGE TO METAL FINISHES. (PAGE 43)

CAUTION: LACK OF STEAM FLOW THROUGH SUPERHEATER CAN CAUSE OVERHEATING OF SUPERHEATER ELEMENTS, WHICH COULD RESULT IN TUBE FAILURE. (PAGE 44)

CAUTION: AVOID USING WATER WITH A TEMPERATURE GREATER THAN 100° F DIFFERENCE FROM THE BOILER SETTING WHEN FILLING THE BOILER, BECAUSE TEMPERATURE STRESSES COULD DEVELOP IN THE TUBES AND DRUMS THAT COULD RESULT IN DAMAGE TO THE EQUIPMENT. (PAGE 44)

WARNING: ANYONE HANDLING BOIL-OUT CHEMICALS MUST TAKE EXTREME CARE. PERSONNEL MUST WEAR RUBBER SUITS, FACEMASKS, AND GLOVES FOR PREOTECTION FROM ALKALINE SOLUTIONS. CHEMICALS MAY GIVE OFF HEAT WHEN DISSOLVED. FOLLOW PRECAUTIONS THAT ARE SUPPLIED BY VENDOR FOR MIXING BOIL-OUT CHEMICALS. (PAGE 44)

CAUTION: CHEMICALS MUST BE THOROUGHLY MIXED WITH WATER OUTSIDE THE BOILER AND INTRODUCED AS SLURRY. DO NOT MIX CHEMICALS WITH WATER UNTIL READY TO PERFORM THE BOIL-OUT. UNDISSOLVED CHEMICALS WILL SETTLE OUT IF NOT USED IMMEDIATELY. (PAGE 44)

CAUTION: ONCE BOIL-OUT CHEMICALS ARE ADDED TO THE BOILER WATER, INITIATE BOIL-OUT PROCEDURES WITHIN 4 HOURS. UNDISSOLVED CHEMICALS WILL SETTLE OUT AND CONCENTRATE IF THE BOILER WATER IS ALLOWED TO SIT AND COULD DAMAGE PRESSURE PARTS. (PAGE 44)

CAUTION: WHENEVER THE BURNER IS SHUT DOWN, ALLOW THE FAN TO CONTINUE RUNNING TO PURGE THE FURNACE AND CONVECTION ZONES OF ANY UNBURNED COMBUSTIBLES. (PAGE 46)

INTRODUCTION

The safe long-term service of a boiler depends on maintaining water-side tube surfaces free of deposits that could hinder heat transfer. When a new boiler is to be started up, it is important to prepare the internal tube surfaces for operation by removing any greasy deposits left behind from assembly. To remove these deposits, the boiler is boiled-out with a strong alkaline water solution. Most boil-out chemical formulations include detergents (wetting agents) and concentrated inorganic chemicals. These are intended to dissolve and absorb grease or oil and to break down other deposits that could cause a problem if left in the boiler during normal operation.

Even though alkaline chemicals in the boiler water during boil-out will tend to loosen mill scale, if the boiler has rusted, or if some other condition has caused internal scale, the boiler may also have to be **acid cleaned** at startup.

Acid cleaning should not be done without a direct specific need determined from a thorough inspection by an experienced specialist.

CAUTION: PERFORM ACID CLEANING ONLY UNDER THE CLOSE SUPERVISION OF AN EXPERIENCED CLEANING SPECIALIST, SINCE THIS OPERATION REQUIRES HANDLING CHEMICALS THAT COULD CAUSE DAMAGE TO THE BOILER.

The boil-out procedure involves firing the boiler, which contains high alkaline, specially treated boiler water, at a low firing rate and at a steam pressure well below design pressure for several hours. Chemical formulations, steam pressure, and the duration of boil-out are determined by a water treatment specialist and approved by those persons responsible for boiler water treatment.

Since the burner is fired during boil-out, it will be necessary to maintain the proper steam drum water level and also to protect boiler system components. It is important that both boiler operators and supervisors be familiar with all boiler operating procedures to ensure that there is no danger to personnel or to the equipment.

Chemicals such as soda ash, caustic soda, sodium phosphates, and wetting agents used in the boil-out operation are added to the steam drum after the unit has been filled with water to a level just slightly below the manhole opening. The chemicals are dissolved prior to use and can be pumped into the normal chemical feed line or manually placed in the steam drum.

OVERALL OPERATIONAL STATUS

The Boil-out Procedure Requirements:

1. Using startup procedures to establish a normal steam drum water level.
2. Setting vents and drains to expel air and protect the superheater (if there is a superheater)
3. Insuring a means to inject feedwater through the economizer (if there is an economizer)
4. Having the following systems operational and ready to use:

- Boiler auxiliary equipment such as fans and burners
- Control systems involving the burner safety systems or burner management system
- Control systems including air-flow control dampers, fuel-flow valves, furnace draft, and feed regulator. Provide at least MANUAL control or REMOTE MANUAL, if that is part of the normal control system.
- Feedwater pumps, condensate pumps, and all equipment involved in providing feedwater for the boiler.
- Feedwater treatment system to deliver filtered, potable water. Normal make-up quality water recommended – although it is not required, since boil-out chemical treatment will inhibit scale, and boil-out is a short-term operation.

To determine the amount of boil-out chemicals to be used in this unit, refer to **G-1a Design Performance Summary Sheet** (page 62) and drawings.

DISPOSAL OF WASTE BOIL-OUT WATER

The highly alkaline boil-out of pH 11 or greater can present a disposal problem for the waste treatment facility. It may be necessary temporarily to connect the normal boiler drain system to a special holding tank or to inject neutralizing chemicals.

WARNING: TEMPORARY PIPING SYSTEMS MUST BE PROPERLY DESIGNED FOR BOIL-OUT PRESSURE AND TEMPERATURE CONDITIONS AND PROPERLY SUPPORTED AND SECURED TO PREVENT FAILURE THAT COULD CAUSE INJURY OR DEATH.

PROTECTION OF OPERATING EQUIPMENT

There may be parts of the boiler that could be damaged if they were exposed to highly alkaline boil-out chemical solutions. For steel alloys, except for austenitic stainless steel, there is no need to make special provisions. Valves and valve packing are not damaged by alkaline solutions and need not be specially protected.

Water Gage

If there are components in the steam drum gage glass that could be damaged (refer to specific gage glass instructions located elsewhere in this instruction manual), install a temporary water gage glass for boil0-out. If, for example, the gage glass is fitted with mica ports, caustic solutions could damage the mica and require replacement.

CAUTION: IF A TEMPORARY WATER GAGE GLASS IS USED, MAKE CERTAIN IT IS CONNECTED TO SHOW THE WATER LEVEL IN THE DRUM DURING THE BOIL-OUT OPERATION AND THAT IT IS ADEQUATE FOR BOIL-OUT PRESSURE. IMPROPER CONNECTIONS OR GAGE CAN RESULT IN PROPERTY DAMAGE OR SEVER INJURY TO PERSONNEL.

In no case should the boiler be put into normal on-line operation using temporary gage glass, since a failure could result in damage to the boiler and injury or death to the operator.

Superheaters and Economizers

Boiler systems components such as super heaters and economizers should be regarded in the same manner as during normal operation for the boil-out process. Do not remove or disable any of the safety equipment, such as relief valves or safety interlock instrumentation.

WARNING: AVOID OPERATING CONDITIONS THAT COULD CAUSE A RELIEF VALVE TO OPERATE DURING BOIL-OUT. HIGHLY ALKALINE SOLUTIONS COULD CAUSE PERSONNEL INJURY OR DAMAGE TO VALVE PARTS.

BOIL-OUT CHEMICALS

The service of an experienced, competent water treatment specialist to provide required alkaline chemical formulation is essential. These chemical formulations are, in some cases, prepackaged mixtures of chemicals developed to remove grease and deposits and hold the material in suspension for draining through the boiler blowdown and drain system.

VEO recommends preparing a boil-out solution as follows:

- Dissolve sufficient sodium phosphate to produce a concentration if 2500 ppm measured as tri-sodium phosphate.
- Add the same amount (equal to the weight of sodium phosphate) each of caustic soda and soda ash to the solution.
- Use a wetting agent in the amount of one pound per 1000 gallons of boiler water.

To determine the amount of boil-out chemicals to be used in this unit refer to **G-1a Design Performance Summary Sheet** (page 62) and drawings.

HYDROSTATIC TEST

Conduct a hydrostatic test prior to boil-out. Refer to **HYDROSTATIC TEST** located elsewhere in this manual.

WARNING: DO NOT LEAVE HYDROSTATIC TEST PUMPS RUNNING UNATTENDED, AS EXCESSIVE PRESSURE CAN BUILD UP AND CAUSE DAMAGE TO THE EQUIPMENT.

PREPARATION FOR BOIL-OUT

If the water is not drained after hydrostatic testing, begin with paragraph titled **MIXING BOIL-OUT CHEMICALS** later in this section of this manual. If the boiler is drained use the following procedure.

Drums and Headers

1. Check all bearing surfaces of manhole/ handhole plates, manhole/ handhole openings in upper and lower drums, and if provided, handholes in the headers. Remove scale, dirt, and ridges.
2. Insert gasket through opening; position evenly around the opening. Refer to **F-4 Drum Manway Gasket Installation Procedures** (page 28)
3. Insert manhole/handhole plate and gasket, fit evenly around the hole.
4. Install yoke with bolts and nuts; be sure gasket is still in place and has not shifted.

NOTE: After unit is filled and a small amount of water pressure (2-3 psig) has built up, check for leaks: tighten nuts.

Water Gage

Install a temporary water gage glass. The boil-out chemicals will damage the glass during boil-out.

WARNING: DO NOT PUT THE BOILER INTO NORMAL OPERATION WITH A TEMPORARY WATER GAGE GLASS. THE GLASS COULD BREAK, RESULTING IN INJURY TO PERSONNEL OR DAMAGE TO THE EQUIPMENT.

Valves

1. Close the following valves:
   - Continuous blowdown valves
   - Water column drain valves
   - Stop-check valves
   - Main steam shut-off valves
2. Reinstall safety valve which was removed, or remove plate used to blank out valve inlet during hydrostatic test.
3. Open boiler steam drum vent valves.

CAUTION: IF THE DRUM VENT OR A BOILER DRAIN VALVE IS OPENED DURING BOIL-OUT, BE CERTAIN THE DISCHARGE IS PIPED TO A SAFE LOCATION TO AVOID INJURY TO PERSONNEL AND DAMAGE TO PROPERTY. THE BOIL-OUT SOLUTION IS HIGHLY CAUSTIC AND COULD CAUSE BURNS AND DAMAGE TO METAL FINISHES.

4. Position valves near the feedwater regulator so that feedwater is manually controlled around the feedwater regulator valves and through the feedwater bypass.

Superheater

If the unit contains a superheater, completely open the vents and drains on both superheater inlet and outlet header to ensure steam flow through the superheater.

CAUTION: LACK OF STEAM FLOW THROUGH SUPERHEATER CAN CAUSE OVERHEATING OF SUPERHEATER ELEMENTS WHICH COULD RESULT IN TUBE FAILURE.

Economizer

If the boiler contains an economizer, make certain the economizer drains are closed, vent is open, and water is flowing into the economizer. Close vent when economizer is completely full.

FILLING WITH WATER

1. Make certain valves between drum and water column and gage glass valves are open.
2. Inspect all valve positions. **Refer to "Table II"** for correct valve position.
3. Introduce water slowly into the boiler to prevent thermal shocking of the equipment.

CAUTION: AVOID USING WATER WITH A TEMPERATURE GREATER THAN 100° F DIFFERENCE FROM THE BOILER SETTING WHEN FILLING THE BOILER, BECAUSE TEMPERATURE STRESSES COULD DEVELOP IN THE TUBES AND DRUMS THAT COULD RESULT IN DAMAGE TO EQUIPMENT.

Recommended temperature for initial filling is 70° F minimum and 100° F maximum. If temperature is above or below these values, fill the unit in a step-wise manner. Introduce water in sufficient quantity in that after 5 to 10 steps the boiler will be full. Wait 20 to 30 minutes between additions of water.

MIXING CHEMICALS FOR BOIL-OUT

Boil-out chemicals can be mixed by one of the following methods.

WARNING: ANYONE HANDLING BOIL-OUT CHEMICALS MUST TAKE EXTREME CARE. PERSONNEL MUST WEAR RUBBER SUITS, FACE MASKS, AND GLOVES FOR PROTECTION FROM THE ALKALINE SOLUTIONS. CHEMICALS MAY GIVE OFF HEAT WHEN DISSOLVED. FOLLOW PRE-CAUTIONS THAT ARE SUPPLIED BY VENDOR FOR MIXING BOIL-OUT CHEMICALS.

Method I

1. Mix chemicals outside the boiler in a separate container, which is provided with continuous fresh water flow to the mixing container and outlet for a continuous flow to the boiler steam drum.
2. Dissolve each chemical separately.
3. Slowly add small amounts of the chemical to a large volume of water in the mixing container; mix well.

Method II

1. Mix chemicals outside the boiler in a separate container to form slurry.

CAUTION: CHEMICALS MUST BE THOROUGHLY MIXED WITH WATER OUTSIDE THE BOILER AND INTRODUCED AS SLURRY. DO NOT MIX CHEMICALS WITH WATER UNTIL READY TO PERFORM THE BOIL-OUT. UNDISSOLVED CHEMICALS WILL SETTLE OUT IF USED IMMEDIATELY.

2. Lower the water level in the steam drum to well below the manhole opening.
3. Introduce slurry to the steam drum through a chemical pump and connections or by hand through the manhole opening.

CAUTION: ONCE BOIL-OUT CHEMICALS ARE ADDED TO THE BOILER WATER, INITIATE BOIL-OUT PROCEDURES WITHIN FOUR HOURS. UN-DISSOLVED CHEMICALS, WHICH WILL SETTLE OUT AND CONCENTRATE IF THE BOILER WATER IS ALLOWED TO SIT, COULD DAMAGE PRESSURE PARTS.

TABLE II
BOIL OUT VALVE POSITION CHECKLIST

Valve	Position
Main Steam Shutoff	Closed
Feedwater Regulator	Closed
Feedwater Regulator Isolation	Closed
Feedwater Regulator Bypass²	Open
Drum Vent¹	Open
Safety Valve(s)	Free
Blow-off	Closed
Continuous Blowdown	Closed
Superheater Vent¹	Open
Superheater Drain	Open
Economizer Vent¹	Closed
Economizer Drain	Closed
Economizer Bypass	Closed
Chemical Feed³	Closed
Water Column Drain	Closed
Water Gage Drain	Closed
Steam Gage Shutoff⁴	Closed

(¹) Valves should be open to fill the steam generator with water.
(²) Valve should be open as needed to control water level.
(³) If not used to inject chemicals.
(⁴) Use a temporary gage until after boil out.

FINAL CHECK BEFORE BOIL-OUT

1. If chemicals were added through the manhole, close manhole securely.

2. Make certain steam drum vent is open.

3. Be sure boiler is filled with water to the normal operating line on the gage glass.

4. Open water column inlet valve and feedwater regulator bypass valve.

5. If the boiler is equipped with a superheater, be certain outlet vent is open.

FIRING BURNER

1. Use natural gas fuel when available for boil-out since the rate of firing is easily controlled.

2. Avoid using oil fuels for boil-out if possible. The low firing rate for oil fuels results in incomplete combustion and condensation of corrosive elements on the relatively cold heating surface. This causes not only dirty heating areas, but fire hazards as well.

3. Fire main burner at a low firing rate until vapor flows from vent valve. Refer to section **BURNER MANAGEMENT SYSTEM** for specific instructions for firing burner.

INCREASING PRESSURE

1. Allow a small amount of pressure (2-5 psig) to build up in the unit; check for leaks and tighten manhole/handhole nuts.

2. After light off, carefully regulate the firing rate by MANUAL control.

   - Slowly heat the unit.

   - Do not exceed a rate of 100° F per hour temperature rise in the boiler water.

3. Use manual feed control to maintain boiler water at normal water level.

4. Increase pressure until the boil-out pressure is reached. The pressure should be as high as possible (100-125 psig is recommended) while not exceeding the set pressure of the safety valves or 300 psig maximum. Refer to manufacturer's instructions for valve pressure.

5. Partially close drum vent valve.

BOIL-OUT PROCEDURE

1. Control burner-firing rate by using manual control or by operating through successive on/off cycles.

2. Hold pressure in the boiler for 8-12 hours or for time determined by start-up consultant or water treatment specialist; use no blowdown.

3. After this 8-12 hour period, shut down boiler.

4. Blow down water level to the low visibility point on the water gage glass.

5. Replace the blowdown water with quantities of fresh boil-out water.

6. Operate blowdown valves at approximately ½ to 1 hour intervals.

7. Re-fire to pressure.

8. Continue blowdown procedure until water sample shows the water to be clear of impurities. Refer to **BLOWDOWN** for further information.

9. Shut down the burner and cool the boiler.

CAUTION: WHENEVER THE BURNER IS SHUTDOWN, ALLOW THE FAN TO CONTINUE RUNNING TO PURGE THE FURNACE AND CONVECTION ZONES OF ANY UNBURNED COMBUSTIBLES.

DRAINING AND WASHING

1. When the boil-out is complete:
    - Open the mud drum drain valve
    - Keep the steam drum vent open
    - Drain the steam generator

2. Allow unit to cool before refilling to avoid thermal shock.

3. Using fresh water, refill and drain the boiler 3-4 times to remove any remaining caustic on the internal surfaces.
    - Be sure the mud drum drain is open.
    - Remove the boiler manhole covers.

4. Wash tube and drum surfaces with fresh water and high-pressure hose.

5. Inspect drum internals for cleanliness; if they are not clean, repeat boil-out procedure.

6. Check tubes carefully, as water and chemicals may have settled during boil-out and become stagnant.

FINAL CHECK BEFORE STARTUP

1. Replace manhole/handhole gaskets.

2. Replace temporary water gage glass used during boil-out with a permanent water gage glass.

3. Adjust valves for boiler operation according to **Operation Valve Position Checklist, Table III.**

4. Fill with fresh treated water to about 2 inches below normal operation level to allow for water expansion.

5. Check system for any leaks or malfunctioning equipment.

TABLE III
OPERATION VALVE POSITION CHECKLIST

Valve	Position
Main Steam Shutoff	Open
Feedwater Regulator	Open
Feedwater Regulator Isolation	Open
Feedwater Regulator Bypass[2]	Closed
Drum Vent[1]	Closed
Safety Valve(s)	Free
Blowoff	Closed
Continuous Blowdown	Open
Superheater Vent[1]	Closed
Superheater Drain	Closed
Economizer Vent[1]	Closed
Economizer Drain	Closed
Economizer Bypass	Closed
Chemical Feed[3]	Open
Water Column Drain	Closed
Water Gage Drain	Closed
Steam Gage Shutoff[4]	Open

(1) Valves should be open to fill the steam generator with water.

(2) Valve should be open as needed to control water level.

(3) If not used to inject chemicals.

(4) Use a temporary gage until after boil out.

SECTION F-7
FIRING–IN BURNER THROATS

TABLE OF CONTENTS

INTRODUCTION

The life of boiler refractory depends solely on the treatment that it receives. Many times boiler refractory has to be replaced due to severe cracking and spalling which develops from abrasive fuels, chemical attack, moisture, and temperature gradients. Firing-in of castable burner throat liners is done to reduce this damage and thus extend the life of the refractory.

ABOUT FIRING-IN

What is Firing-In of Refractory?

Firing-in of refractory is a dry out process which the castable refractory develops a strong hydraulic bond. The process entails numerous heating periods and temperature holding plateaus that are specifically set for the type and thickness of the refractory.

Why is Firing-In Refractory Necessary?

Castable refractory receives its strength from the hydraulic bond that is formed when the binder is dried. Rapid heating of the castable on initial firing not only retards the formation of this bond but also vaporizes moisture within the body of the material. Steam escapes through the hot face of the refractory and will cause fissures throughout the liner. Firing-in of castable refractory controls the evaporation of the moisture so that the hydraulic bond, which the refractory life is dependent upon, can be developed.

When Should Firing-In of Refractory Be Done?

The firing-in process actually begins the minute the castable is poured. This is due to the fact that a twenty-four hour air-drying time is required for any castable refractory before heat can be applied. The actual heating sequence of the firing-in process should be accomplished before loading is applied to the burner.

THE FIRING-IN SCHEDULE

One of the most difficult aspects of refractory application is recommending proper firing-in schedules for boiler refractory. Refractory type, material thick-ness, unit type and size, method of ignition, type of fuel, type of burners, and customer conscientiousness must be considered before a schedule is selected.

FIRING-IN CHART

The firing-in chart is a graphical guide of the firing-in schedule for a given refractory. This chart should be adhered to as written.

EQUIPMENT

The firing-in of boiler refractory requires the dependable and reliable operation of all of the units' equipment. A thorough check of this equipment is therefore required before starting a firing-in schedule.

As previously mentioned an auxiliary burner should be considered if the main burners cannot be controlled in the lower temperature range.

It is recommended that thermocouples be installed in regions that avoid flame impingement and appear to indicate the true temperature of the liner. The leads should be 1/8 inch beneath the surface of the hot face of the lining. The types of thermocouples used can be Chromel-Alumel up to 2500° F, Platinum-Platinum 10% Rhodium up to 2800° F, or Platinum–Platinum 13% Rhodium up to 2800° F. An optical pyrometer can give a fast accuracy of the thermocouple measurement.

FIRING-IN PROCESS

The firing-in of boiler refractory is an important factor in the life of the liner; therefore, neither the manufacturer nor the customer should take it lightly.

A responsible firing-in procedure is often difficult to achieve because of the perceived urgency of placing the equipment in operation. However, refractory firing-in must be considered an integral part of the total startup process.

It should be noted that a boiler boil-out schedule and/or procedure does not serve the purpose of refractory firing-in procedure and should in no case exceed the temperature gradients and/or time periods indicated on the firing-in chart.

The actual firing-in process is accomplished in four steps, which should be closely followed.

Step 1: Equipment Check Out

As previously mentioned, the dependable operation of all of the units' equipment, as well as auxiliary burners, is of the utmost importance. This equipment should be thoroughly checked out, calibrated, and tested before the firing-in process actually begins.

Step 2: Air Dry Period

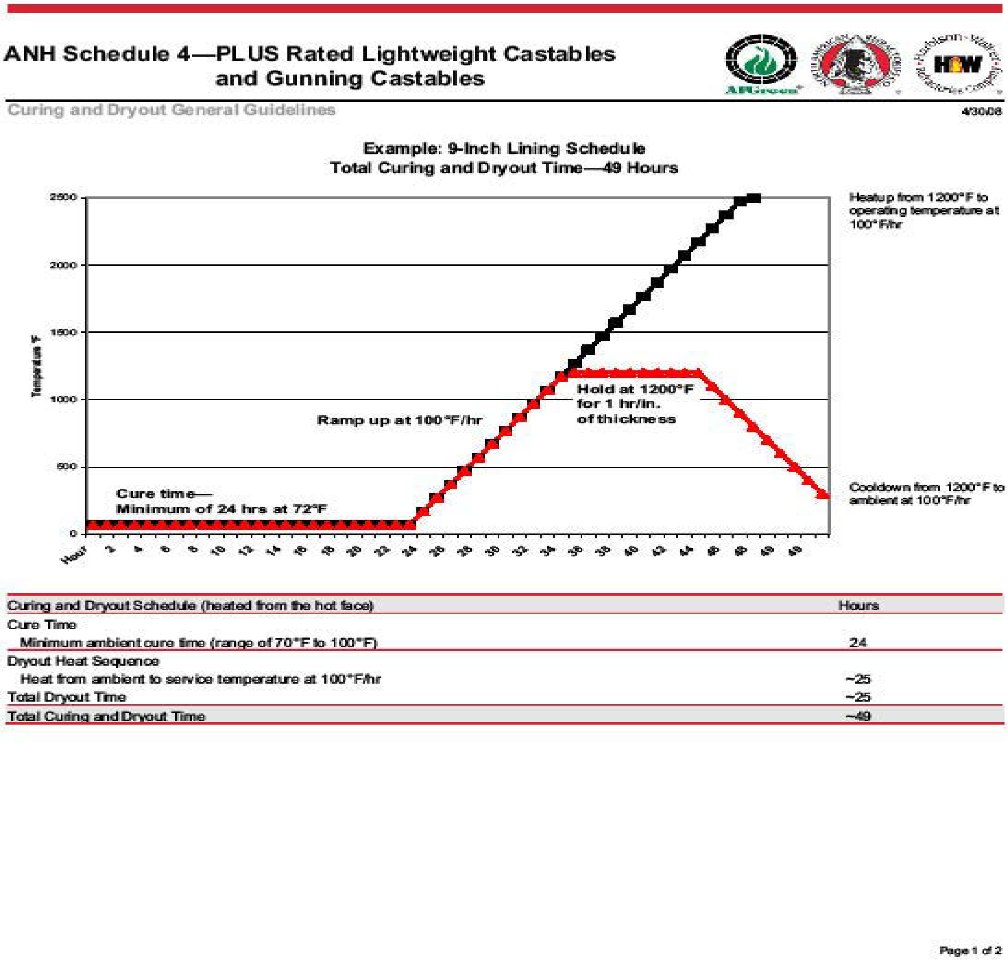
A twenty-four hour air-drying period is required after the casting or gunning of the refractory before flame can be introduced to the burner. In most cases this air-drying time has already taken place before the customer receives the unit. In those cases where the refractory is installed on the job site this air-drying period must be adhered to.

Step 3: Heat and Hold Periods

The actual firing-in of the refractory is accomplished during this step. Through the use of the equipment and the firing-in chart the refractory is slowly heated and held at certain temperatures. This is dictated by the firing-in chart which should be closely adhered to.

Step 4: Cool Down

If the unit is not put into operation upon completion of the firing-in schedule the unit should be held at its' operating temperature for twenty–four hours allowing the refractory to be cooled down



ANH Schedule 4—PLUS Rated Lightweight Castables and Gunning Castables

Curing and Dryout General Guidelines

4/30/08

Example: 9-Inch Lining Schedule
Total Curing and Dryout Time—49 Hours

Curing and Dryout Schedule (heated from the hot face)	Hours
Cure Time	
Minimum ambient cure time (range of 70°F to 100°F)	24
Dryout Heat Sequence	
Heat from ambient to service temperature at 100°F/hr	~25
Total Dryout Time	~25
Total Curing and Dryout Time	~49

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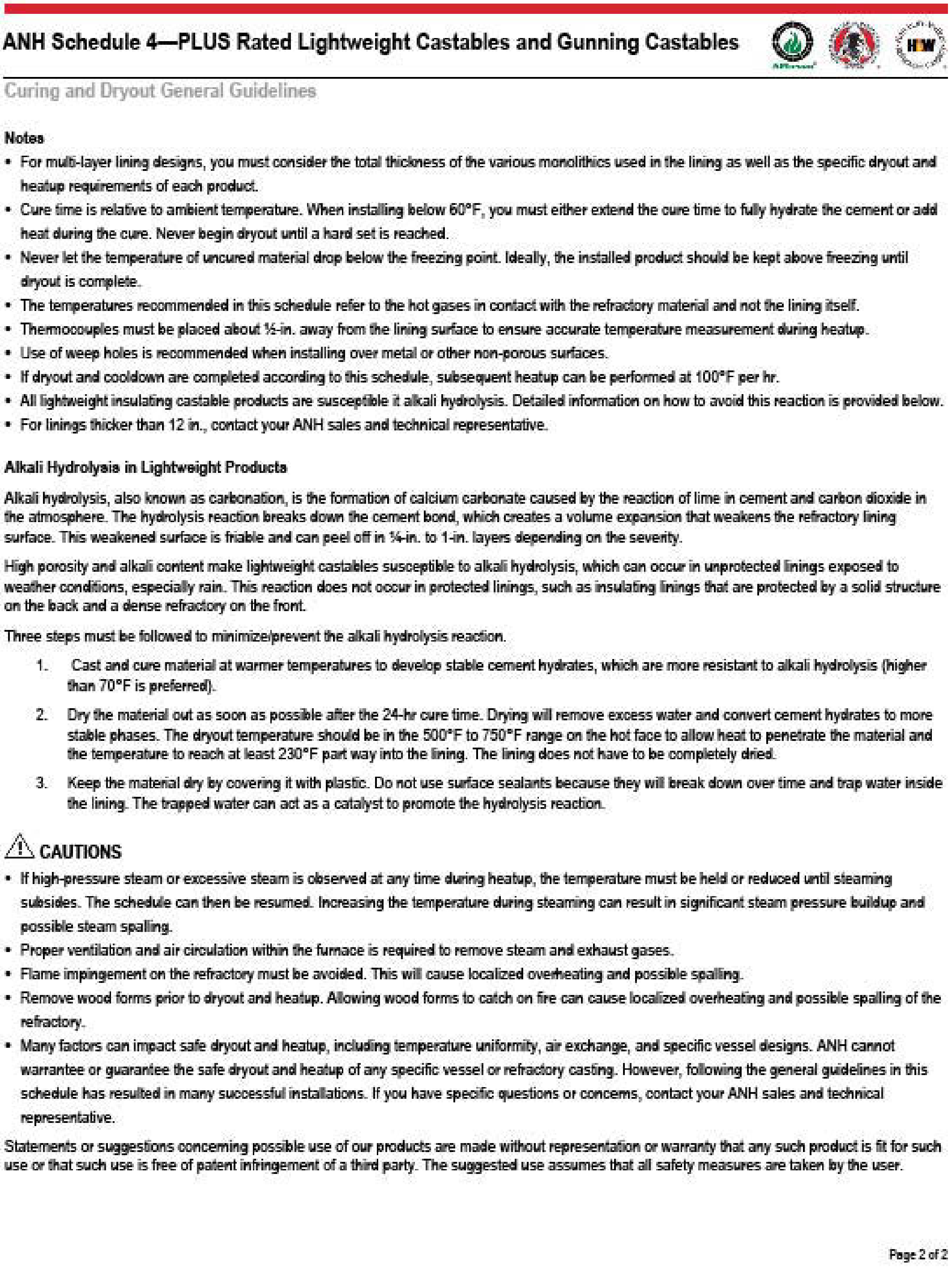

ANH Schedule 4—PLUS Rated Lightweight Castables and Gunning Castables

Curing and Dryout General Guidelines

Notes

- For multi-layer lining designs, you must consider the total thickness of the various monolithics used in the lining as well as the specific dryout and heatup requirements of each product.
- Cure time is relative to ambient temperature. When installing below 60°F, you must either extend the cure time to fully hydrate the cement or add heat during the cure. Never begin dryout until a hard set is reached.
- Never let the temperature of uncured material drop below the freezing point. Ideally, the installed product should be kept above freezing until dryout is complete.
- The temperatures recommended in this schedule refer to the hot gases in contact with the refractory material and not the lining itself.
- Thermocouples must be placed about ½-in. away from the lining surface to ensure accurate temperature measurement during heatup.
- Use of weep holes is recommended when installing over metal or other non-porous surfaces.
- If dryout and cooldown are completed according to this schedule, subsequent heatup can be performed at 100°F per hr.
- All lightweight insulating castable products are susceptible it alkali hydrolysis. Detailed information on how to avoid this reaction is provided below.
- For linings thicker than 12 in., contact your ANH sales and technical representative.

Alkali Hydrolysis in Lightweight Products

Alkali hydrolysis, also known as carbonation, is the formation of calcium carbonate caused by the reaction of lime in cement and carbon dioxide in the atmosphere. The hydrolysis reaction breaks down the cement bond, which creates a volume expansion that weakens the refractory lining surface. This weakened surface is friable and can peel off in ¼-in. to 1-in. layers depending on the severity.

High porosity and alkali content make lightweight castables susceptible to alkali hydrolysis, which can occur in unprotected linings exposed to weather conditions, especially rain. This reaction does not occur in protected linings, such as insulating linings that are protected by a solid structure on the back and a dense refractory on the front.

Three steps must be followed to minimize/prevent the alkali hydrolysis reaction.

1. Cast and cure material at warmer temperatures to develop stable cement hydrates, which are more resistant to alkali hydrolysis (higher than 70°F is preferred).
2. Dry the material out as soon as possible after the 24-hr cure time. Drying will remove excess water and convert cement hydrates to more stable phases. The dryout temperature should be in the 500°F to 750°F range on the hot face to allow heat to penetrate the material and the temperature to reach at least 230°F part way into the lining. The lining does not have to be completely dried.
3. Keep the material dry by covering it with plastic. Do not use surface sealants because they will break down over time and trap water inside the lining. The trapped water can act as a catalyst to promote the hydrolysis reaction.

⚠ CAUTIONS

- If high-pressure steam or excessive steam is observed at any time during heatup, the temperature must be held or reduced until steaming subsides. The schedule can then be resumed. Increasing the temperature during steaming can result in significant steam pressure buildup and possible steam spalling.
- Proper ventilation and air circulation within the furnace is required to remove steam and exhaust gases.
- Flame impingement on the refractory must be avoided. This will cause localized overheating and possible spalling.
- Remove wood forms prior to dryout and heatup. Allowing wood forms to catch on fire can cause localized overheating and possible spalling of the refractory.
- Many factors can impact safe dryout and heatup, including temperature uniformity, air exchange, and specific vessel designs. ANH cannot warrantee or guarantee the safe dryout and heatup of any specific vessel or refractory casting. However, following the general guidelines in this schedule has resulted in many successful installations. If you have specific questions or concerns, contact your ANH sales and technical representative.

Statements or suggestions concerning possible use of our products are made without representation or warranty that any such product is fit for such use or that such use is free of patent infringement of a third party. The suggested use assumes that all safety measures are taken by the user.

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SECTION G
IN-OPERATION

SECTION G-1
STARTUP

TABLE OF CONTENTS

FEEDWATER SUPPLY

Before lighting off the boiler or attempting to place a boiler online, a check should be made of all feedwater supply equipment to insure a continuous and adequate supply of chemically treated and deaerated feedwater to the boiler. Particularly note pressure on the pump suction to ensure proper suction pressure at the feedwater temperature. (Consult Pump Operating Manual)

VALVE SETTINGS

Once again make an inspection of the unit, noting the position of all valves. All valves on blowdown lines, continuous blowdown, water column and gage glass drains, and feedwater regulator should be closed. Initially, feedwater should be introduced around the feedwater regulator or through the feed water regulator bypass. Vent on the steam drum should be opened as later noted. Where a superheater is included vents and/or drains on the inlet header should be opened slightly and the vent on the outlet header opened fully. Also, check valves to insure their being open. It is also advisable to trace feedwater piping from supply to boiler ensuring that proper valves are opened or closed as the case may be.

FILLING WITH WATER

Fill the boiler to about 2 inches below normal operating level, thus allowing room for expansion of water with heating and pressure rise.

It is desirable to fill the boiler with the properly treated feedwater which has been deaerated. Filling with hot water is permissible, providing water is added slowly and flow does not exceed capacity of deaerating. When filling with water, drum vent should be opened to permit escape of steam or air.

LIGHTING OFF

Once the boiler has been filled with water a light fire may be lit, observing the rules of caution for the fuel being used. Initially, all firing equipment should be placed on hard control until after unit had been placed on line. Where a boiler contains an air preheater with cold air bypass, the dampers should be positioned to bypass the air heater. (A cold air bypass is usually incorporated in the boiler design when low steaming rates are anticipated for the unit) In all cases, insure proper furnace draft either by natural means or induced draft fan.

PLACING IN SINGLE OPERATION

When placing a boiler in operation without other boilers in service it is generally advisable to raise the steam pressure on the entire piping system with the boiler. The header gate valve and non-return valve, as well as all drip valves, should be opened prior to steaming. When this procedure is not practical or not used, raise boiler pressure almost to line pressure, open drips in system, open the gate valve bypass, and slowly open non-return valve, allowing steam to flow through the gate valve bypass, thus warming the line slowly. When line has been warmed and evidence of moisture has disappeared, slowly open gate valve, admitting full steam flow to the line. Gate valve bypass and drip valve should then be closed.

PLACING IN PARALLEL OPERATION

When placing a boiler in parallel operation with other boilers, the headers should first be warmed by back-feeding steam through the gate valve bypass. Drip lines in header should be open. When line has been warmed, open gate valve and close drips after all evidence of moisture has disappeared. The non-return valve should then be opened about 25 percent, thus allowing the unit to come on line automatically when pressure reaches line pressure. The non-return valve may be opened fully when the boiler cuts in on the line.

INCREASING LOAD

After boiler has been placed on line, close all drips, drum, and superheater vents. Gradually increase boiler loading manually up to about 30 percent of rating, depending on control characteristics, and place on automatic control, observing all the rules concerning controls operation. Before placing feedwater regulator in service, blowdown the temperature element and allow the system to come to equilibrium.

PLACING AIR HEATERS IN SERVICE

Air preheaters equipped with cold air bypass may be placed in service when flue gas temperatures warrant their use. Sufficient gas temperature must be available to prevent condensation of the gases on the cold end of the air heater. When placing in service, close air bypass slowly to prevent sudden temperature reductions in air heater tubing.

STARTUP AND SHUTDOWN SEQUENCE

SEQUENCES FOR BOILERS WITH AND WITHOUT SUPERHEATERS

Cold Startup Sequence

1. Definition:
    a. A cold startup is a startup with any of the following conditions:
        - After the majority of components have cooled to near ambient conditions
        - Greater than 48 hours after shutdown
        - No steam pressure in the steam drum

2. Boiler Permissives: Enables the PID control loops
    a. Drum water level not low
    b. Steam pressure not high

3. Open the steam drum vent valve, superheater vent valve, superheater drain valves, and superheater outlet/main steam header vent valve. **(applicable for superheated units only)**

4. Start burner.
    Note: Intermittent firing will be required to maintain the designated warm-up rate as provided in Section G-1B, “Load Vs. Time”.

CAUTION: THERE MAY BE A LIMITATION ON THE FREQUENCY OF FAN MOTOR STARTS. REFER TO MOTOR LITERATURE FOR THE LIMITATIONS OF YOUR MOTOR. EXCESSIVE STARTS MAY DAMAGE THE MOTOR.

5. Monitor boiler outlet temperature and/or drum pressure. The initial outlet temperature or drum pressure will be the initial set point for the ramp rate.

6. Maintain burner firing rate as required to provide a warm-up rate based on temperature. Rate of increase is limited to 1.6° F per minute (100° F per hour). Gas temperature measured at the boiler outlet prior to economizer.

CAUTION: EXCEEDING THE RECOMMENDED RAMP RATE WILL RESULT IN OVERHEATING OF THE SUPERHEATER TUBES, BOILER TUBE LEAKS, AND/OR OTHER DAMAGE. THE DAMAGE MAY NOT BE EVIDENT IMMEDIATELY, BUT OVER TIME WILL RESULT IN INCREASED MAINTENANCE AND DECREASED BOILER LIFE.

7. When steam discharge is visible from the steam drum vent close the steam drum vent valve.

8. Close super heater drain and main steam header drain valves when the boiler has reached 25 psig. **(applicable for superheated units only)**

9. While maintaining the flue gas temperature ramp rate, monitor the steam drum pressure. The maximum pressure increase as a function of time is provided in Section G-1B, “Load vs. Time”. Use the superheater outlet vent valve to control this rate by opening or throttling down on the superheater vent valve. **(applicable for superheated units only)**

10. Monitor the superheater outlet temperature. The superheater outlet temperature must not exceed the normal operating temperature by more than 100° F. Reduce the firing rate and/or increase steam outlet vent flow to reduce the steam temperature. **(applicable for superheated units only)**

11. For a single boiler installation or a cold main steam header open the main steam header warm-up valve and main steam header isolation valve.

12. Continue warm-up ramp rate until boiler flue gas outlet temperature is within 50° F of normal operating temperature.

13. Open main steam non-return and stop valves.

14. When you are sure that steam is flowing into the main steam header close the header warm-up valves and close the superheater outlet vent valve.

CAUTION: STEAM FLOW MUST BE MAINTAINED THROUGH THE SUPERHEATER WHENEVER THE BURNER IS FIRING. LOSS OF STEAM FLOW WILL RESULT IN OVERHEATING OF THE SUPERHEATER TUBES. (applicable for superheated units only)

15. Verify all systems are functioning properly.

16. Place burner in automatic.

CAUTION; AT NO TIME CAN THE SUPERHEATER TEMP EXCEED THE NORMAL OPERATING TEMPERATURE BY MORE THAN 100° F.

Warm Startup Sequence

1. Definition:
   a. A warm startup is a startup with all of the following conditions:
      - After components have cooled below normal operating conditions
      - 12-48 hours after shutdown
      - Steam drum pressure up to/within 30% of normal operating pressure

2. Boiler Permissive: Enables the PID control loops
   a. Drum water level not low
   b. Steam pressure not high
   c. Superheater outlet vent valve open enough to see steam plume out of silencer

3. Open main steam header warm-up valves.

4. Start burner at minimum fire.

CAUTION: THERE MAY BE A LIMITATION ON THE FREQUENCY OF FAN MOTOR STARTS. REFER TO MOTOR LITERATURE FOR THE LIMITATIONS OF YOUR MOTOR. EXCESSIVE STARTS MAY DAMAGE THE MOTOR.

5. Monitor boiler flue gas outlet temperature and/or drum pressure. The initial outlet temperature value or drum pressure after the fan starts will be the initial set point for the ramp rate.

6. Maintain burner firing rate as required to provide a warm-up rate based on temperature. Rate of increase is limited to 1.6° F per minute

   (100° F per hour). Gas temperature measured at the boiler outlet prior to economizer.

7. While maintaining the flue gas temperature ramp rate, monitor the steam pressure. The maximum pressure increase as a function of time is provided in Section G-1B, "Load vs. Time". Using the superheater vent valve to control this rate by opening or throttling down on the superheater outlet vent valve. **(applicable for superheated units only)**

8. Close superheater drain and main steam header drain valves when the boiler has reached 25 psig. **(applicable for superheated units only)**

9. Continue ramping up until boiler flue gas outlet temperature is within 50° F of normal operating temperature.

10. Open main steam non-return and stop valves.

11. When you are sure that steam is flowing into the main steam header close the header warm-up valves and close the superheater outlet vent valve.

12. At this point the burner may be placed in automatic control.

CAUTION: STEAM FLOW MUST BE MAINTAINED THROUGH THE SUPERHEATER WHENEVER THE BURNER IS FIRING. LOSS OF STEAM FLOW WILL RESULT IN OVERHEATING OF THE SUPERHEATER TUBES. (applicable for superheated units only)

13. Verify all systems are functioning properly.

CAUTION: AT NO TIME CAN THE SUPERHEATER TEMPERATURE EXCEED THE NORMAL OPERATING TEMPERATURE BY MORE THAN 100° F.

Hot Startup Sequence

1. Definition:
   a. A hot startup is a startup with all of the following conditions:
      - All components are very close to normal operating conditions
      - Up to 12 hours after shutdown
      - Steam drum pressure within 30% of normal operating pressure

2. Boiler Permissive: Enables the PID control loops
   a. Drum water level not low
   b. Steam pressure not high
   c. superheater SH outlet vent valve open enough to see steam plume out of vent or silencer

3. Open main steam header warm-up valves

4. Start burner at minimum fire.

CAUTION: AT NO TIME CAN THE SUPERHEATER TEMPERATURE EXCEED THE NORMAL OPERATING TEMPERATURE BY MORE THAN 100° F.

5. Monitor stacks temperature and/or drum pressure. The initial outlet temperature value or drum pressure after the fan starts will be the initial set point for the ramp rate.

6. While maintaining the flue gas temperature ramp rate, monitor the steam pressure. The maximum pressure increase as a function of time is provided in Section **G-1B, "Load vs. Time"**. Using the superheater vent valve to control this rate by opening or closing down on the superheater vent valve. **(applicable for superheated units only)**

7. Continue ramping up until boiler flue gas outlet temperature is within 50° F of normal operating temperature.

8. Open main steam non-return and stop valves.

9. When you are sure that steam is flowing into the main steam header close the header warm-up valves and close the superheater outlet vent valve.

10. At this point the burner may be placed in automatic control.

CAUTION: STEAM FLOW MUST BE MAINTAINED THROUGH THE SUPERHEATER WHENEVER THE BURNER IS FIRING. LOSS OF STEAM FLOW WILL RESULT IN OVERHEATING OF THE SUPERHEATER TUBES. (applicable for superheated units only)

11. Verify all systems are functioning properly.

CAUTION: AT NO TIME CAN THE SUPERHEATER TEMPERATURE EXCEED THE NORMAL OPERATING TEMPERATURE BY MORE THAN 100° F.

Hot Restart Sequence

1. Definitions:
   a. A hot restart is a startup with any of the following conditions:
      - All components are at normal operating conditions
      - Up to 1 hour after shutdown
      - Steam drum pressure within 25 psig of normal operating pressure

2. Boiler Permissive: Enables the PID control loops.
   a. Drum water level not low
   b. Steam pressure not high

3. Open main steam non-return and stop valves. Crack open superheater drains and vent.

4. Start burner at minimum fire.

CAUTION: THERE MAY BE A LIMITATION ON THE FREQUENCY OF FAN MOTOR STARTS. REFER TO MOTOR LITERATURE FOR THE LIMITATIONS OF YOUR MOTOR. EXCESSIVE STARTS MAY DAMAGE THE MOTOR.

5. Close super heater drain and main steam header drain valves when the boiler has reached 25 psig.

6. Maintain burner firing rate until steam drum pressure increases to normal operating pressure.

7. When you are sure that steam is flowing into the main steam header close the header warmup valves and close the superheater outlet vent valve.

8. At this point the burner may be placed in automatic control.

CAUTION: STEAM FLOW MUST BE MAINTAINED THROUGH THE SUPERHEATER WHENEVER THE BURNER IS FIRING. LOSS OF STEAM FLOW WILL RESULT IN OVERHEATING OF THE SH TUBES.

9. Verify all systems are functioning properly.

SECTION G-1a

DESIGN PERFORMANCE SUMMARY SHEET

JVE 13288 Columbia Pulp Project

Customer Performance

Contents

1. Performance for current operation – Heat input of 99 mmBtu/hr

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                     VICTORY ENERGY CUSTOMER SPEC SHEET

  Customer:  Columbia Pulp Project               Date:   09/7/2017
  Reference:  VS-5-78SP SH                       Quote #: JVE 13288 Current
_________________________________________________________________________
PERFORMANCE DATA:
Boiler Load of MCR              (%)       73.66   55.24   36.83   18.42
Steam Output-SH               (lb/h)      66294   49720   33147   16574

  FUEL/FIRING CONDITIONS:
Fuel Type                               Natural Natural Natural Natural
                                            Gas     Gas     Gas     Gas
Excess Air                      (%)          15      15      30      80
Flue Gas Recirc.                (%)          30      30      30      30

  STEAM/WATER CONDITIONS:
Steam T.,NRV Outlet             (F)         889     909     909     872
Steam P.,NRV Outlet           (psig)        800     800     800     800
Boiler Sat. Temp.               (F)         523     522     521     521
Boiler Drum Press.            (psig)      821.1   812.1   805.4   801.4
ECON. Water Outlet T.           (F)         366     361     371     408
Feedwater T. to ECON            (F)         227     227     227     227

  FLOW QUANTITIES:
Percent Blowdown                (%)           1       1       1       1
Blowdown Flow                 (lb/h)        670     502     335     167
Feedwater Flow                (lb/h)      66964   50223   33482   16741
Fuel Flow                     (lb/h)       4241    3207    2155    1097
Combustion Air Flow           (lb/h)      83398   63056   47907   33756
Flue Gas LVG System           (lb/h)      87640   66263   50063   34853
Flue Gas Recirc. Flow         (lb/h)      26292   19879   15019   10456
Flue Gas w/Recirc.            (lb/h)     113932   86142   65081   45309
(FGR from Outlet of ECON/H #1)

  AIR/GAS TEMPERATURE:
Entering Air Temp.              (F)          80      80      80      80
Flue Gas Recirc. Temp.          (F)         273     260     253     254
Comb. Air/FGR Mixture           (F)         131     127     125     124
Flame Temp w/ Recirc.           (F)        2666    2664    2434    1904
Furnace Exit Gas Temp.          (F)        2078    1997    1795    1437
Superheater Gas Inlet T.        (F)        2078    1997    1795    1437
Superheater Gas Outlet T.       (F)        1651    1551    1390    1143
Boiler Exit Gas Temp.           (F)         584     559     541     527
Gas T LVG. ECON/HTR #1          (F)         273     260     253     254

  SYSTEM EFFICIENCY:
Heat Losses:
   Dry Gas Losses               (%)        3.61    3.36    3.69    5.21
   Water From Fuel Fired        (%)       10.58   10.53    10.5    10.5
   Moisture in Air Losses       (%)         .11    .099     .11     .15
   Radiation Loss               (%)         .65     .86    1.27    2.49
   Manufactures Margin          (%)           1       1       1       1
   Unburn Fuel Loss             (%)           0       0       0       0
   Total Heat Losses            (%)       15.96   15.85   16.56   19.35
Boiler Efficiency, by HHV       (%)       84.04   84.15   83.44   80.65
HHV Heat Input by Fuel  (mmBtu/h)            99   74.85   50.31    25.6
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Heat Absorbed by Steam  (mmBtu/h)        83.2   62.99   41.98   20.65

  SYSTEM DRAFT LOSSES:
Burner                    (in.WC)        5.05    2.93    1.36     .37
Silencer                  (in.WC)         .84     .49     .23    .061
Fan Inlet Ducts           (in.WC)         .28     .16    .076     .02
Fan Outlet Ducts          (in.WC)         .28     .16    .076     .02
Outlet gas Ducts          (in.WC)         .28     .16    .076     .02
Screen & Conv. Zone       (in.WC)        6.78    3.87    2.16       1
Super Heater              (in.WC)         .52      .3     .16     .07
ECON/Heater #1            (in.WC)          .9     .54     .33     .18
Total Draft Losses        (in.WC)       14.93    8.62    4.47    1.73

  FURNACE PERFORMANCE:
Liberation Rate, HHV
                     (Btu/h_ft^3)       61606   46531   31308   16020
Heat Release Rate, LHV
                     (Btu/h_ft^2)      107444   81153   54603   27940
Heat Absorbed in FNC    (mmBtu/h)        21.2    18.1    12.7       6

  SUPERHEATER PERFORMANCE:
Steam Flow                 (lb/h)       66294   49720   33147   16574
Steam Outlet Temp             (F)         889     910     909     872
Steam Inlet Temp              (F)         523     522     521     521
Steam Outlet Pressure      (psig)         805     803     801     800
Steam Inlet Pressure       (psig)         821     812     805     801
Steam Press.Drop, in tube   (Psi)       15.65    9.01    4.06    1.02
Gas outlet Temp               (F)        1651    1551    1390    1143
Overall U          (Btu/ft^2_h_F)       15.21   13.19    10.8    7.76
LMTD                          (F)        1112    1001     814     530
Heat Transfer,     Total(mmBtu/h)     16.6253 13.0393  8.6697  3.9926
       rad. from furnace(mmBtu/h)      1.0419     .87   .5669   .2046

  CONV. ZONE PERFORMANCE:
Gas outlet Temp               (F)         584     559     541     527
Overall U          (Btu/ft^2_h_F)       16.31   13.89   11.62    9.08
LMTD                          (F)         365     298     224     137
Heat Transfer           (mmBtu/h)       35.99  25.037   15.73   7.501

  ECON/Heater PERFORMANCE
Gas Flow                   (lb/h)      113932   86142   65081   45309
Gas inlet Temp                (F)         584     559     541     527
Gas outlet Temp               (F)         273     260     253     254
Water Flow                 (lb/h)       66964   50223   33482   16741
Water Outlet Temp             (F)         366     361     371     408
Water Inlet Temp              (F)         227     227     227     227
Outlet Pressure            (psig)         821     812     805     801
Inlet Pressure             (psig)         825     815     807     802
Overall U          (Btu/ft^2_h_F)        5.22    4.55    3.89    3.08
LMTD                          (F)       110.6    91.9    76.7    61.8
Heat Transfer           (mmBtu/h)      9.5321  6.9046  4.9334  3.1428
Gas Draft Loss            (in.WC)          .9     .54     .33     .18
Tube Side Press. Drop       (Psi)        4.37    2.48    1.13      .3

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FUEL and FLUE GAS DATA:
  Fuel Analysis:
  Fuel Type                           Natural Natural Natural Natural
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                                       Gas      Gas      Gas      Gas
    C                    (% wt)        73.9     73.9     73.9     73.9
    H                    (% wt)       24.35    24.35    24.35    24.35
    O                    (% wt)         .11      .11      .11      .11
    N                    (% wt)        1.64     1.64     1.64     1.64
    S                    (% wt)           0        0        0        0
    H2O                  (% wt)           0        0        0        0
    ASH                  (% wt)           0        0        0        0

    HHV                (Btu/lb)       23341    23341    23341    23341
    LHV                (Btu/lb)     21098.8  21098.8  21098.8  21098.8

  Flue Gas Analysis -
    H2O                 (% vol)       18.31    18.31     16.6    12.85
    CO2                 (% vol)        8.28     8.28      7.4     5.46
    N2                  (% vol)       70.14    70.14     70.8    72.24
    Ar                  (% vol)         .82      .82      .83      .85
    O2                  (% vol)        2.45     2.45     4.38      8.6
    SO2                 (% vol)           0        0        0        0
    Total               (% vol)         100      100      100      100

    MW of Flue Gas      (lb/mole)      27.7     27.7    27.81    28.05
    Ash in Flue Gas(lb ash/lb FG)         0        0        0        0

Altitude Above Sea Level     (ft)       630      630      630      630
Ambient Temp.                 (F)        80       80       80       80
Relative Humidity             (%)        60       60       60       60
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2. Performance for Future operation – Steam production of 90,000 PPH

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                    VICTORY ENERGY CUSTOMER SPEC SHEET

  Customer:  Columbia Pulp Project                 Date:   09/7/2017
  Reference:  VS-5-78SP SH                         Quote #: JVE 13288 Future
_________________________________________________________________________
PERFORMANCE DATA:
Boiler Load of MCR            (%)         100      75      50      25
Steam Output-SH             (lb/h)      90000   67500   45000   22500

  FUEL/FIRING CONDITIONS:
Fuel Type                             Natural Natural Natural Natural
                                          Gas     Gas     Gas     Gas
Excess Air                    (%)          15      15      15      30
Flue Gas Recirc.              (%)          30      30      30      30

  STEAM/WATER CONDITIONS:
Steam T.,NRV Outlet           (F)         861     887     914     903
Steam P.,NRV Outlet         (psig)        800     800     800     800
Boiler Sat. Temp.             (F)         526     523     522     521
Boiler Drum Press.          (psig)      837.9   821.8   809.9   802.5
ECON. Water Outlet T.         (F)         373     366     360     368
Feedwater T. to ECON          (F)         227     227     227     227

  FLOW QUANTITIES:
Percent Blowdown              (%)           1       1       1       1
Blowdown Flow               (lb/h)        909     682     455     227
Feedwater Flow              (lb/h)      90909   68182   45455   22727
Fuel Flow                   (lb/h)       5707    4316    2909    1465
Combustion Air Flow         (lb/h)     112221   84871   57190   32565
Flue Gas LVG System         (lb/h)     117929   89187   60098   34030
Flue Gas Recirc. Flow       (lb/h)      35379   26756   18029   10209
Flue Gas w/Recirc.          (lb/h)     153307  115943   78128   44239
 (FGR from Outlet of ECON/H #1)

  AIR/GAS TEMPERATURE:
Entering Air Temp.            (F)          80      80      80      80
Flue Gas Recirc. Temp.        (F)         293     274     256     243
Comb. Air/FGR Mixture         (F)         136     131     126     122
Flame Temp w/ Recirc.         (F)        2670    2666    2663    2432
Furnace Exit Gas Temp.        (F)        2158    2083    1964    1657
Superheater Gas Inlet T.      (F)        2158    2083    1964    1657
Superheater Gas Outlet T.     (F)        1755    1658    1515    1252
Boiler Exit Gas Temp.         (F)         621     586     552     528
Gas T LVG. ECON/HTR #1        (F)         293     274     256     243

  SYSTEM EFFICIENCY:
Heat Losses:
   Dry Gas Losses             (%)        3.99    3.63    3.3     3.48
   Water From Fuel Fired      (%)       10.67   10.59   10.51   10.46
   Moisture in Air Losses     (%)         .12     .11    .097      .1
   Radiation Loss             (%)         .49     .64     .94    1.84
   Manufactures Margin        (%)           1       1       1       1
   Unburn Fuel Loss           (%)           0       0       0       0
   Total Heat Losses          (%)       16.26   15.97   15.85   16.88
Boiler Efficiency, by HHV     (%)       83.74   84.03   84.15   83.12
HHV Heat Input by Fuel  (mmBtu/h)      133.22  100.75   67.89    34.2
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Heat Absorbed by Steam  (mmBtu/h)      111.55   84.66   57.13   28.42

  SYSTEM DRAFT LOSSES:
Burner                    (in.WC)           9    5.23    2.43     .66
Silencer                  (in.WC)         1.5     .87      .4     .11
Fan Inlet Ducts           (in.WC)          .5     .29     .13    .036
Fan Outlet Ducts          (in.WC)          .5     .29     .13    .036
Outlet gas Ducts          (in.WC)          .5     .29     .13    .036
Screen & Conv. Zone       (in.WC)       12.29    7.02    3.19       1
Super Heater              (in.WC)         .94     .54     .25    .074
ECON/Heater #1            (in.WC)        1.59     .93     .45     .17
Total Draft Losses        (in.WC)       26.82   15.46    7.12    2.12

  FURNACE PERFORMANCE:
Liberation Rate, HHV
                     (Btu/h_ft^3)       83026   62698   42190   21264
Heat Release Rate, LHV
                     (Btu/h_ft^2)      144802  109350   73582   37085
Heat Absorbed in FNC    (mmBtu/h)        24.9    21.4    17.2    10.4

  SUPERHEATER PERFORMANCE:
Steam Flow                 (lb/h)       90000   67500   45000   22500
Steam Outlet Temp             (F)         862     888     914     903
Steam Inlet Temp              (F)         526     523     522     521
Steam Outlet Pressure      (psig)         810     806     803     801
Steam Inlet Pressure       (psig)         838     822     810     803
Steam Press.Drop, in tube   (Psi)        27.9   16.19    7.43    1.89
Gas outlet Temp               (F)        1755    1658    1515    1252
Overall U          (Btu/ft^2_h_F)       17.67   15.34   12.54    8.77
LMTD                          (F)        1226    1119     961     667
Heat Transfer,     Total(mmBtu/h)     21.2187 16.8726 11.9192  5.8136
       rad. from furnace(mmBtu/h)      1.2621  1.0536   .8165   .4249

  CONV. ZONE PERFORMANCE:
Gas outlet Temp               (F)         621     586     552     528
Overall U          (Btu/ft^2_h_F)       19.37   16.48   13.13    9.33
LMTD                          (F)         444     370     277     159
Heat Transfer           (mmBtu/h)      51.976  36.794  21.938   8.964

  ECON/Heater PERFORMANCE
Gas Flow                   (lb/h)      153307  115943   78128   44239
Gas inlet Temp                (F)         621     586     552     528
Gas outlet Temp               (F)         293     274     256     243
Water Flow                 (lb/h)       90909   68182   45455   22727
Water Outlet Temp             (F)         373     366     360     368
Water Inlet Temp              (F)         227     227     227     227
Outlet Pressure            (psig)         838     822     810     803
Inlet Pressure             (psig)         846     826     812     803
Overall U          (Btu/ft^2_h_F)           6    5.26    4.34    3.17
LMTD                          (F)       137.6     112    86.5    62.9
Heat Transfer           (mmBtu/h)     13.6301  9.7336  6.1889  3.2961
Gas Draft Loss            (in.WC)        1.59     .93     .45     .17
Tube Side Press. Drop       (Psi)        7.98    4.52    2.04     .53

_______________________________
FUEL and FLUE GAS DATA:
  Fuel Analysis:
  Fuel Type                           Natural Natural Natural Natural
```

```
                                         Gas      Gas      Gas      Gas
    C                    (% wt)         73.9     73.9     73.9     73.9
    H                    (% wt)        24.35    24.35    24.35    24.35
    O                    (% wt)          .11      .11      .11      .11
    N                    (% wt)         1.64     1.64     1.64     1.64
    S                    (% wt)            0        0        0        0
    H2O                  (% wt)            0        0        0        0
    ASH                  (% wt)            0        0        0        0

    HHV                (Btu/lb)        23341    23341    23341    23341
    LHV                (Btu/lb)      21098.8  21098.8  21098.8  21098.8

  Flue Gas Analysis -
    H2O                 (% vol)        18.31    18.31    18.31     16.6
    CO2                 (% vol)         8.28     8.28     8.28      7.4
    N2                  (% vol)        70.14    70.14    70.14     70.8
    Ar                  (% vol)          .82      .82      .82      .83
    O2                  (% vol)         2.45     2.45     2.45     4.38
    SO2                 (% vol)            0        0        0        0
    Total               (% vol)          100      100      100      100

    MW of Flue Gas     (lb/mole)        27.7     27.7     27.7    27.81
    Ash in Flue Gas(lb ash/lb FG)          0        0        0        0

Altitude Above Sea Level     (ft)        630      630      630      630
Ambient Temp.                 (F)         80       80       80       80
Relative Humidity             (%)         60       60       60       60
```

3. Physical design data

```
  - Furnace Design Data -
Furnace Volume             (ft^3)        1633
Furnace Project. Area      (ft^2)       828.7
Furnace Effective Area     (ft^2)       747.8

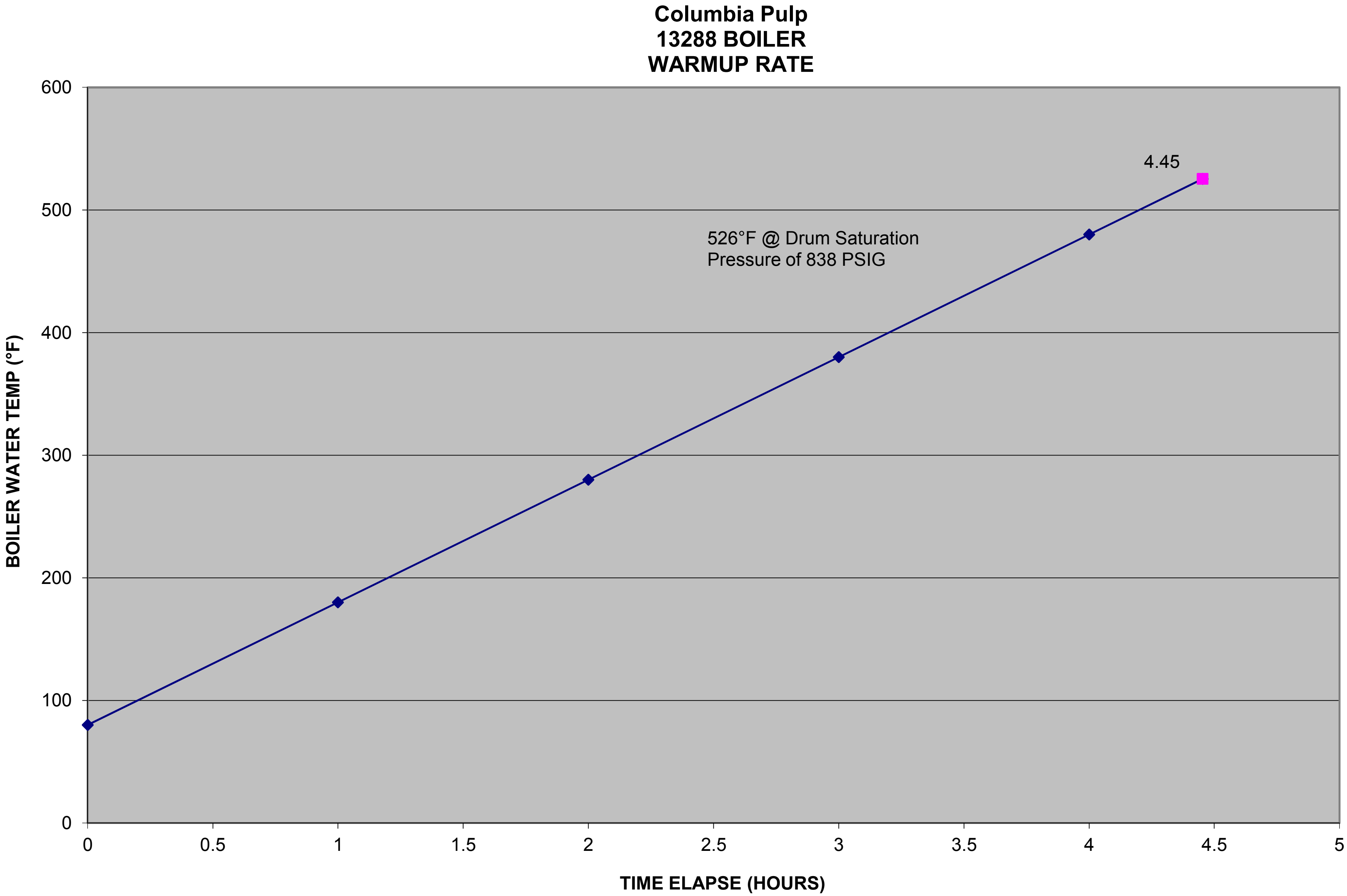
  - SUPERHEATER Design Data -
Total Heat Transfer Area   (ft^2)       980.2
Tube OD                      (in)           2
Tube MW                      (in)         .18
Tube Specification                SA-213TP304

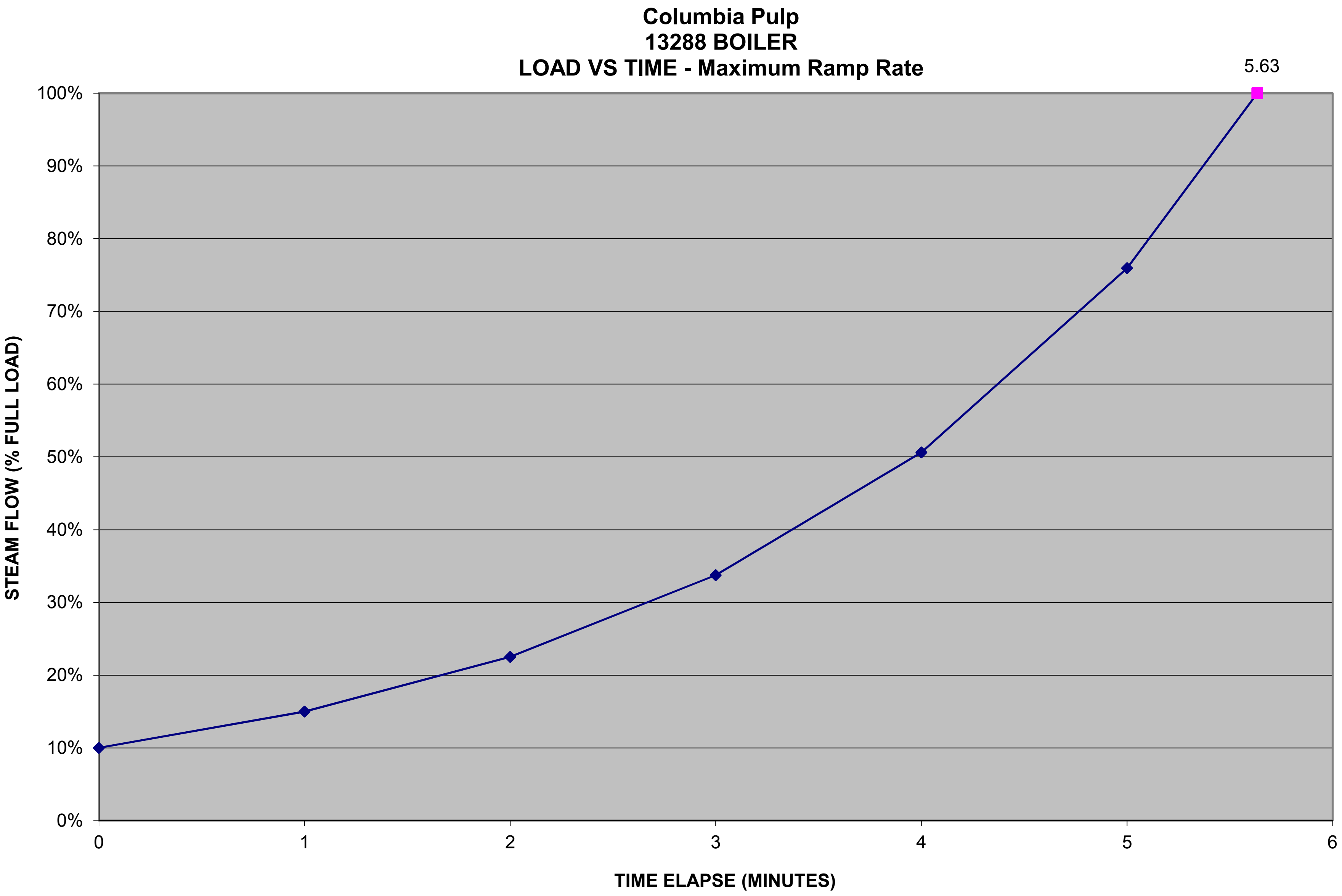
  - CONV. ZONE Design Data -
Total Heat Transfer Area   (ft^2)      6360.9
Tube OD, avg.                (in)           2
Tube MW                      (in)       .1199
Tube Specification                    SA-178A

  Economizers/Heaters Design Data -
       Economizer
Total Heat Transfer Area   (ft^2)     17380.5
Tube OD                      (in)           2
Tube MW                      (in)        .135
Tube Specification                    SA-178A
Fin Material                               CS
```

SECTION G-1b

STARTUP GUIDE
LOAD vs. TIME


Columbia Pulp
13288 BOILER
WARMUP RATE
BOILER WATER TEMP (°F)
600
500
400
300
200
100
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
TIME ELAPSE (HOURS)
4.45
526°F @ Drum Saturation
Pressure of 838 PSIG


Columbia Pulp
13288 BOILER
LOAD VS TIME - Maximum Ramp Rate
5.63
STEAM FLOW (% FULL LOAD)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
1
2
3
4
5
6
TIME ELAPSE (MINUTES)

SECTION G-2

OPERATING GUIDE

TABLE OF CONTENTS

WATER LEVEL

Rules for Operating

Probably the most important rule in the operation of boilers is to maintain water in the boiler at the proper level. Thus, it becomes highly important that water gages and water level equipment are kept clean and maintained carefully.

Gage Glass

The water column gage glass should be visible from the operating floor at all times and should be well lit for easier viewing. It is highly recommended that the gage glass be blown down at the beginning of each operating shift. This procedure not only insures free operation of the gage glass but also insures that each on-coming operator has a check on the water level. The water column should also be blown down each shift to remove accumulated boiler water sludge, which may foul the water column and cause false water level observations.

Water Column Leaks

Keep the water column and gage glass free of leaks, which also may cause false water level indication. When blowdown is completed and valves are closed, visually observe the return of water in the gage glass. Always be sure drain valves are closed tightly after a blowdown. Should a gage glass break during operation, shut gage glass valves and replace the broken glass immediately. Never attempt to operate for extended periods without visual indication of water level.

Low Water

Should difficulty arise in maintaining proper water level, it is advisable to reduce the boiler load until the condition is corrected. In the case of low water, or when water is no longer visible in the gage glass, reduce or stop firing and air supply, close all boiler dampers and allow boiler to cool. Do not change feed valve opening or try to relieve pressure by opening safety valves. It is also not advisable to attempt filling with cold water as undue stresses can set up from rapid contraction of steel.

When the boiler stops steaming, cut it off the line and investigate for damage and cause of low water. Where superheaters are installed, open outlet header drain before stop check valve closes to allow steam flow through the superheater.

FIRING EQUIPMENT

General Rules

Manufacturer's recommended operating procedure should be followed for all firing equipment during boiler operation. The following information is offered as general rules only when operating VEO boilers.

- Never attempt to light off burners without first purging furnace of any unburned gages or dust.

Oil Burners

When oil burners are used and operation at low capacities is required, operate with a reduced number of burners, thereby avoiding low fuel pressure, which induce improper oil atomization and unstable flame conditions. Consult burner-operating manual for minimum safe fuel pressures. Adjust fuel/air ratio to provide correct combustion in accordance with manufacturers' performance predictions. Burner flame pattern should be adjusted to prevent direct flame impingement on tube surfaces as well as to prevent after-combustion in the boiler convection zone. Here again, consult the burner operating manual for method of adjusting flame pattern and resulting combustion.

Gas Burners

When operating gas burners, maintain a constant check of combustion conditions should gas pressure be low. In cases of flame failure, close gas valves and purge the furnace before attempting to relight the burner. As with oil burners, operate with reduced burners at low steaming rates. Never attempt operation on automatic control at low boiler capacities. Always maintain primary air in such condition that the gas flame is burning away from the burner. Consult burner-operating manual for proper burner operation.

AIR HEATER

Rules Governing Operation

The most important rule pertaining to the operation of an air heater, as well as the boiler itself, is insuring proper operation of firing equipment to provide good combustion. Proper combustion control will prevent fouling of the air while decreasing dangers from fires due to deposits of combustible soot or condensed vapors. Gas and air temperatures should be checked often and compared to expected performance. Wide variations in temperatures will provide advance warning of air heater fouling.

Cold Air Bypasses

On some installations where very low load operation is anticipated, an air heater is sometimes equipped with a cold air bypass. At low capacities, where flue gas exit temperatures are close to or below the dew point, air through the air heater can be bypassed around the air heater. This procedure will prevent corrosion of the air heater due to condensed flue gases. Observe air heater exit gas temperatures closely and control temperature to above the dew point by proportioning air through and around the air heater.

Internal Fires

Should a fire develop in the gas passages of an air heater, shut off fuel supply to the boiler, shut down all fans, and close all air inlet dampers. Locate the fire and extinguish it with an approved fire extinguisher. Never operate soot blowers when a fire is suspected. Serious explosion may occur. Soot blowers, when installed, should be operated as needed to keep heating surface clean and during blowing. Gas velocities should be high to insure deposits are swept out of the air heater.

REMOVAL OF SOOT AND ASHES

Soot Blower Operation

The efficiency, capacity, and draft loss of a boiler installation are all dependent on the cleanliness of the heating surface. For this reason, soot blowers may have been provided to enable the operator to clean the heating surfaces. There is no set rule regarding the frequency at which soot blowers should be operated. The frequency is dependent on fuel type, load, steam temperature, and boiler arrangement. In general, frequency of cleaning can be determined by observing flue gas exit temperature rises from the boiler, air heater, or economizer.

Manufacturer's recommendations regarding the operation of soot blowers should be followed in all cases. In general, the following rules should be followed when operating soot blowers. Prior to operating, furnace draft should be increased considerably to insure sufficient draft to carry soot through the boiler. Where a unit contains an induced draft fan, furnace draft should be increased to about 0.4 inches of water. When boilers are operated with natural draft, open outlet damper full. Secondly, open soot blower piping drain valve and main condensate. The correct order of operating soot blowers is to operate first, followed by each successive pass, until all units have been operated. Rotate elements slowly until soot issuing from stack clears. When all blowers have been operated, close main steam valve and return furnace draft to the set point. Observe retractable type blowers during operation to prevent damage to boiler tubes should the element "hang-up" or fail to retract. To prevent loss of ignition, never operate soot blowers at reduced firing rates.

Ash Removal Systems

Never permit accumulation of ash in or around the boiler, ash pit, or boiler stack and, when wetting down ashes, be careful not to allow water to spray hot casting. Where suction systems are used for ash removal, be sure explosion door on storage hopper is free to operate. **Operators should stand clear when dumping ash hoppers to avoid burns from water accumulation and hot ashes.**

BOILER LEAKS

Causes of Leaks

Leakage in seams or around tubes of modern boilers is usually the result of abnormal strains created in the boiler. Some of the most frequent causes of leaks are rapid changes in feedwater temperature, overheating by allowing low water conditions, lack of free expansion, localized overheating caused by fouled heating surfaces, and extreme and rapid changes in furnace temperature.

Minor Leaks

When small leaks occur, the boiler should be shut down for repair as soon as possible to prevent scoring or erosion of the metal. An investigation should be made to determine the cause of the leak and the condition to prevent further damage.

Tube Failure

In the event of a tube failure during operations, stop burner, close air supply, and allow induced draft fan to operate with an open damper. Reduce the steam load slowly and, where applicable, vent the superheater. Maintain feedwater supply until boiler has cooled. Investigate cause of the tube failure in the presence of an authorized inspector; make necessary repairs.

Leakage Around Access Openings

Improper placing of parts, improper tightening of bolts, defective gaskets, or damaged gasket surfaces cause leakage around handhole plates and manhole plates. Aside from gently tapping around a leaking handhole plate or key cap with a soft hammer, no attempt should be made to take up any such leakage while boiler is under steam pressure. Never allow prolonged leakage around handhole and manhole plates as seating surfaces will become cut thus requiring major repair.

SCHEDULED MAINTENANCE

Daily Procedure

1. Blowdown the primary LWCO while the burner is firing. Verify that the feedwater pump cycles normally and that the burner shuts off.

2. Observe burner starting sequence and flame characteristics to verify normal behavior. Check the furnace for debris and soot. Check the burner throat refractory for damage.

3. Check safety valves, handholes and manways for signs of leakage.

4. If the burner is firing oil, check the oil storage tank level. If the burner has an atomizing air compressor, check its lubrication oil level.

5. Enter all pressure and temperature gauge readings into the operating log.

6. Check and record stack temperature. If temperature is higher than normal, check burner operation for over-firing or improper combustion.

7. Check temperature of water supplied to unit and if below preheat return as required.

8. Check water sample readings for proper chemical treatment.

9. Perform bottom blowdown at an interval set by the chemical representative.

Weekly Procedure

1. Check combustion control operation. Investigate and correct any failure.

2. Check the pressure limit shutdown. During this check, observe the operation of the programming control to make sure that the operation is as described in the sequence of operation section of the service manual.

3. Wipe the entire unit, particularly the operating parts, so that oil and dust do not accumulate.

4. If firing heavy oil, clean oil nozzle as detailed in burner manufacturer's instructions. Nozzle and electrode setting must be returned to original adjustments.

5. Check chemical feed equipment against check list supplied by water treatment company. Treatment should be introduced directly into the boiler or device located on discharge side of the feedwater pump.

6. Check auxiliary LWCO to verify that it shuts burner off.

Monthly Procedure

1. Clean feedwater strainer between the pump and the condensate return tank.

2. Clean the air intake filter on the atomizing air compressor, if present. Replace filter oil with clean compressor lubricating oil.

3. Clean combustion air fan and air inlet assembly.

4. Check rear door for flue gas leaks and tighten bolts as required. Tighten bolts evenly. Uneven tightening could cause leakage.

5. Check air flow and fuel pressure switches.

6. Clean scanner lens.

Semi-Annual Procedure

1. Cool boiler slowly to room temperature. (110° F minimum) **NOTE:** Failure to cool boiler slowly will possibly cause tubes to leak. **This is very important!** To assist cool down use the Test/Run or Check/Run switch located on the programmer to run the blower.

2. Remove all the nuts and clamps around the rear door flange, pry the door loose from the boiler and remove it from the boiler.

3. Check refractory and patch any cracks or spalled areas with high temperature cement. Refractory may be obtained from the factory.

4. Always replace the 1” ceramic fiber seal around the edge of the rear refractory with a new seal when rear door is opened and gasket is damaged.

5. Tighten rear door nuts evenly to take up any slack created through drying out.

6. Clean the peep sight glass or replace if required.

7. If boiler is used for a steam process with a high percentage of feedwater makeup, follow the Annual Procedure – items 2 & 3.

8. Clean and adjust the pilot assembly.

Annual Procedure

1. Follow steps 1 through 8 listed under “Semi-Annual Procedure”.

2. Clean water side of boiler as follows:

    - Open upper tri-cocks and any other available vent valves to prove that the boiler contains no steam.

    - Drain the boiler through the blowdown valve.

    - Remove all handhole covers and the manhole cover.

    - Inspect shell and tube surfaces for signs of corrosion or scale formation. If scale is forming to any degree on internal surfaces, the chemical treatment is not correct. Consult chemical supplier.

    - Remove plugs from low water cutoff equalizer crosses and rod piping if scale is present.

    - Remove low water cutoff head and clean chamber. Reassemble with new gasket.

    - Using new gaskets, install the handhole covers and manhole cover.

    - Disconnect the piping on the discharge side of the feedwater pump and inspect for scale build up. Check stop and check valves for proper operation and replace if necessary.

    - Install new safety valves of proper pressure and capacity rating. Old valves may be refurbished by a reputable valve repair company in possession of a VR stamp and kept as spares.

    - Fill the boiler by means of the feedwater pump and reset the low water cutoff.

3. At the time of this yearly inspection and cleaning, it is recommended that the local state or insurance inspector, boiler supplier distributor, or agent be called in to check the condition of the equipment. The chemical supplier should also be present.

If Burner Does Not Start – Check For Controller Fault Codes

1. Check all electric fuses.
2. Check water level in boiler.
3. Check limit controls to make sure they are making circuit.
4. Push motor or starter rest button.
5. Push reset button on the programming control.
6. Push reset on high and low gas pressure switches.
7. Push reset button(s) on LWCO and temperature devices. If burner then fails to start, call a qualified service technician.

To Stop Burner

1. Switch off burner control switch or push emergency door switch.
2. Do no pull feedwater pump switch until boiler is cooled.

SECTION G-3

WATER TREATMENT

TABLE OF CONTENTS

SAFETY WARNINGS

The following is a personnel and equipment warning which is to be observed while operating or servicing a boiler.

WARNING: WHEN AN INERT GAS IS USED TO BLANKET INTERNAL SURFACES OF A BOILER, MAKE CERTAIN THAT THERE IS SUFFICIENT OXYGEN TO BREATHE INSIDE BEFORE ALLLOWING PERSONNEL TO ENTER. INSUFFICIENT OXYGEN IN A CLOSED SPACE CAN CAUSE DEATH. (PAGE 84)

INTRODUCTION

The purpose of boiler system water treatment is to:

- Prevent hardness scale or any other insulating type deposits from accumulating on the inside of boiler tubes.
- Prevent corrosion of the waterside of boiler tubes, headers, and drums.
- Prevent boiler water carry-over from the steam drum.

Obtaining long-term good service from a boiler depends on correct water treatment. Those responsible should understand interrelations between the boiler and auxiliary equipment and must maintain constant watch over and control boiler feedwater contamination and boiler water chemistry.

Boiler system water treatment includes:

- Operating water softeners or demineralizers that remove contaminants from water entering the boiler systems.
- Injecting chemicals into the boiler to prevent hardness, scale, deposits, and corrosion.
- Testing boiler water and steam condensate samples to document water quality and to control chemical additions.
- Documenting boiler operations and sample analysis and maintaining comprehensive records that can be used to optimize water treatment.

Feedwater and boiler water treatment should be considered all through the life of a boiler, starting with planning for a new boiler system and continuing as it is being constructed, when it is being started up for the first time, when it is being operated normally, and when it is taken out of service. At any time, there are water treatment factors that will affect a boiler's performance and availability for operation.

This section of boiler operating instructions is to draw attention to important aspects of boiler system water treatment and to present industry-accepted data and concepts which can be helpful to those who have responsibility for, or who are interested in proper boiler system water treatment.

PLANNING FOR WATER TREATMENT

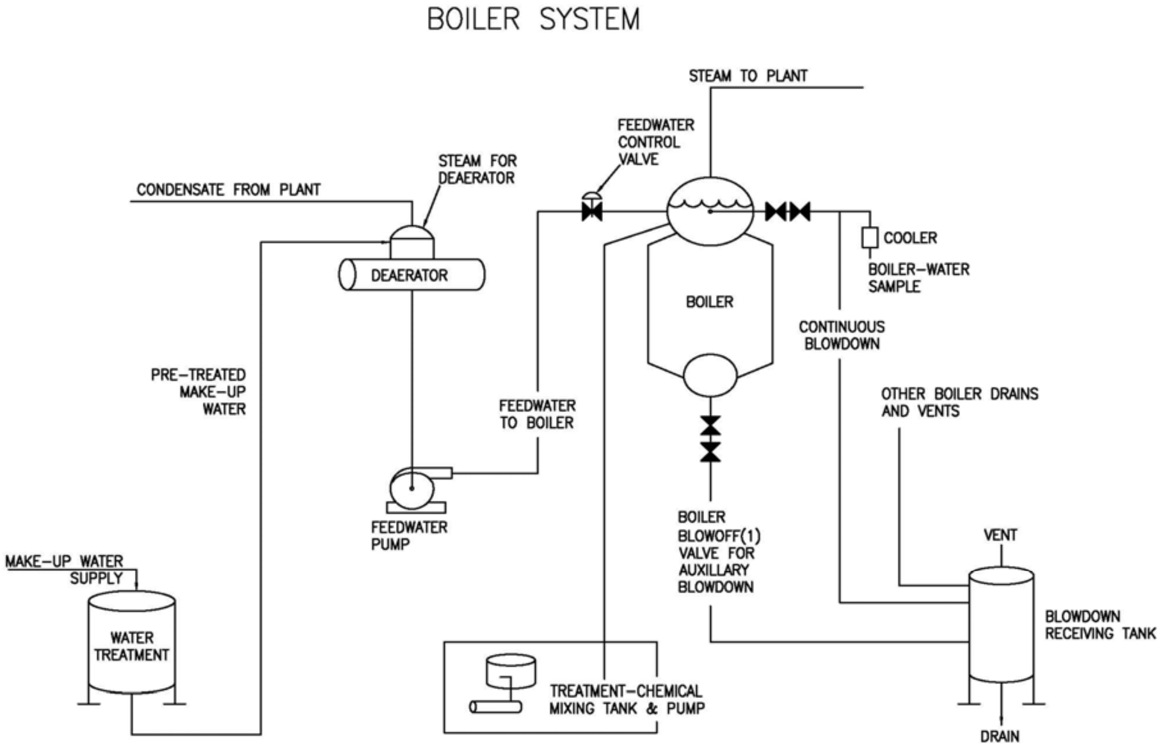
There are fundamental relationships that relate operational factors of steam flow to feedwater, feedwater flow to condensate being returned, and to make up water required. A typical boiler system is shown schematically on the next page. The diagram shows:

- Feedwater equals steam from the boiler plus blowdown.
- Feedwater less condensate being returned equals make-up water.
- Contamination in feedwater is the weighted average of contaminants in make-up and condensate.
- Contaminants carried into the boiler with feedwater equal contaminants in boiler blowdown.

Feedwater is a combination of make-up and condensate. Condensate is condensed steam and will have fewer contaminants than make-up so that feedwater that has more condensate will have less contamination. But, if there is less condensate and more make-up, feedwater concentrations will be greater. Whether it is better to treat make-up by dissolved solids by demineralization can be decided by comparing cost of blowdown against cost of make-up water treatment.

Blowdown, which means extracting some boiler water from an operating boiler, is the means of controlling boiler water concentrations.

FIG G3-1



How much blowdown is required depends on allowable boiler water concentrations. It will be seen that:

- To maintain boiler water concentrations, boiler feedwater that has more condensate and less make-up will have less blowdown.
- Higher boiler steam pressures require lower boiler water concentrates and blowdown will be greater unless contamination in feedwater is reduced.
- Demineralizing, rather than softening make-up water can reduce blowdown, since make-up will have less contamination and because silica iron, and sodium are reduced.

In planning a boiler system treatment, boiler water concentrations of dissolved alkaline and suspended solids are determined by the American Boiler Manufacture's Association (ABMA) guidelines as well as feedwater quality. (See "ABMA Boiler Water Concentrations" and "Feedwater Quality Limits,").

ABMA GUIDELINES

American Boiler Maker Association (ABMA) has endorsed boiler water concentration guidelines based on industry-wide experience in achieving required steam purity. Boiler water concentration guidelines are referenced to boiler operating pressure (steam drum pressure) and different levels of steam purity ranging from 0.1 to 1 part per million parts (ppm).

The principle limiting factor for boiler water concentrations is dissolved solids. Dissolved solids are those inorganic materials in the boiler water whose concentration can be measured by determining electrical conductivity, the inverse of resistivity.

ABMA guidelines also set a relationship between alkalinity and dissolved solids to limit foaming tendencies. (See Alkalinity below) Guidelines also limit suspended solids concentrations.

For each step of boiler operating pressure up to 1000 psig steam drum steam pressure, a range of total dissolved solids and alkalinity is shown. Lower concentrations are for greater steam purity of 0.2 ppm total solids in steam at lower pressure and 0.1 ppm at high pressures. Higher concentrations are indicated for steam purities of 1 to 0.5 ppm. Consult boiler data for actual levels.

Following ABMA guidelines requires that boiler water total solids and total water alkalinity be controlled to less that maximum. Either factor may be limiting and would be controlled by blowing down.

FIG G3-2

ABMA BOILER WATER CONCENTRATIONS

	Range of Boiler Water Concentrations, ppm			Total Dissolved Solids in Steam, ppm (maximum-expected)
Drum Pressure psig	Total Dissolved Solids in Boiler Water	Total Alkalinity in Boiler Water	Suspended Solids	
0-300	700-3500	140-700	15	
301-450	**600-3000**	**120-600**	**10**	**0.20-1.0**
451-600	**500-2500**	**100-500**	**8**	**0.20-1.0**
601-750	**400-2000**	**80-400**	**3**	**0.200-1.0**
751-900	**300-1500**	**60-300**	**2**	**0.1-0.5**
901-1000	**250-1250**	**50-250**	**1**	**0.1-0.5**
1001-1800	**100**	**(1)**	**1**	**0.1**

BOILER WATER SILICA CONCENTRATION

In some cases, boiler water silica concentrations can be the controlling factor for blowdown, especially when there is more make-up and less condensate in feedwater.

In low pressure boilers, boiler water silica concentrations should be controlled, since it has been found that silica will combine with precipitated hardness and other feedwater suspended solids contaminants, forming deposits on the inside of boiler tubes which are difficult to remove.

At higher steam pressures, silica will vaporize and carry along with steam. As steam is expanded and pressure decreases, silica will deposit on turbine blades affecting turbine performance.

Based on operating experience over a range of operational pressures, silica concentrations in boiler water should be limited as shown below.

FEEDWATER QUALITY

Feedwater will contain dissolved, suspended solids, silica and other contaminants from condensate and make-up water. Dissolved solids, alkalinity, suspended solids, and silica can and must be controlled by boiler blowdown. Feedwater contamination from dissolved and suspended iron and copper stemming from corrosion of upstream equipment must be limited by other factors. To prevent corrosion in the boiler and other parts of the system in contact with feedwater - the economizer, for example – and to avoid deposits in the boiler feedwater hardness concentrations, iron and copper oxide concentrations, oxygen content, and pH should be controlled to be in line with accepted limits. VEO recommends guidelines as per Fig G3-2 and Fig G3-4 for boilers.

FIG G3-3

Recommended Maximum Silica Concentration in Boiler Water

Steam Drum Pressure psig	Silica Concentration ppm		Steam Drum Pressure psig	Silica Concentration ppm
100	100		900	15
200	80		1000	10
300	65		1100	7
400	55		1200	5
500	45		1300	4
600	35		1400	3
700	25		1500	2
800	20		1600	1

Hardness

Treating make-up water to remove hardness using sodium zeolite softeners will reduce hardness to trace levels. However, hardness in the treated make-up water will be greater at the end of softener “run” before regeneration and for a period of time after a softener has been returned to service after regeneration. Feedwater hardness must be limited at all times since there is limited effectiveness of chemicals used to prevent scale and deposits.

For higher pressure boilers, lower boiler water concentrations must be maintained, requiring make-up water to be demineralized. Ion exchange and reverse osmosis processes will eliminate hardness so that, at pressures higher than 1000 psig it is better to demineralize make-up water. Operation of demineralizers is based on removing dissolved solids. Regeneration and rinsing after generation will not increase hardness, which will be consistently controlled to trace quantities

Iron and Copper

Iron and copper in boiler feedwater will be mostly suspended solids, with only small amounts dissolved. Iron and copper can come from water used for make-up or can be products of corrosion of piping systems, valves, pumps, and any other equipment upstream of a boiler that handles make-up and condensate.

In the boiler, iron and copper from feedwater will tend to form layered deposits on tube surfaces, favoring high heat zones such as furnace water walls. In lower pressure boilers, iron and copper deposits will elevate tube overheating. In higher pressure boilers, iron or copper deposits on tube surfaces can become “concentration cells” allowing boiler water chemicals to become highly concentrated, eventually eroding tube metal. Studies have shown that iron and copper deposition in a boiler cannot be satisfactorily controlled by boiler blowdown, meaning concentrations in boiler feedwater must be limited by specific treatment of make-up and/or reducing corrosion of steam and condensate piping systems.

Experience has shown that at higher pressures and higher saturation temperatures problems with iron and copper will be more acute and less iron and copper should be allowed in boiler feedwater.

Oxygen

Oxygen in the air that is dissolved in water will rust and corrode steel parts of a boiler system and can accelerate corrosion of copper containing materials. Piping, valves, economizer and the boiler can be seriously damaged if oxygen concentrations in water that contact steel parts are not reduced to trace values. In designing and operating a boiler, there has to be attention to expelling air and oxygen from boiler feedwater.

pH

Feedwater pH must be controlled to prevent corrosion of piping systems, economizer, and the boiler. At higher pressures and higher saturation temperatures, corrosion will be accelerated, increasing alkaline pH requirements for boiler feedwater.

Based on long term industry-wide experience, recommended feedwater quality limitations are noted below:

FIG G3-4

Recommended Boiler Feedwater Quality Limits

Parameter	Boiler Operating Pressure, psig		
	Below 600	**600 - 1000**	**Above 1000**
Hardness, ppm, as CaCO3	0 (1 ppm temporary max)	0 (1 ppm temporary max)	0
Iron, ppm	0.1	0.05	0.01
Copper, ppm	0.5	0.03	0.005
Oxygen, ppm	0.007	0.007	0.007
pH, units	7.0 to 9.5	8.0 to 9.5	8.5 to 9.5

EXTERNAL AND INTERNAL BOILER SYSTEM WATER TREATMENT

Boiler system water treatment involves external treatment, which comprises all things done outside the boiler to prevent corrosion and deposition, and internal treatment, which is chemical additions and management of boiler water chemistry.

EXTERNAL TREATMENT

Raw Water Treatment

“Hardness” meaning calcium and magnesium compounds that contain silica will be found in any natural source of water. Hardness, silica, or any other scale forming compounds not removed from raw water will contaminate boiler feedwater. Make-up water treatment must reduce these compounds to trace quantities.

Make–up water treatment technologies can be ion-exchange processes such as sodium zeolite softeners or demineralizers, or they can be molecular sieves such as reverse osmosis.

Zeolite softeners are most commonly used for boilers with operating pressures up to 1000 psig because they have lower operating costs and will provide satisfactory water quality. Softeners will control hardness to very low levels, but will not reduce dissolved solids; higher alkalinity, and higher silica concentrations, blowdown is not a significant cost factor. On the other hand, if there is little condensate and a high proportion of make-up water it may be better to consider demineralization to reduce blowdown.

Demineralization or reverse osmosis must be used to reduce dissolved solids, alkalinity, and silica. Demineralization or reverse osmosis will eliminate hardness and control dissolved solids, silica, and alkalinity.

Make-up treatment may have several stages, such as filters to remove suspended materials, filters with special filter media to remove organic materials and chlorine. A make-up system can include a degasifying system to reduce alkalinity.

Proper design of a make-up water treatment system will consider:

- Control of fouling chemicals in raw water that could affect the capability of the treatment processes.
- Seasonal variations of raw water analysis.
- Maximum possible flow rates, taking into account possible loss of condensate return or water quantities needed for some other special operation or emergency situation.
- Operator interfaces such as automatic operation, instrumentation, personnel protection, isolation of regeneration chemicals.
- Frequency of regeneration.
- Personnel safety and equipment protection against demineralizer regeneration acid and caustic.

Deaeration

Air becomes much less soluble in water as temperature increases. A deaerator reduces oxygen by taking advantage of decreased solubility in the presence of steam to separate air from boiler feedwater and vent it to atmosphere.

In a deaerator feedwater is heated to saturation temperature at some pressure above atmospheric pressure, typically just a few pounds per square inch, gauge. Feedwater is exposed to steam by spraying it or by distributing it over multiple layers of cascading trays or allowing it to flow over chemical processing type packing in a steam environment. As water is heated, air separates and passes into the steam phase; and then, because it is denser, air is concentrated by gravity and removed through a vent to atmosphere. A deaerator's air removal capability is stated as the concentration of dissolved oxygen in water leaving.

A deaerator will be combined with a water storage tank maintained at the deaerator steam pressure. Typically, the deaerator storage tank water level is used to detect need for make-up water. Make-up water flow to the deaerator is modulated to control deaerator water level. Deaerator storage is made large enough to allow continued operation of the boiler system for several minutes if condensate being returned and/or make-up water flow is interrupted and is less than required. The deaerator and deaerator storage tank usually are set at an elevation higher than boiler feedwater pumps to increase pressure at the pump suctions to prevent cavitation.

Deaeration is a requisite to avoid rapid devastating corrosion that will occur within a boiler system when feedwater contains higher levels of dissolved oxygen.

It is important to minimize boiler operation when feedwater has not been deaerated. At starting up a boiler system, when there is no other source, deaerator-pegging steam should be taken from the boiler as soon as boiler pressure rises above atmospheric.

Chemicals can be injected into feedwater or into the boiler water that will reduce the effects of trace quantities of air in feedwater. Oxygen scavenging chemicals will increase protection against oxygen corrosion, but have limited capability to remove oxygen and should not be used in lieu of a deaerator.

INTERNAL CHEMICAL TREATMENT

Hardness Control

Internal treatment chemicals will either precipitate hardness forming suspended solids or capture hardness and keep it in solution. Precipitating chemicals, typically sodium phosphate, will react with calcium and magnesium compounds, forming precipitate, which circulates with the boiler chemicals, keeping them in solution in the boiler water until being blown down.

Many proven boiler water treatment programs depend on maintaining a chemical reserve in boiler water available to react with feedwater hardness. If concentrations of hardness reacting on higher heat absorbing zones of the boiler and, within hours, usually lead to tube damage. It is vital to a boiler's continued good operation to make sure that hardness chemical concentrations are never fully depleted.

Alkaline Conditions

Internal chemical treatment programs will maintain boiler water within a range of alkaline pH to prevent corrosion and to favor reaction with hardness.

Boiler water alkalinity can be measured by relative alkalinity measurements, either phenothalein ("P") or methyl orange ("M") alkalinity.

Phenothalein alkalinity is a measure of hydroxide or caustic alkalinity. It is representative of how much sodium hydroxide would be found in concentrated chemical residues if a sample of boiler water were completely evaporated. In most internal treatment programs, minimizing "P" alkalinity is important. Highly concentrated caustic chemicals are corrosive to steel. It is possible even in a well-maintained boiler to have concentration cells, especially iron or copper deposits, on internal surfaces of tubes.

Methyl orange alkalinity is a measure of all alkaline chemicals in a sample of water. "MO" alkalinity is measured and controlled in boiler water to maintain a ratio to dissolved solids to control foaming tendencies of circulation boiler water.

Boiler water pH is also used to track alkalinity and corrosiveness of boiler water. pH of 7 is neutral, but water with pH of 7 is very corrosive to steel. To control corrosion, boiler water pH should not be allowed to fall below 9 and should be maintained between 9.5 and 10.5. At pH levels greater than 10.5 there will be increased tendency for boiler water to "foam" which could affect steam separation and steam purity. At pH values lower than 9.5, there will be less chemical reserve to guard against excursions during upset operations and there may be less favorable conditions for reactions with trace quantities of hardness.

Protection from Corrosion

Alkaline chemicals, called amines, that are volatile at boiler water temperatures, may be injected into condensate, feedwater, or boiler water to reduce and to control corrosion of steam and condensate systems. Because they are volatile, they will carry along with steam and will not concentrate in boiler water. Steam has a neutral pH and can be corrosive where it condenses. A volatile chemical will buffer steam condensate to be alkaline and will significantly reduce corrosion of condensers, pumps, valves, piping, and feedwater equipment, greatly reducing iron and copper in boiler feedwater. Volatile chemicals will not cause deposits in a boiler or on turbine blades or condenser.

The result of corrosion within steam and condensate systems is iron and copper oxides that will be carried back to the boiler in feedwater. Maintaining iron and copper oxides below recommended limits will allow long periods of operation without deposits. In most cases, without chemical injections to minimize recommended limits of iron and copper in feedwater cannot be obtained.

Several volatile chemicals have produced favorable results for steam side corrosion protection. A water treatment specialist can recommend and help determine those chemicals that are best suited for a steam generating system.

Each steam and condensate system will be slightly different in regard to controlling feedwater iron and copper. It may be necessary to try different treatment schemes to find which gives the best results. This sort of study can be done only if comprehensive water analysis records are maintained and reviewed. When evaluating results of different chemical treatments, it is important to remember that corrosion is an equilibrium condition. Changes should be made gradually, because if treatment is changed suddenly, equilibrium will be upset, causing unnecessary contamination of boiler feedwater and higher than desired levels of iron and copper.

Consulting Services

The service of experienced water treatment specialists is essential to develop and oversee basic chemical treatment programs, to train people responsible for analysis, and to be available for reference and advice.

When selecting a specialist cost should not be the sole factor in making a choice. Selecting a water treatment specialist should include evaluating factors such as how the treatment company is represented locally; what support services are available, such as laboratory facilities for special investigations; and whether there are other satisfied customers.

For a specific boiler system, there are many factors involved in selecting a boiler system chemical treatment program beyond the control and knowledge of VEO. Therefore, VEO will not intentionally condemn a water treatment program or treatment chemical unless there is consistently poor experience with it, nor will VEO intentionally favor one successful proven water treatment program over another.

Water Treatment Records

Records of water analysis and water treatment status reports are an essential part of boiler system operation.

Water analysis from critical points in the boiler system must be made often enough:

- To judge the performance and proper operation of the make-up water treatment system
- To adjust blowdown
- To set the rate of chemical injection for boiler water, steam, and condensate treatment

The frequency of water sampling and analysis depends upon operation. A boiler operated at constant steaming rates (base loaded) or when rates of change are low, such as heating steam applications, does not require sampling more than once per day. On the other hand, boilers that are cycled on and off line, or where steam generation rates vary widely and frequently should be sampled more often and perhaps as frequently as once per shift.

CARE OF A BOILER'S WATER AND STEAM CONTACTED INTERNAL SURFACES

Keeping basic concepts in mind is helpful in planning and managing the water treatment program intended to keep a boiler's internal surfaces free from troublesome corrosion, damaging scale, or excessive deposits. These could affect good operation and the life of the boiler.

Steel is the Basic Construction Material for a Boiler

Water will corrode iron, steel, and most steel alloys if oxygen is present or if the pH (alkalinity) of water in contact with the metal is less than 8.5. Either oxygen or low alkalinity water will destroy a protective oxide, a film that builds up on parent metal with the right conditions of alkaline pH, oxygen free water.

The protective oxide film is a black-gray coating of magnetite, “black” iron oxide, which is ferrous oxide, a form of iron oxide that is less oxidized than rust. When internal surfaces of a properly treated boiler are inspected out-of-service, it is normal to find a slight excess of black iron oxide that can be brushed off dry surfaces.

Maintain Close Attention to Deaerator Operation

Proper system design and operation take full advantage of a deaerator's ability to remove and to control oxygen in feedwater. Starting up procedures should call for admitting steam to the deaerator and increasing deaerator pressure above atmospheric pressure as soon as there is positive steam pressure in the boiler. At all times during boiler system operation, maintaining deaerator pressure must be given high priority.

In the operating life of a boiler system, at every opportunity during the first year of operation, the boiler and all boiler system components should be inspected for signs of oxygen pitting or other corrosion. After the first year of operation, and when there have been no signs of problems, the frequency of inspection of the boiler system components can be reduced to once per year. If corrosion damage is found or if other suspicious conditions are found, the findings should be documented and tracked at all subsequent inspections.

Boiler Systems with no Deaerator

A pressurized deaerator is sometimes called an "open" feedwater heater. It is possible to have a boiler system where air and oxygen are purged from feedwater in a vacuum system, such as a turbine steam condenser. Oxygen levels in condensate leaving a condenser can be almost as low as a pressurized deaerator. It is imperative that air inflow, or the possibility of air inflow, into a vacuum system are kept very low by comprehensive inspection, repair, and replacement of turbine steam seals, piping connections, and expansion joints between the turbine and condenser.

Chemical Oxygen Scavengers can be Effective

Chemical oxygen scavengers can be used to react with residual amounts of oxygen in feedwater. Chemical treatment to minimize oxidizing conditions will produce positive benefits, especially when the boiler system must respond to transient operation. Water treatment specialists should be asked to review the chemicals that would be best suited for a particular boiler system.

Loss of Deaerating Capability

Oxygen damage of a boiler's steel components occurs very rapidly and can lead to a substantial loss of service life. An emergency shutdown of the boiler system should be considered if:

1. Deaerator pressure cannot be maintained
2. Condenser vacuum cannot be maintained

If the ability to expel air and oxygen from feedwater is lost, immediately initiate or increase the rate of injection of an oxygen-scavenging chemical.

When a boiler is taken out-of-service and will be drained to allow maintenance or inspection, it is better to drain the boiler when it is still warm in order to dry internal surfaces. If the boiler is to remain off line and is not to be open for inspection or maintenance after the boiler is drained, drain valves and vent valves should be closed to prevent moisture condensation. Drains or vents that are connected in common with other boilers should be closed to prevent back flow into the idle boiler.

When the boiler is drained, it is recommended that it be drained under and left slightly pressurized at 1 to 5 psig with an inert gas blanket. A commonly available inert gas is moisture free nitrogen.

WARNING: WHEN AN INERT GAS IS USED TO BLANKET INTERNAL SURFACES OF A BOILER, MAKE CERTAIN THAT THERE IS SUFFICIENT OXYGEN TO BREATHE INSIDE BEFORE ALLOWING PERSONNEL TO ENTER. INSUFFICIENT OXYGEN IN A CLOSED SPACE CAN CAUSE DEATH.

Protect Internal Surfaces Against Acidic Conditions

Make-up water treatment with zeolite softeners will not reduce alkalinity, and thus naturally produces alkaline feedwater and boiler water. However, using dealkalizers or demineralizers for make-up water treatment or where there is a high proportion of condensate will reduce make-up water alkalinity and there will be a tendency for low boiler water pH that must be counteracted with boiler water treatment chemicals. Internal treatment chemicals can be selected either to reduce boiler water alkalinity when feedwater alkalinity will not maintain pH levels above 10.

Sudden and drastic changes to a much lower pH can occur when condensate is contaminated with acid or acidic materials or when, by error, acid used for demineralizer regeneration leaks into make-up water. Sudden and significantly lower boiler water pH requires immediate action, because corrosion damage can occur in a very short time. If pH values become neutral, pH 7 or acidic, pH less than 7, there must be swift and dramatic action to prevent or to control corrosion damage.

If Boiler Water pH is Found to be Less than 9:

1. Immediately confirm pH monitor reading
2. Continue to measure pH to detect changes and to note the effect of other action until pH readings return to the normal range.
3. Immediately adjust chemical feed to favor higher pH by injecting treatment chemicals that are more alkaline.
4. Identify and isolate the source of low pH water, such as make-up water, condensate, or chemical leak.
5. Consider shutting the boiler system down to prevent extensive damage if, after 4 hours, boiler water pH has not been restored to pH 9 or higher and the cause of the low pH has not been identified and isolated.

Scale and Deposits on Internal Surfaces must be Prevented

Care of internal surfaces of a boiler includes prevention of scale or deposits on the heat transfer surfaces. Scale is hard and dense, will retard heat transfer, and is the primary cause for the tube overheating and failure. Deposits are softer porous materials that will promote corrosion that can lead to tube failures. The primary cause of scale is unreacted hardness entering the boiler with feedwater that is not controlled by boiler water treatment chemicals. Deposits are usually from iron and copper or other suspended materials from make-up or condensate carried into the boiler with feedwater.

Typically, make-up water treatment will reduce hardness to trace quantities, but there will be a certain amount of hardness entering the boiler. If left uncontrolled, hardness forms a very insulating type scale on tubes in the high heat zones of a boiler within a very short period of operation. Boiler water chemical treatment programs are very effective in preventing scale, but depend on having a residual of treatment chemicals in boiler water. If boiler water concentrations of the hardness reacting chemical are depleted during transient or upset operation because of inadequate make-up treatment or condensate contamination, there must be immediate action.

If no hardness reacting chemical residual can be found in the boiler water:

1. Immediately increase the rate of chemical injection
2. Identify and isolate the source of higher hardness containing water
3. Shut down the boiler if chemical residuals have not been restored within 24 hours and the source of higher hardness water has not been isolated.
4. Inspect the boiler if it has operated with uncontrolled hardness and consider chemical cleaning to restore proper heat transfer in high heat zones.

Suspended or dissolved iron and copper is either from iron and copper that has not been removed from raw water in the make-up treatment system or from corrosion within the steam and condensate system, which produces iron and copper oxides that are carried into the boiler with feedwater. Iron and copper will deposit on heat transfer surfaces in the higher heat zones of a boiler. Left uncontrolled, the deposits can form concentration cells in contact with tube metal that will lead to very high concentration of boiler water chemicals, which can lead to corrosion damage.

Some of the suspended iron and copper will remain suspended in boiler water and can be removed by blowdown, but it is better to minimize the amounts carried into the boiler. In addition, it is better to select boiler water treatment chemicals that, in a highly concentrated form, will be less corrosive to steel. Also, since highly concentrated caustic will be corrosive it is better to control and minimize the caustic alkalinity of boiler water. In some cases, where raw water, iron and copper concentrations cannot be controlled, it may be necessary to have iron removal processes associated with make-up treatment. For all boiler systems, there should be considerations of using steam and condensate treatment chemicals to control condensate systems with higher operating pressures and longer on-line periods, condensate iron removal filters should be considered. Caustic, sodium hydroxide, and most chelant type chemicals at high concentrations will quickly corrode steel.

If porous deposits are allowed on water contacted surfaces in higher heat zones, boiler water caustic can be concentrated to high enough levels to cause destructive corrosion. Boiler water treatment chemicals should be selected and controlled so that “free” caustic is at low levels and chelant residuals are as low as possible.

The internal surfaces of the boiler should be inspected routinely to find, document, and track iron deposits that could lead to corrosion damage. If excessive deposits are found it may be necessary to chemically clean the boiler to maintain on line availability.

Boiler System Water Treatment Trouble Shooting Guide

Symptom	Possible Causes	Action
Sudden increase of boiler water concentrations	Make-up water treatment failure	Increase continuous blowdown.
	Condensate contamination	Use supplemental blowdown to restore concentration to proper levels
	Excessive treatment chemical injection	Increase frequency of analysis until normal conditions are restored.
		Find source(s) of contamination by sampling other than normal points in system.
	Improperly diluted treatment chemicals	Isolate source of contamination.
	Raw water leak into system	Check chemical feed pump operation.
		Check treatment chemical dilution.
Sudden decrease of boiler water concentrations	Boiler tube leak	Reduce continuous blowdown.
	Leaking boiler drain valve	Investigate boiler tube or boiler drain valve leak.
	Improperly diluted chemical feed	Check rate of make-up and condensate flow.
		Check chemical feed pump operation.
	Excessive condensate demand	Check treatment chemical dilution.
Finding more than a trace of hardness in boiler water chemicals **Greater demand for hardness treatment**	Make-up water treatment bypassed	**<u>Very Important</u>** - Confirm sufficient hardness treatment chemicals are being injected.
	Make-up water treatment failure	Check water analysis technique and testing reagent chemicals
	Contamination in condensate	Check operation of make-up water treatment.
	Chemical feed problem	Check for condenser cooling water leaks
	Raw water leak into boiler system (steam turbine condenser cooling-water leak)	Consider shutting down if hardness treatment chemical residues cannot be maintained.
	Faulty analysis or contaminated sample (sample cooler cooing-water leak)	Check chemical feed pump operation.
		Check treatment chemical dilution.

Symptom	Possible Causes	Action
Sudden increase of boiler water alkalinity, pH, to very high values, above pH 11 **Sudden decrease of boiler water alkalinity, pH, values below pH 9**	Make-up water treatment failure	**<u>Very Important</u>** - Immediately confirm reading. Use another technique or instrument to confirm pH measurements.
		Immediately begin to feed caustic chemicals to restore pH, if low pH is confirmed.
	Condensate contamination	Increase frequency of analysis until normal conditions are restored
		Use fresh chemical analysis reagents.
		Check regeneration chemical systems for leaks
	Improper chemical analysis	Analyze make-up water
		Discard treatment chemicals - prepare new batch
	Raw water leak into system	If pH is high feed less caustic chemicals
		If pH is too low immediately feed strongly alkaline chemicals - caustic soda
	Demineralizer regeneration acid leak	Consider shutting down, draining and filling boiler with alkaline water, if pH is too low and is not restored to higher values immediately.
Boiler water sample: Colored red or black turbidity contains oily material	Make-up contamination	Analyze suspended or dissolved material
	Condensate contamination	Increase sample frequency to document trends
	Make-up treatment equipment	Check condensate treatment chemical dilution
		Confirm condensate pH is alkaline
	Sudden change of boiler water alkalinity	Check raw water make-up source for unexpected changes
	Sudden change for make-up water	Confirm operation of make-up pre-filter
	Hot restart after tripping off line	Check for condenser cooling water leaks
	Low boiler water pH incident	Check for sample cooler cooling water leaks

APPENDIX

Useful Terms and Definitions Involved with Boiler System Water Treatment

The following information may be useful to help understand and use water analysis for boiler system water treatment.

Concentration

The most common analytical term used to describe water samples is “concentration”, which can refer to the amount of dissolved solids or suspended solids or gases in the sample. Concentrations are useful to develop historical data, to control treatment of make-up water, boiler water, and feedwater. Concentrations are used to detect abnormal operation of a boiler system.

Concentrations referred to in boiler system water treatment are stated as parts per million parts and are usually stated on a weight basis. One pound of material per million pounds of water would be one part per million parts or 1 ppm. (The most common base of reference is by weight. If a concentration is stated as ppm it can be assumed to be on a weight volume basis – for example, gaseous emissions from the boiler stack – the terms would be noted as ppm volume or ppmv.)

For convenience, levels of concentrations of water samples in a boiler system are usually stated as ppm in whole numbers. Concentration of materials in steam may be so low that they may be stated in parts per billion parts (ppb) so that whole numbers can be used (one ppm equals 1,000 ppb) There are other conventions that can be used interchangeably – for example, milligrams per liter (mg/l) or milliliters per liter (ml/l). Both are equal to concentrations stated as ppm.

For reference:

- **% = parts per 100 parts = 10,000 parts per million** (salt content of seawater is about 3.5% or 35,000 ppm)
- **ppm = parts per million = 1,000,000,000 / 1,000,000 or 1,000 ppb** (modern turbines require no more than 50 ppb or .05 ppm solids in steam)
- **mg/l = (gram/1,000) / 1,000 milliliters x 1 gram / milliliter (density of water) = g/ 1,000,000g = ppm** (Deaerator outlet oxygen concentration should be less than .007 mg/l)

An important concept when considering concentration is that if the water or steam sample were completely dried the amount of material would equal the concentration. If 1,000,000 pounds of boiler water has a concentration of 1,000 ppm were evaporated, 1000 pounds of material would remain. In a boiler, part of the boiler water continuously evaporates and if, at the point of evaporation, water is concentrated beyond solubility limits, deposition can occur. Deposits will hinder heat transfer leading to overheating. That is why boiler water concentrations are routinely analyzed and controlled by blowdown.

Chemical Buffered Solutions

A “buffered” water solution refers to water that has some amount of dissolved chemicals and has a certain pH value. If some chemicals that have a different pH tendency when dissolved in water are added, the “buffered” solution will not substantially change and begin to exhibit pH that is in line with the added chemical. It is correct to say that water can be “un-buffered”, meaning that it contains no chemicals (example: steam condensate, distilled water, or demineralized water). “Lightly buffered” then would mean that there is considerable chemical in solution.

pH

pH is an index, measured electrochemically , stated in units ranging from 1 to 14, indicating whether water is acidic, neutral, or alkaline. Water that exhibits pH of 7 is "neutral" – neither acid nor alkaline. Water with pH below 7 is "acidic", and water that has greater than 7 is "alkaline". As there is a greater difference from pH 7, water will be more acid or more alkaline. Extremely corrosive "strong acids" will have pH of 2 or 3. Weak acids will have pH of 4 or 5. Highly alkaline water will have a pH of 12 or 13.

Conductivity

Electrical conductivity of samples of make-up water, boiler feedwater, boiler water, and steam condensate is important because of the direct correlation to the amount of dissolved chemicals, electrolytes, in the water. Electrical conductivity will increase with greater amounts of dissolved solids and decrease with lesser amounts. To have a common reference, electrical conductivity is based on electrical current flow that occurs between two electrodes immersed in the sample that have a certain size surface area spaced at a certain distance apart.
Conductivity is stated in units called mhos, which is the reciprocal of electrical resistance. For example, one ohm of resistance is equal to 1 mho, 10 ohms is equal to .01 mhos, 1,000 ohns is equal to .001 mhos, and 1,000,000 ohns is equal to 1 micro mho. The conductivity of a boiler system water sample is typically very low, meaning that electrical resistance is very high. A typical water sample from a boiler system will have conductivity that is more conveniently stated in micro mhos (millions of ohms of resistance).

Note: The unit of conductivity, mho, is frequently referred to as Siemen, which can be used interchangeably. One mho is the same as one Siemen.

The neutral conductivity of pure water is .4 micro mhos and when chemicals are added, dissolved and become ionized, conductivity will increase. In general, chemicals that exhibit neutral and alkaline pH will have a set relationship between their concentration and conductivity. On the other hand, acidic chemicals can have as much as a threefold greater conductivity.

It is typical to find that boiler water and feedwater conductivity will have a 2 to 1 relationship to the amount of dissolved solids. Most commonly, conductivity measured in micro mhos can be divided by two to find dissolved solids concentrations. For example, if a sample of boiler water blowdown has a conductivity of 3000 micro mhos, there would be 3000/2, or approximately 1500 ppm dissolved solids in the sample.

Dissolved gases such as ammonia or carbon dioxide will add to electrical conductivity, but in most boiler systems, dissolved gases are not primary interest, so prior to measuring conductivity, it is common practice to add a chemical reagent to the sample that will expel dissolved gases so as to have measured conductivity indicate only dissolved solids. This sort of measurement is called "degassed" conductivity.

Note: A special technique can be used to take advantage of the greater conductivity of acids to track dissolved solids at very low concentrations by measuring conductivity. An acid regenerated cation ion exchanger that converts all dissolved solids to their respective acids before measuring conductivity treats a sample of water. Conductivity measured downstream of the ion exchanger will have a 6 or 7 to 1 relationship between conductivity and dissolved solids concentration instead of 2 to 1. For example, a water sample that has an "acid" conductivity of 10 micro mhos would indicate 10/7 or 1.4 ppm dissolved solid.

Blowdown

Chemicals that are carried into a boiler will be concentrated when steam that contains no chemicals is generated. Blowdown is the means to control boiler water chemical concentrations.

The amount of blowdown required can be found by determining the allowable number of concentrations for feedwater that has a certain concentration of material and boiler water that must be limited to certain levels of dissolved and suspended solids or limited amounts of certain chemicals.

For example, if boiler water dissolved solids concentration is to be maintained at 2,000 ppm and if feedwater has 100 ppm dissolved solids, feedwater can be "concentrated" 2,000/100 or 20 times so that the number of concentrations is 20. In this case, to maintain boiler water dissolved solids concentration, 1/20th of the feedwater will have to be blown down making it necessary to blow down 1/20 x 100 or 5% of the feedwater. Thus, boiler blowdown will have to be 5% to control dissolved solids.

If the allowable boiler water silica concentration is 40 ppm and there is 1 ppm silica in the feedwater, the number of concentration will be 40 and blowdown required to control silica concentrations must be 1/40 x 100 or 2.5%. In this case, if dissolved solids concentrations required 5% blowdown and the number of concentration was 20, boiler water silica concentrations would be 20 x 1 or 20 ppm.

Refer to the following section for blowdown procedures.

SECTION G-4

BLOWDOWN

IN-OPERATION BLOWDOWN

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SAFETY WARNINGS

CAUTION: DO NOT BYPASS ANY STEAM DRUM LOW WATER LEVEL INTERLOCKS. SEVERE OVER-HEATING DAMAGE COULD OCCUR. (PAGE 96)

INTRODUCTION

Blowdown is the process of discharging a portion of boiler water through a system of valves to a receiving tank (blowdown tank) at some lower pressure, usually near atmospheric pressure. Blowdown is the principle means of controlling boiler water chemical concentrations. Steam transported from the boiler is free of dissolved or suspended chemicals and material carried into the boiler with feedwater will remain. To maintain constant levels of boiler water solids, the total amount of material carried into the boiler with the feedwater must equal the amount of material in the blowdown.

By testing boiler water at routine intervals blowdown rates can be adjusted to maintain proper chemical concentrations in the boiler water.

Blowdown flow rates can range from a small fraction to 30% of feedwater flow depending on the amount of material in the feedwater. There are heat losses, energy losses, and make-up water costs associated with blowdown. Excessive blowdown will unnecessarily add to operating costs.

CONTINUOUS BLOWDOWN

Smooth chemical control is based on a continuous flow of blowdown proportion to feedwater flow and internal chemical injections. Continuous blowdown is taken from a distribution pipe located in the steam drum.

A continuous blowdown sample, since it is taken from an actively flowing section of the boiler, is representative of the boiler water. Concentrations and temperature of the sample are considered to be those of the boiler water. Use a properly arranged sample cooler to collect the sample.

Boiler water taken for blowdown will flash and partially vaporize when the pressure is relieved downstream of the blowdown valve. To prevent burns or flashing at the point of disposal, provide a blowdown tank. The blowdown tank should have a steam vent and a drain to prevent hazards from hot water. Often the same tank can receive hot water or vented steam from other sources.

CONTINUOUS BLOWDOWN VALVES

Any valve in the blowdown line can be used to control blowdown flow. This valve often has a reference plate to indicate the amount of opening. Make further opening and closing adjustment according to this reference plate.

INTERMITTENT BLOW-OFF

The intermittent blow-off is used to remove solids that settle to the bottom of the water drum. The frequency of intermittent blow-off is entirely dependent on the quality of water supplied to the boiler and the chemicals used to maintain proper boiler water.

The intermittent blow-off is typically performed once a day. Depending on the water quality, it could be required as often as once a shift. Discuss your specific requirements with your water chemical provider. We recommend an initial frequency of once a day. When the boiler is shut down, inspect the lower drum for sediment. If the drum is clean, the frequency can be decreased.

The boiler blow-off valves may also be opened momentarily if large increase in boiler water concentrations occurs beyond recommended levels. This supplementary blow-off will help restore proper concentrations.

When intermittent blow-off is performed:

- Carefully study the plan of action and its effect on safe boiler circulation.
- Make certain there is proper venting of steam from blow-off flow. Blow-off flashes when throttled into a receiving tank.
- Make sure discharge from blow-off valves is piped to a safe disposal area.

PROCEDURE FOR USING THE BOILER BLOW-OFF VALVES

Prior to use of the intermittent blow-off valves, set up a routine to protect operating personnel and boiler equipment. Use the following guidelines:

1. **The boiler operating load must be reduced to 25% maximum.** This is to prevent an upset of the boiler water circulation and possible overheating of the boiler tubes.

2. Verify correct operation of the drum level and feedwater flow controls. This is to ensure proper drum level control during and after the intermittent blow-off.

CAUTION: DO NOT BYPASS ANY STEAM DRUM LOW WATER LEVEL INTERLOCKS. SEVERE OVERHEATING DAMAGE COULD OCCUR.

3. Station an operator at the water column to observe the water level in the gage glass.

4. Open the following two valves for blow-off:

Isolation or Shut-off Valve

Fully open the isolation or shut-off valve. (Usually the blow-off valve most downstream of the boiler)

Blow-off Valve

Open and then close the blow-off valve. (valve closest to the boiler)

The duration of the intermittent blow-off is only as long as it takes to open and close the blow-off valve. This should take no more than 10 seconds.

DO NOT leave a supplemental blow-off valve open for more than 10 seconds, even though stable conditions appear to be maintained.

To stop blow-off:

- Tightly close the blow-off valve

- When flow stops, close the isolation valve

- Re-check both valves to make sure blow-off flow has stopped completely

ALTERNATE INTERMITTENT BLOW-OFF PROCEDURE

There are different schools of thought on the intermittent blow-off procedure. The other method of intermittent blow-off operates the valves opposite of what was previously described. The isolation valve is the one closest to the boiler. This valve may be a quick-opening valve. The valve will have a handle rather than a handwheel and is to be opened first.

The blow-off valve is the downstream valve. It is typically a slow opening valve (a valve requiring 5 or more turns of the handwheel to open).

The duration of intermittent blow-off is only as long as it takes to fully open and then close the valve. This should take no more than 10 seconds.

When the blow-off valve is closed, the isolation valve should be closed. The blow-off valve can then be opened to release any pressure between the valves. Then close the blow-off valve.

The philosophy of this procedure is that the intermittent blow-off procedure is a very sever service. The boiler water is flashing to steam as it passes through the blow-off valve. By using the downstream valve as the blow-off valve, it can be replaced, if needed, without shutting down and draining the boiler.

The isolation valve must be locked in the closed position if the blow-off valve is removed for replacement.

PROCEDURE FOR USING THE BOILER BLOW-OFF VALVES TO SUPPLEMENT CONTINUOUS BLOWDOWN

When operating conditions require supplementing continuous blowdown, the above noted intermittent blow-off procedure can be repeated as needed. It is recommended that sufficient time is allowed between blow-offs to allow the drum level controls to recover and return to a steady state condition.

SECTION H

POST OPERATION

SECTION H-1

SHUT DOWN

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TAKING BOILERS OUT OF SERVICE

Reducing Load

When it has been decided to take a boiler off line, the following procedure should be followed. Reduce boiler steaming rate slowly. When unit reaches 25 to 30 percent rate capacity the fuel and air should be placed on manual control before proceeding to reduce the load any further. Cut the fuel supply when load has been reduced as much as practical with the type of fuel burning equipment. Allow all fuel in the furnace to turn out while allowing fans to purge the furnace until all fuel is completely burned. Also, place feedwater on signal element control and maintain normal water level.

Cutting Off Line

As soon as automatic stop check valve closes, and where a superheater exists, open and throttle outlet superheater until the furnace temperature drops below the point at which overheating of the superheater elements may occur. The boiler setting should be cooled slowly. Close all inlet and outlet dampers to the boiler to retain heat in the furnace, thus allowing temperatures to drop slowly. Close feedwater valves when boiler ceases to require water. When drum pressure reaches just above atmospheric, open drum vents and superheater drains where applicable. The unit may be drained when boiler water reaches 200° F or lower.

General Storage Methods

There are two generally recognized systems for laying up a boiler out of service. These are the wet system and the dry system. The wet system is used when boilers are to be placed on standby for short periods of time. It is not recommended where freezing temperatures are likely. The dry system is used when a unit is out of service for extended periods or when freezing temperatures are likely. Before employing either system, after taking a unit off line, the boiler should be flushed clean and inspected to determine maintenance work required.

Wet System

With the wet system, fill the boiler with fresh condensate or chemically treated feedwater until water runs from drum vent. Where a superheater is installed also flood until water runs from outlet header vent. To protect against corrosion, add caustic soda sulfite to the water in such quantities that water will have a concentration of 450 ppm caustic soda and 200 ppm sodium sulfite. The caustic soda maintains an alkaline condition while the sodium sulfite serves as an oxygen scavenger. When water overflows from the drum vent or superheater vent raise the water pressure just above atmospheric and shut off water supply. Open the vents about one week later and again fill until water flows from vents. Raise the water pressure just above atmospheric and shut off water supply. The slight pressure should be maintained during storage.

Dry System

With the dry system, first insure that all internal surfaces are dry. Insure that no moisture can enter the boiler from feed lines, steam lines, etc. Tightly close all connections to the boiler, blanking the lines if deemed necessary. To protect against moisture from the air, place trays of quick lime at the rate of 21 pounds per 1000 gallon capacity in the boiler drums. Close all manholes and handholes tightly. During the storage period, regular inspections should be made and the lime replaced when necessary.

SECTION H-2

STORAGE

POST OPERATION STORAGE

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SAFETY WARNINGS

CAUTION: A VACUUM CAN BE CREATED INSIDE THE WATER SIDE OF THE BOILER IF THE BOILER IS DRAINED WITH THE VENTS CLOSED. THIS VACUUM CAN BE VIOLENTLY RELEASED IF IT STILL EXISTS WHEN A MANHEAD OR HANDHOLE IS OPENED. THE SUDDEN IN-RUSH OF AIR COULD CREATE CONDITIONS LEADING TO INJURY. MAKE CERTAIN THAT VENT VALVES HAVE BEEN OPENED AND NO VACUUM EXISTS BEFORE BEGINNING TO OPEN A MANHEAD OR A HANDHOLE. (PAGE 105)

CAUTION: ALTHOUGH NITROGEN IS A NON-FLAMMABLE GAS, THERE IS NOT ENOUGH OXYGEN TO BREATHE SHOULD ANYONE ENTER THE EQUIPMENT WHILE THE UNIT IS FILLED WITH NITROGEN. (PAGE 105)

CAUTION: WHEN A BOILER HAS BEEN PRESSURIZED WITH AN INERT GAS AND IS TO BE WORKED ON LATER, FULLY OPEN ACCESS DOORS AND FORCE AIR INTO AND THROUGH AN OPENING ON THE WATER SIDE OF THE BOILER AND THROUGH AN OPENING ON THE OTHER SIDE. DO NOT ALLOW PERSONNEL TO ENTER INTO A PRESSURE VESSEL UNLESS IT IS KNOWN WITHOUT DOUBT THAT THERE IS ENOUGH AIR TO BREATHE. (PAGE 106)

CAUTION: MAKE SURE THAT VENT AND DRAIN VALVES CONNECTED TO A COMMON HEADER ARE CLOSED PROPERLY TO PREVENT BACK FLOW. SET THE VALVES ON AN IDLE BOILER AND AN OPERATING BOILER TO PREVENT FLOW INTO THE IDLE BOILER WHEN IT IS OPEN FOR REPAIR AND WHEN PERSONNEL HAVE ENTERED THE PRESSURE VESSEL TO MAKE INSPECTIONS OR REPAIRS. (PAGE 106)

CAUTION: WHEN INITIAL OPERATION OF THE STEAM GENERATOR IS TO BE DELAYED FOR MORE THAN THREE MONTHS, PROCEDURES SHOULD BE TAKEN TO DRY OUT ANY UNFIRED OR GREEN CASTABLE REFRACTORIES TO PREVENT CORRODING OF PRESSURE PARTS IN CONTACT WITH IT. THE CASTABLE SHOULD FIRST BE PROTECTED FROM FREEZING UNTIL HEAT CAN BE APPLIED TO DRIVE OUT THE MOISTURE. THE REFRACTORY CONTRACTOR SHOULD BE CONSULTED AS TO AN AP-PROPRIATE DRY-OUT AND FIRING–IN SCHEDULE FOR THE MATERIALS AND THICKNESS USED WITH THE FURNACE. (PAGE 107)

POST OPERATION STORAGE

INTRODUCTION

A boiler is made of steel parts and, like anything made of steel, it will rust and corrode rapidly if not properly protected. When a boiler is operating, ambient conditions of temperature and humidity are important in preventing damage through corrosion. But when a boiler is shut down, it becomes especially vulnerable to corrosion from oxidation (rusting) of the steel parts. Attention must be given to developing and following out-of-service storage procedures in order to obtain the best reliability and to minimize maintenance expense.

These instructions contain general information regarding out of service boiler protection and do not represent all those details that need to be considered in a comprehensive plan to store a boiler when it is out-of-service. They are meant to initiate, confirm, or supplement specific storage procedures developed to guard against out of service corrosion damage for this boiler installation.

There are just two basic principles that underlie proper action for any situation where a boiler will be stored:

- Oxygen in the air will corrode steel by chemically reacting with it, and
- Water on the surface of the steel parts will greatly accelerate corrosion from oxygen in the air.

Boilers will be damaged by internal (water side) corrosion if left full or partially full of water and open to the air. Rusting and pitting under these conditions is very rapid and extensive damage can occur in just a few hours. It is important, therefore, that if the boiler is to be drained it must be drained completely or, if it is to be left full of water, valves and water side access openings must be closed to prevent air from infiltrating. On the fire side, wet ash deposits and humid air will lead to corrosion of steel parts of the boiler when the boiler is shut down. Hot, humid air flowing freely into a boiler setting while the boiler remains cooler at temperatures below or near the dew point can lead to moisture condensation and corrosion damage to the exterior (fire side) surfaces. The best ways to prevent corrosion damage on the fire side are to keep the boiler warm (above the dew point) and to limit humid air flow through the boiler as much as possible.

A boiler may be shut down for a planned off-line period, or it could be unexpectedly forced out of service because of an operational problem. No matter what the reason is for shutdown, it is possible to determine approximately how long the boiler will have to be stored and whether the boiler needs to be drained or not. The status of the boiler during the outage can be outlined by one of the following four criteria. Develop a specific plan of action for proper out-of-service protection under each of the following situations.

Short Term – Open Boiler

An unscheduled shut-down to make boiler repairs.

- Boiler will be out of service for less than a week.
- Boiler will be opened for inspection, maintenance, or repair.

Short Term – Closed Boiler

An unscheduled outage to repair auxiliary equipment.

- Boiler will be out of service for less than one week.
- Boiler can remain closed.

Long Term – Indefinite Period

An unscheduled outage to make major repairs or alterations.

- Boiler will be out of service for more than a week.
- Boiler must be made ready for service within a few hours after completion of repairs.

Long Term – Definite Period

A scheduled long term normal outage, such as during the summer for a heating boiler.

- Boiler will be out of service for an extended period (several weeks).
- Boiler start-up date can be determined several days ahead of time.

COMMON PROCEDURES

Certain procedures, important to proper out-of-service protection, are common to all the different plans for storage. These procedures can be considered separately and then applied to specific circumstances.

- Draining a boiler
- Pressurizing a drained boiler with inert gas
- Filling a boiler to be stored full of water
- Protecting boilers against back flow through common waste connections

Draining a Boiler

When a boiler system is taken out of service it is almost always possible to plan to use the residual heat in the boiler setting (drums, tubes, refractory, and other heat retaining parts) to dry all the metal surfaces, inside and outside, and to dry out the water that may be trapped at low points. This drying process requires only that the boiler be drained after steam pressure has decayed to where steam pressure gages read less than 5 psig and before the boiler cools further. A rule of thumb check for knowing when pressure is low enough is when venting steam flow is reduced to a noiseless condition. Leave the boiler drains and vents wide open after draining for no more than four hours. If the boiler is to be worked on right away open the drum head and other openings for full access, but if the work will not begin until some later time after several hours of cooling after draining, tightly close the drains and vents and all other access to the water side until work is to begin.

CAUTION: A VACUUM CAN BE CREATED INSIDE THE WATER SIDE OF THE BOILER IF THE BOILER IS DRAINED WITH THE VENTS CLOSED. THIS VACUUM CAN BE VIOLENTLY RELEASED IF IT STILL EXISTS WHEN A MANHEAD OR HANDHOLE IS OPENED. THE SUDDEN IN-RUSH OF AIR COULD CREATE CONDITIONS LEADING TO INJURY. MAKE CERTAIN THAT VENT VALVES HAVE BEEN OPENED AND NO VACUUM EXISTS BEFORE BEGINNING TO OPEN A MANHEAD OR A HANDHOLE.

Draining a Boiler Using Inert Gas Atmosphere

The preferred alternative procedure for draining the boiler consists of applying a pressure from an inert gas such as nitrogen. Storage of the boiler with an inert gas storage atmosphere is strongly recommended if the boiler is to be stored for long term indefinite periods before being restarted or before repair or maintenance begins.

CAUTION: ALTHOUGH NITROGEN IS A NON-FLAMMABLE GAS, THERE IS NOT ENOUGH OXYGEN TO BREATHE SHOULD ANYONE ENTER THE EQUIPMENT WHILE THE UNIT IS FILLED WITH NITROGEN.

1. Prepare signs in advance and put them on the boiler immediately after filling it with nitrogen.
2. Post a warning sign prominently on both sides of the boiler and at all boiler access doors.
3. Use wording on the sign similar to the following: **WARNING: DO NOT ENTER. NITROGEN INSIDE. LACK OF OXYGEN WILL CAUSE DEATH.**
4. Develop an inert gas environment as the boiler steam pressure decays to less than 5 psig.
5. Connect the source of nitrogen through a steam drum vent.
6. Open the valve for the nitrogen source to maintain a regulated, measurable pressure of 2 or 3 psig.
7. Close off all other vents or sources of possible air in-leakage (for example, steam line drains or vents).
8. Set the inert gas pressure regulator and drain the boiler while the boiler is still warm.
9. Observe the pressurizing system carefully as the water is drained and replaced by the inert gas to make sure there is sufficient gas supply and that the pressure regulator functions properly.

10. Drain the boiler completely.

11. Shut off the drain system, but leave the gas pressurizing system open to regulate the pressure.

12. Check the operation of the regulator and gas supply routinely during the remainder of the boiler outage.

CAUTION: WHEN A BOILER HAS BEEN PRESSURIZED WITH AN INERT GAS AND IS TO BE WORKED ON LATER, FULLY OPEN ACCESS DOORS AND FORCE AIR INTO AND THROUGH AN OPENING ON THE WATER SIDE OF THE BOILER AND THROUGH AN OPENING ON THE OTHER SIDE. DO NOT ALLOW PERSONNEL TO ENTER INTO A DRUM UNLESS IT IS KNOWN WITHOUT DOUBT THAT THERE IS ENOUGH AIR TO BREATHE.

Pressurizing a Drained Boiler with Inert Gas

Even though it is better to drain the boiler while hot under an inert gas blanket, it is conceivable that circumstances can occur where the boiler would be drained first and then closed up at some later time. The recommended procedure is to pressurize the water side by injecting an inert gas.

1. Connect the inert gas through a pressure regulator to a drum vent.

2. Close all other boiler drains and vents; steam line shut-off, drain and vent valves.

3. Establish and maintain a positive inert gas pressure of 2 or 3 psig.

While it is possible to eventually purge air out of the waterside spaces by setting up inert gas flow, there is no significant gravity separation between air and nitrogen to help purge out air. The inert gas will only mix with and dilute the air already in the boiler steam spaces. Pressurizing the boiler prevents any air in – leakage and will be enough to minimize internal water side corrosion.

Protecting Boilers Against Back Flow Through Common Connections

When a boiler is out of service in a plant where it is connected to a common blowdown or drain header, it is possible that there could be steam or hot water pressure in the header high enough to cause back flow. It is vital to recognize this possibility and to guard against it.

On the boiler and auxiliary equipment which are out of service:

1. Shut off and tag drain valves or any connection to a plant header common to other boilers to prevent opening without proper authority.

2. Where possible, install and use a bleed-off valve between two shut-off valves connected in series as a positive means to bleed off back flow and prevent damage.

CAUTION: MAKE SURE THAT VENT AND DRAIN VALVES CONNECTED TO A COMMON HEADER ARE CLOSED PROPERLY TO PREVENT BACK FLOW. SET THE VALVES ON AN IDLE BOILER AND AN OPERATING BOILER TO PREVENT FLOW INTO THE IDLE BOILER WHEN IT IS OPEN FOR REPAIR AND WHEN PERSONNEL HAVE ENTERED THE DRUMS TO MAKE INSPECTIONS OR REPAIRS.

Long Term Storage – Prior to or After Operation

Storage procedures and guidelines discussed in this instruction manual typically refer to boilers and boiler equipment that have been operating. In this category, however, the principles and action are appropriate for a boiler and auxiliary equipment that were installed and where initial operation is to be delayed for an extended time.

CAUTION: WHEN INITIAL OPERATION OF THE STEAM GENERATOR IS TO BE DELAYED FOR MORE THAN THREE MONTHS, PROCEDURES SHOULD BE TAKEN TO DRY OUT ANY UNFIRED OR GREEN CASTABLE REFRACTORIES TO PREVENT CORRODING OF PRESSURE PARTS IN CONTACT WITH IT. THE CASTABLE SHOULD FIRST BE PROTECTED FROM FREEZING UNTIL HEAT CAN BE APPLIED TO DRIVE OUT THE MOISTURE. THE REFRACTORY CONTRACTOR SHOULD BE CONSULTED AS TO AN AP-PROPRIATE DRY-OUT AND FIRING–IN SCHEDULE FOR THE MATERIALS AND THICKNESS USED WITH THE FURNACE.

The principles of sealing the boiler water side and gas side carefully are the guidelines for long-term storage. Take off valves, motors, burner parts, electrical equipment, and other items that are particularly vulnerable and store indoors when not being used. Even during storage, some equipment, such as bearings and shafts for fans, pumps, and motors should be attended to routinely to ensure a normal service life.

PROCEDURE

Air and Gas Side Preparation

1. Cap or plug all pipe connections to the windbox or furnace. At weekly intervals, inspect the boiler system carefully in order to be sure all openings, nozzles and couplings are found, properly capped or sealed, and remain sealed.

2. Place 10 gauge steel plates over the flue gas outlet and the inlet to the burner windbox or forced draft fan inlet.

3. Hang bags of desiccant, such as renewable silica gel, throughout the furnace.

    - Use 4 pounds of a renewable silica gel desiccant for every 50 cubic feet of boiler volume. Regularly check to see that the condition of the desiccant will not cause corrosion problems and the desiccant is still effective. Guard against very active or spent desiccant getting on metallic parts.

    - Optional: hang humidity indicating cards inside the furnace to help determine when the desiccant is to be renewed.

4. Protect burner louver operating mechanism, burner fuel injector, and other similar parts. Coat any moveable parts with grease or suitable rust preventative.

5. Keep all openings to both the gas and water side of the boiler sealed off as much as possible. If routine inspections are made, close up any of the access openings as soon as the inspections are completed.

6. Remove parts of the boiler or burner system, such as oil burner guns, gas nozzles, igniter assemblies, ignition transformers, and any other part that can be removed or unbolted, and store them in a sheltered, weather-protected area.

7. Remove gages and water columns and store them in a humidity controlled environment.

SECTION I

BOILER TRIM EQUIPMENT

COLUMBIA PULP VE-13288 INSTRUMENT INDEX

P&ID NUMBER	INSTRUMENT TAG NUMBER	SERVICE	FURN BY	MANUFACTURER	MODEL NUMBER	ACCESSORY	CONN SIZE	I/O TYPE	SIG VOLTS	RANGE	ENGR UNITS
21-13288-01	LG - 81001	Steam Drum Level Gage	VEO	Quest-Tec	ST-1000-81-TB-06-N	11.88" visible range					
21-13288-01	GV - 81002	Drum Level Gage Valve	VEO	Quest-Tec	SV-1600-V06M-G06N-DO6T-QL		3/4" NPT				
21-13288-01	GV - 81003	Drum Level Gage Valve	VEO	Quest-Tec	SV-1600-V06M-G06N-DO6T-QL		3/4" NPT				
21-13288-01	LG - 81005	Steam Drum Level Gage	VEO	Quest-Tec	ST-1000-81-TB-06-N	11.88" visible range					
21-13288-01	GV - 81006	Drum Level Gage Valve	VEO	Quest-Tec	SV-1600-V06M-G06N-DO6T-QL		3/4" NPT				
21-13288-01	GV - 81007	Drum Level Gage Valve	VEO	Quest-Tec	SV-1600-V06M-G06N-DO6T-QL		3/4" NPT				
21-13288-01	LE - 81009	Aux Low Water Cutout	VEO	VEO	21-13288-99						
21-13288-01	LIT - 81020A	Steam Drum Level	VEO	Rosemount	3051C D 1 A 0 2 B 1 A S5 E5 M5 Q4	0305 R C 8 2 B 2 1 B4	1/2" NPT	AI, 4-20mA	24 VDC	+16.0 to 0.0 "WC	-8.0 to +8.0 IN WC
21-13288-01	LIT - 81020B	Steam Drum Level	VEO	Rosemount	3051C D 1 A 0 2 B 1 A S5 E5 M5 Q4	0305 R C 8 2 B 2 1 B4	1/2" NPT	AI, 4-20mA	24 VDC	+16.0 to 0.0 "WC	-8.0 to +8.0 IN WC
21-13288-01	LIT - 81020C	Steam Drum Level	VEO	Rosemount	3051C D 1 A 0 2 B 1 A S5 E5 M5 Q4	0305 R C 8 2 B 2 1 B4	1/2" NPT	AI, 4-20mA	24 VDC	+16.0 to 0.0 "WC	-8.0 to +8.0 IN WC
21-13288-01	PIT - 81030	Steam Drum Press	VEO	Rosemount	3051T G 4 A 2B 2 1 A S5 E5 M5 Q4	0306 R T 3 2 BA 2 1	1/2" NPT	AI, 4-20mA	24 VDC	0-1000 PSI	0-1000 PSIG
21-13288-01	PIT - 81032	Steam Drum Press	VEO	Rosemount	3051T G 4 A 2B 2 1 A S5 E5 M5 Q4	0306 R T 3 2 BA 2 1	1/2" NPT	AI, 4-20mA	24 VDC	0-1000 PSI	0-1000 PSIG
21-13288-01	PI - 81035	Steam Drum Press	VEO	Ashcroft	60-1379SS-04L-XSGC4-1500#	50-1098SD Siphon	1/2" NPT			0-1500 PSI	
21-13288-01	FE - 81400	Feedwater Flow	VEO	Rosemount	1595P040A3SA065		3" 600 RF			0 - 171.63 "WC	0-100,000 LB/HR
21-13288-01	FIT - 81400	Feedwater Flow	VEO	Rosemount	3051C D 2 A 0 2 B 1 A S5 E5 M5 Q4	0305 R C 8 2 B 2 1 B4	1/2" NPT	AI, 4-20mA	24 VDC	0 - 171.63 "WC	0-100,000 LB/HR
21-13288-02	FIT - 81200	Fresh Air Flow	VEO	Rosemount	3051C D 1 A 0 2 B 1 A S5 E5 M5 Q4	0305 R C 8 2 B 2 1 B4	1/2" NPT	AI, 4-20mA	24 VDC	0 - 4.0 "WC	0-183,000 LB/HR
21-13288-02	TE - 81205	Fresh Air Temp	VEO	Sandelius	5H-250KK304-RS-17-GE46F		1" NPT			Type K	
21-13288-02	TIT - 81205	Fresh Air Temp	VEO	Rosemount	3144P D1 A 1 E5 M5 Q4 B5	Type K T/C		AI, 4-20mA	24 VDC	0 - 150 F	0-150 DEG F
21-13288-02	FCA - 81210	Fresh Air Damp Actuator	VEO	Beck	11-309-400-60-2				120 VAC		
21-13288-02	FY - 81210	Fresh Air Damper Control	VEO	Beck	11-309-400-60-2			AO, 4-20mA	24 VDC	0-100%	0-100% OPEN
21-13288-02	ZSH - 81210	Fresh Air Damper Open	VEO	Beck	11-309-400-60-2			DI	120 VAC		

COLUMBIA PULP VE-13288 INSTRUMENT INDEX

P&ID NUMBER	INSTRUMENT TAG NUMBER	SERVICE	FURN BY	MANUFACTURER	MODEL NUMBER	ACCESSORY	CONN SIZE	I/O TYPE	SIG VOLTS	RANGE	ENGR UNITS
21-13288-02	ZSL - 81210	Fresh Air Damper Low Fire	VEO	Beck	11-309-400-60-2			DI	120 VAC		
21-13288-02	ZT - 81210	Fresh Air Damper Position	VEO	Beck	11-309-400-60-2			AI, 4-20mA	24 VDC	0-100%	0-100% OPEN
21-13288-02	TE - 81213	Combustion Air Temp	VEO	Sandelius	5H-250KK304-RS-17-GE46F		1" NPT			Type K	
21-13288-02	TIT - 81213	Combustion Air Temp	VEO	Rosemount	3144P D1 A 1 E5 M5 Q4 B5	Type K T/C		AI, 4-20mA	24 VDC	0 - 300 F	0-300 DEG F
21-13288-02	FCA - 81220	Inlet Box Damp Actuator	VEO	Beck	11-309-400-60-2				120 VAC		
21-13288-02	FY - 81220	Inlet Box Damper Control	VEO	Beck	11-309-400-60-2			AO, 4-20mA	24 VDC	0-100%	0-100% OPEN
21-13288-02	ZSH - 81220	Inlet Box Damper Open	VEO	Beck	11-309-400-60-2			DI	120 VAC		
21-13288-02	ZSL - 81220	Inlet Box Damper Low Fire	VEO	Beck	11-309-400-60-2			DI	120 VAC		
21-13288-02	ZT - 81220	Inlet Box Damper Position	VEO	Beck	11-309-400-60-2			AI, 4-20mA	24 VDC	0-100%	0-100% OPEN
21-13288-02	FCA - 81240	FD Fan Out Damp Actuator	VEO	Beck	11-209-175-60-2				120 VAC		
21-13288-02	FY - 81240	FD Fan Out Damp Control	VEO	Beck	11-209-175-60-2			AO, 4-20mA	24 VDC	0-100%	0-100% OPEN
21-13288-02	ZSH - 81240	FD Fan Out Damp Open	VEO	Beck	11-209-175-60-2			DI	120 VAC		
21-13288-02	ZSL - 81240	FD Fan Out Damp Low Fire	VEO	Beck	11-209-175-60-2			DI	120 VAC		
21-13288-02	ZT - 81240	FD Fan Out Damp Position	VEO	Beck	11-209-175-60-2			AI, 4-20mA	24 VDC	0-100%	0-100% OPEN
21-13288-02	BE - 81260	Flame Scanner	VEO	Fireye	65UV5-1004EQD		1" BSP	DI, AI, 4-20mA	24 VDC	0-100%	0-100%
21-13288-02	BE - 81261	Flame Scanner	VEO	Fireye	65UV5-1004EQD		1" BSP	DI, AI, 4-20mA	24 VDC	0-100%	0-100%
21-13288-02	BE - 81262	Flame Scanner	VEO	Fireye	65UV5-1004EQD		1" BSP	DI, AI, 4-20mA	24 VDC	0-100%	0-100%
21-13288-02	PIT - 81269	Windbox Pressure	VEO	Rosemount	3051C D 2 A 0 2 B 1 A S5 E5 M5 Q4	0305 R C 8 2 B 2 1 B4	1/2" NPT	AI, 4-20mA	24 VDC	0 - 50.0 "WC	0-50.0 IN WC
21-13288-02	PIT - 81277	Furnace Pressure	VEO	Rosemount	3051C D 2 A 0 2 B 1 A S5 E5 M5 Q4	0305 R C 8 2 B 2 1 B4	1/2" NPT	AI, 4-20mA	24 VDC	0 - 50.0 "WC	0-50.0 IN WC
21-13288-02	TI - 81282	Econ In Flue Gas Temp	VEO	Ashcroft	50EI 60 E 240 200/700 XSGC4	10 W 2250 -- S T 260 C	1" NPT			200F -700F	
21-13288-02	AE - 81285	Exhaust Gas O2 Probe	VEO	Rosemount	6888A-1OXY-4-1-1HT-09-00-0-0-0-0		4" 150 RF		120 VAC		

COLUMBIA PULP VE-13288 INSTRUMENT INDEX

P&ID NUMBER	INSTRUMENT TAG NUMBER	SERVICE	FURN BY	MANUFACTURER	MODEL NUMBER	ACCESSORY	CONN SIZE	I/O TYPE	SIG VOLTS	RANGE	ENGR UNITS
21-13288-02	AIT - 81285	Exhaust Gas O2 Xmitter	VEO	Rosemount	6888XI-1OXY-02-00-00-00-00-00			AI, 4-20mA	120 VAC	0-25%	0-25% OXYGEN
21-13288-02	AY - 81285	Exhaust Gas O2 Calibrator	VEO	Rosemount	XSO2CAL-01-00				120 VAC		
21-13288-02	TI - 81292	Econ Out Flue Gas Temp	VEO	Ashcroft	50EI 60 E 240 50/550 XSGC4	10 W 2250 -- S T 260 C	1" NPT			50F - 550F	
21-13288-02	FCA - 81295	FGR Damp Actuator	VEO	Beck	11-209						
21-13288-02	FY - 81295	FGR Damper Control	VEO	Beck	11-209			AO, 4-20mA	24 VDC	0-100%	0-100% OPEN
21-13288-02	ZSH - 81295	FGR Damper Open	VEO	Beck	11-209			DI	120 VAC		
21-13288-02	ZSL - 81295	FGR Damper Low Fire	VEO	Beck	11-209			DI	120 VAC		
21-13288-02	ZT - 81295	FGR Damper Position	VEO	Beck	11-209			AI, 4-20mA	24 VDC	0-100%	0-100% OPEN
21-13288-02	FIT - 81297	Flue Gas Recirc Flow	VEO	FCI	ST102A-80N0120G6CH1ETE0001			AI, 4-20mA	120 VAC	0 - 50,000 LB/HR	
21-13288-02	FE - 81297A	Flue Gas Recirc Flow	VEO	FCI	ST102A-80N0120G6CH1ETE0001			AI, 4-20mA			
21-13288-02	FE - 81297B	Flue Gas Recirc Flow	VEO	FCI	ST102A-80N0120G6CH1ETE0001			AI, 4-20mA			
21-13288-02	FCA - 81300	Stack Damp Actuator	VEO	Beck	11-209						
21-13288-02	FY - 81300	Stack Damper Control	VEO	Beck	11-209			AO, 4-20mA	24 VDC	0-100%	0-100% OPEN
21-13288-02	ZSH - 81300	Stack Damper Open	VEO	Beck	11-209			DI	120 VAC		
21-13288-02	ZSL - 81300	Stack Damper Low Fire	VEO	Beck	11-209			DI	120 VAC		
21-13288-02	ZT - 81300	Stack Damper Position	VEO	Beck	11-209			AI, 4-20mA	24 VDC	0-100%	0-100% OPEN
21-13288-02	FE - 81620	Main Steam Flow	VEO	Veris	hold		8" 900 RF			0- "WC	0-100,000 LB/HR
21-13288-02	FIT - 81620	Main Steam Flow	VEO	Rosemount	hold	hold	1/2" NPT	AI, 4-20mA	24 VDC	0 - "WC	0-100,000 LB/HR
JZ 9188020	FE - 81507	Natural Gas Flow	VEO	Rosemount	3051SFC 1CS040 N065 T32JA1A3 Q4	0305 R C 8 2 B 2 1 B4	4" 150 RF	AI, 4-20mA	24 VDC	0 - 142.12 "WC	0-6,000 LB/HR
JZ 9188020	FIT - 81507	Natural Gas Flow	VEO	Rosemount	3051SFC 1CS040 N065 T32JA1A3 Q4	0305 R C 8 2 B 2 1 B4	4" 150 RF	AI, 4-20mA	24 VDC	0 - 142.12 "WC	0-6,000 LB/HR

Project #	13288
Project Name	Columbia Pulp
Document #	**67-13288-13**
Project Manager	**GMcNUTT**
Revision	**0**
Report By	**gmcnutt**
Report Date	**5/16/2018**

MANUAL VALVE LIST

REV	P&ID NUMBER	Tag	Customer Tag	QTY	Service	DESCRIPTION	Physical Description					MFR	MODEL #	SHIPPING METHOD
							Size (in)	Valve Type	Valve Class	End Conn.	Material Type			
0	21-13288-01	HV-81401	SAME	1	ECON VENT	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81402	SAME	1	ECON DRAIN	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81001	SAME	1	UPPER DLT	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81002	SAME	1	LOWER DLT	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81003	SAME	1	UPPER DLT	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81004	SAME	1	LOWER DLT	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81005	SAME	1	UPPER DLT	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81006	SAME	1	LOWER DLT	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81007	SAME	1	DRAIN	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81008	SAME	1	DRAIN	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81009	SAME	1	DRAIN	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81010	SAME	1	DRAIN	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81011	SAME	1	DRAIN	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81012	SAME	1	DRAIN	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81013	SAME	1	DRAIN	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81014	SAME	1	DRAIN	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81015	SAME	1	DRAIN	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81016	SAME	1	DRAIN	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81017	SAME	1	PT ISOLATION	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81018	SAME	1	PI ISOLATION	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81019	SAME	1	TEST PORT	GATE VALVE: 1/2"-800# TSW	1/2"	GATE	800	TSW	SA-105	VOGT	TSW12111	PIPING
0	21-13288-01	HV-81020	SAME	1	CHEMICAL FEED	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	CV-81021	SAME	1	CHEMICAL FEED	PISTON CHECK VALVE: 1"-800# SW	1"	CHECK	800	SW	SA-105	VOGT	SW701	PIPING
0	21-13288-01	HV-81022	SAME	1	BLOWDOWN	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81023	SAME	1	BLOWDOWN	GLOBE VALVE: 1"-800# SW	1"	GLOBE	800	SW	SA-105	VOGT	SW12443	PIPING
0	21-13288-01	HV-81024	SAME	1	INTERMITTENT BLOW OFF	BLOW-OFF ANGLE VALVE: 1 1/2" RF	1 1/2"	VALVE	600	FLANGED		EDWARDS	1643	LOOSE
0	21-13288-01	HV-81025	SAME	1	INTERMITTENT BLOW OFF	BLOW-OFF GLOBE VALVE: 1 1/2"-600# RF	1 1/2"	GLOBE	600	FLANGED		EDWARDS	1641	LOOSE
0	21-13288-01	HV-81026	SAME	1	VENT	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81027	SAME	1	DRAIN	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	HV-81028	SAME	1	PT ISOLATION	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-01	PSV-81601	SAME	1	SAFETY RELIEF VALVE	SAFETY VALVE: INLET 1 1/2"-600# FLG X OUTLET 2 1/2"-150# FLG	-1/2"X2 1/2	PSV	600x150	FLANGED	A216 WCB	KUNKLE	600NHG01-AS0950	LOOSE
0	21-13288-01	PSV-81602	SAME	1	SAFETY RELIEF VALVE	SAFETY VALVE: INLET 1 1/2"-600# FLG X OUTLET 2 1/2"-150# FLG	-1/2"X2 1/2	PSV	600x150	FLANGED	A216 WCB	KUNKLE	600NHG01-AS0955	LOOSE
0	21-13288-02	HV-81603	SAME	1	CROSSOVER VENT	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING
0	21-13288-02	HV-81604	SAME	1	STEAM SAMPLING	GATE VALVE: 3/4"-800# TSW	3/4"	GATE	800	TSW	SA-105	VOGT	TSW12111	PIPING
0	21-13288-02	HV-81605	SAME	1	SAT. STEAM SOURCE	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	PIPING

REV	P&ID NUMBER	Tag	Customer Tag	QTY	Service	DESCRIPTION	Physical Description					MFR	MODEL #	SHIPPING METHOD
							Size (in)	Valve Type	Valve Class	End Conn.	Material Type			
0	21-13288-02	HV-81803	SAME	1	DRAIN, SH INLET HEADER	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	BOILER
0	21-13288-02	HV-81804	SAME	1	DRAIN, SH INLET HEADER	GATE VALVE: 1"-800# SW	1"	GATE	800	SW	SA-105	VOGT	SW12111	BOILER
0	21-13288-02	HV-81807	SAME	1	DRAIN, SH OUTLET HEADER	GATE VALVE: 1"-1500# SW	1"	GATE	1500		SA-182-F11 CL2	VOGT	SW15321	BOILER
0	21-13288-02	HV-81808	SAME	1	DRAIN, SH OUTLET HEADER	GATE VALVE: 1"-1500# SW	1"	GATE	1500		SA-182-F11 CL2	VOGT	SW15321	BOILER
0	21-13288-02	PSV-81809	SAME	1	SH SAFETY RELIEF VALVE	SAFETY VALVE: INLET 1 1/2"-1500# X 3"-150# RF	1 1/2"X3"	PSV	1500x150	FLANGED	A216 WCC	CONSOLIDATED	1-1/2" 2717 D-1-X1-F1	LOOSE
0	21-13288-02	HV-81810	SAME	1	STARTUP VENT	GATE VALVE: 3"-900# BW	3"	GATE	900	BW	A217 WC6	CRANE	83-1/2XU6	PIPING
0	21-13288-02	HV-81811	SAME	1	STARTUP VENT	GLOBE VALVE: 3"-900# BW	3"	GLOBE	900	BW	A217 WC6	CRANE	183 1/2 XU6	PIPING
0	21-13288-02	CV-81812	SAME	1	NON-RETURN VALVE	NON-RETURN VALVE: 6"-900# BW	6"	NRV	900	BW	WC6	EDWARDS	B4002Y	PIPING
0	21-13288-02	HV-81813	SAME	1	MAIN STEAM DRAIN	GATE VALVE: 1"-1500# SW	1"	GATE	1500		SA-182-F11 CL2	VOGT	SW15321	PIPING
0	21-13288-02	HV-81814	SAME	1	MAIN STEAM STOP	GATE VALVE: 6"-900# BW	6"	GATE	900	BW	A217 WC6	CRANE	83-1/2XU6	PIPING
0	21-13288-02	HV-81815	SAME	1	MAIN STEAM STOP BY-PASS	GLOBE VALVE: 1"-1500# SW	1"	GLOBE	1500	SW	SA-182-F11 CL2	VOGT	SW15351	PIPING

Project #: 13288
Project Name: Columbia Pulp
Document #: 67-13288-13A
Project Manager: Greg McNutt
Revision: 0
Report By: gmcnutt
Report Date: 5/23/18

ANCILLARY LIST

REV	QTY	Drawing #	Service	DESCRIPTION	MFR	MODEL #	SHIPPING METHOD
0	1	17-1184-009	RAIN HOOD	RAIN HOOD AIR INLET	VAW	GOOSENECK	L
0	1	17-1184-009	AIR INLET SILENCER	FRESH AIR INLET SILENCER W/ VOLU PROBE FLOW ELEMENT	VAW	RIB	L
0	1	63586.01	FD FAN	COMBUSTION AIR FAN SYSTEM - FD FAN	NORTHERN BLOWER	4270	L
0	1	4A040W602	FD FAN MOTOR	COMBUSTION AIR FAN SYSTEM - FD FAN MOTOR	TECO WESTINGHOUSE	AEHH-8N	I
0	1	63586.01	FD FAN FRESH AIR DAMPER (OPPOSED BLADE)	COMBUSTION AIR FAN SYSTEM - FD FAN FRESH AIR DAMPER	NORTHERN BLOWER	STANDARD	I
0	1	63586.01	FRESH AIR DAMPER ACTUATOR	BECK ELECTRIC W/ 4-20MA IN/OUT & OPEN/CLOSE SWITCHES	BECK	11-309	I
0	1	63586.01	FD FAN FGR MIXING BOX	COMBUSTION AIR FAN SYSTEM - FD FAN FGR MIXING BOX	NORTHERN BLOWER	60" w/30"FGR	L
0	1	63586.01	FD FAN INLET DAMPER (PARALLEL BLADE)	COMBUSTION AIR FAN SYSTEM - FD FAN INLET DAMPER (PARALLEL BLADE)	NORTHERN BLOWER	STANDARD	I
0	1	63586.01	FAN INLET DAMPER ACTUATOR	BECK ELECTRIC W/ 4-20MA IN/OUT & OPEN CLOSE SWITCHES	BECK	11-309	I
0	1	63586.01	FD FAN OUTLET DAMPER (OPPOSED BLADE)	COMBUSTION AIR FAN SYSTEM - FD FAN OUTLET DAMPER (OPPOSED BLADE)	NORTHERN BLOWER	STANDARD	I
0	1	63586.01	OUTLET DAMPER ACTUATOR	BECK ELECTRIC W/ 4-20MA IN/OUT & OPEN CLOSE SWITCHES	BECK	11-209	I
0	1	1941-001	FAN OUTLET EXPANSION JOINT	FAN OUTLET EXPANSION JOINT - 6" F-F, BELT TYPE W/ BOLTED BACKING BARS	FSP	BELT & BARS	L
0	1	71-13288-01	FAN TO BURNER WINDBOX AIR DUCT	FAN TO WINDBOX TRANSITION, BOLTED CONNECTIONS, W/ FOUR 1" HALF COUPLINGS 6" LONG I/C TAPS AND ACCESS DOOR	VEO	TRANSITION	L
0	1	9188020	NATURAL GAS BURNER/WINDBOX	COEN RAPID MIX BURNER / WINDBOX	COEN	CRMB	I
0	1	9188020	NATURAL GAS FUEL TRAIN	COEN NATURAL GAS FUEL TRAIN, WINDBOX MOUNTED	COEN	GAS	I
0	1	9188020	BMS/CCS CONTROL CABINET	FLOOR MOUNTED NEMA 4 ENCLOSURE, ALLEN BRADLEY PANEL VIEW PLUS 1250 TOUCHSCREEN, COMPACT LOGIX PROCESSORS	COEN	FyrMonitor	L
0	1	00-13288-00	SUPERHEATED STEAM BOILER	VICTORY ENERGY, VOYAGER SERIES, SUPERHEATED STEAM BOILER	VEO	VS-5-78SP SH	L
0	1	30-13288-00	FEEDWATER ECONOMIZER	VICTORY ENERGY, EXPLORER SERIES, FEEDWATER ECONOMIZER	VEO	30-13288-00	L
0	1	1588-1	STACK DAMPER	STACK OPPOSED BLADE DAMPER, 46" I.D, BOLTED CONNECTION DESIGNED FOR SUPPORTING STACK	FOX EQUIPMENT	36" 2 BLADE	L
0	1	1588-1	STACK DAMPER ACTUATOR	BECK ELECTRIC ACTUATOR W/ 4-20MA IN/OUT & OPEN/CLOSE SWITCHES	BECK	11-209	I
0	1	1588-2	FGR DAMPER	FGR OPPOSED BLADE DAMPER, 30" I.D. BOLTED CONNECTIONS	FOX EQUIPMENT	30" 2 BLADE	L
0	1	1588-2	FGR DAMPER ACTUATOR	BECK ELECTRIC ACTUATOR W/ 4-20MA IN/OUT & OPEN/CLOSE SWITCHES	BECK	11-209	I

INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR ALL ASHCROFT® BIMETAL DIAL THERMOMETERS

ASHCROFT®

GENERAL

In removing the thermometer out of the packing box, handle it by the case or case outlet. Avoid handling it by the stem.

INSTALLATION OF THERMOMETERS

The thermometer should be mounted at any convenient location where it will be subjected to the average temperature variations to be indicated.

For an EVERYANGLE CONNECTION PLEASE REFER TO THE REVERSE SIDE OF THIS DOCUMENT before beginning the installation.

Avoid bending the stem as this will cause misalignment of the internal parts, resulting in undue frictional errors.

To tighten the thermometer to the apparatus, use a wrench applied to the hexagon head of the threaded connection located just outside of the case.

INSTALLATION

Locate the stem so that at least two inches will be subjected to the average temperature to be measured.

Exposing the stem to a temperature in excess of the highest dial reading should be avoided.

The thermometer is normally provided with a threaded connection. To tighten the thermometer to the apparatus or into the well, use an open-end wrench applied to the hexagon head of the threaded connection. Turn until reasonably tight, then tighten still further in the same manner as a pipe elbow or similar pipe fitting until the scale is in the desired position for reading. DO NOT TIGHTEN BY TURNING THE THERMOMETER CASE. *Install the dry type thermometer so that the maximum case temperature is kept below 200°F at all times. Install the liquid filled type thermometer so that the maximum case temperature is kept below 150°F at all times.*

When a thermometer is equipped with a well, the well should be installed onto the apparatus first. The stem of the thermometer should then be coated with a heat conducting medium (a mixture of glycerin and graphite or vaseline or any other heavy lubricant may be used), after which the thermometer stem is inserted, and tightened into the well.

CAUTION:
Thermowells should be used on all pressurized applications, to protect the thermometer from corrosion or physical damage, and to facilitate removal of the thermometer without disturbing the process.

TESTING

Ashcroft Bimetal Dial Thermometers are carefully calibrated at the factory and under most operating conditions will retain their accuracy indefinitely. However, as in the case of all instruments, it is well to make periodic checks for accuracy against known standards.

ADJUSTMENT

If it is necessary to make an adjustment to the thermometer proceed as follows:

On thermometers fitted with an “External Adjustment” – Use a small wrench, small screwdriver or a coin to turn the slotted hexagon head in the back of the case until the pointer indicates the proper temperature on the dial.

MAINTENANCE OF DIAL THERMOMETERS

Aside from occasional testing, little or no maintenance is required.

Be sure that the gasketed glass cover is on the case at all times, as moisture and dirt inside the case will eventually cause the thermometer to lose its accuracy. (See caution note below.)

If the thermometer is used for measuring the temperature of a material that may harden and build up an insulating layer on the stem, the thermometer should be removed from the apparatus occasionally, and the stem cleaned. Observe this precaution to ensure the sensitivity of the instrument.

CAUTION:
Bimetal Thermometers operating below freezing must have a perfectly tight case to prevent entrance of moisture which eventually will condense and freeze inside the stem. This condition shows up as a failure of the thermometer to read accurately below 32°F or 0°C. For this reason it is important to avoid damage to the glass front while the stem temperature is at freezing or below. All thermometers are hermetically sealed in a dry atmosphere at the factory and require no further maintenance.

VICTORY ENERGY®

INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR ASHCROFT® BIMETAL THERMOMETERS WITH EVERYANGLE™ CONN.

ASHCROFT®

This thermometer was designed to be positioned to face the direction of easiest reading.

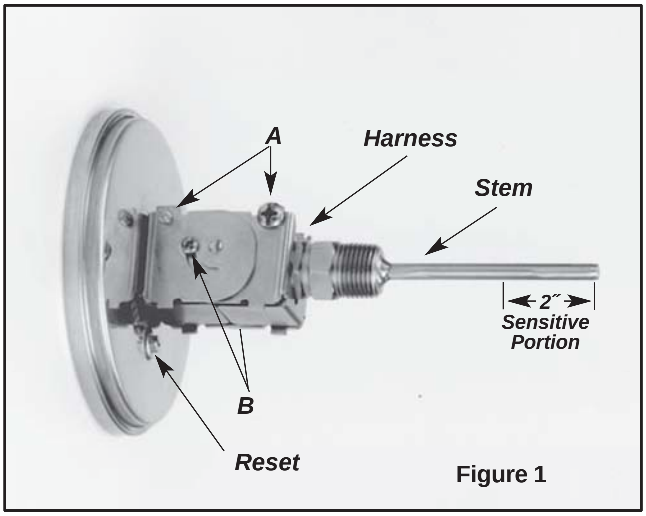

Figure 1

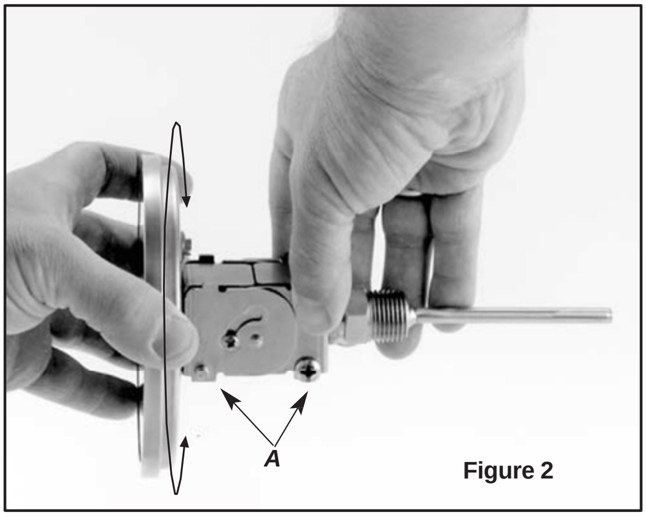

Figure 2

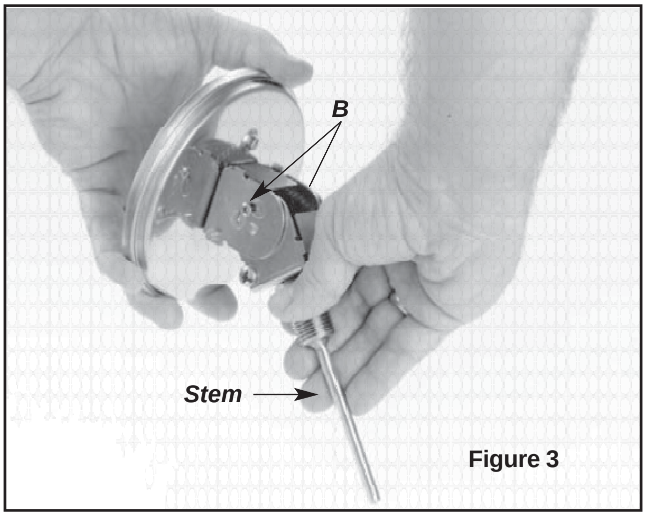

Figure 3

CAUTION: *To assure longest life, the "EVERY- ANGLE" joint should be operated only when necessary during installation or removal of the thermometer.*

POSITIONING THE STEM

Before installation, the stem should be set to the desired angle as follows:

Figure 1: Loosen the four screws labeled "A" and "B" in Figure 1, until the harness revolves freely without twisting the flexible housing.

Figure 2: While holding the case, revolve the harness clockwise or counterclockwise, as indicated by arrows in Figure 2, to place the harness in a position that will permit flexing the stem in the desired direction with respect to the case. Then lock the two screws labeled "A."

Figure 3: Flex the stem to the desired angle with respect to the face of the thermometer, as shown in Figure 3, then lock the two screws labeled "B."

INSTALLATION

The lower 2″ of the stem is the sensitive portion. Be sure this part of the stem is exposed to the temperature to be measured.

Tighten the thermometer to the apparatus or into the thermometer well, using an open-end wrench applied to the hexagon head of the connection bushing. Turn until reasonably tight, then tighten further (in the same manner as a pipe fitting) until the scale is in the desired position for reading.

DO NOT TIGHTEN BY TURNING THE THERMOMETER CASE OR THE HARNESS. INSTALL THE DRY TYPE EVERYANGLE THERMOMETER SO THAT THE MAXIMUM CASE TEMPERATURE IS KEPT BELOW 200°F. INSTALL THE LIQUID-FILLED TYPE EVERYANGLE THERMOMETER, SO THAT THE MAXIMUM CASE TEMPERATURE IS KEPT BELOW 150°F.

THERMOMETER WELLS

When the thermometer is equipped with a well, the well should first be removed from the thermometer and screwed into the apparatus.

VICTORY ENERGY®