FORM U-1A MANUFACTURER'S DATA REPORT FOR PRESSURE VESSELS
(Alternative Form for Single Chamber, Completely Shop or Field Fabricated Vessels Only)
As Required by the Provisions of the ASME Code Rules, Section VIII, Division 1

H156

1. Manufactured and certified by CHART COOLER SERVICE COMPANY, INC. 5500 E. INDEPENDENCE TULSA, OK 74115
(Name and address of manufacturer)

2. Manufactured for EXTERRAN ENERGY; 12001N. HOUSTON ROSSLYN; HOUSTON TX 77086
(Name and address of purchaser)

3. Location of installation UNKNOWN
(Name and address)

4. Type: HEAT EXCHANGER (Horiz. or vert. tank) | 33408-1 (Mfgr's serial No.) | - (CRN) | 33408-1 (Drawing no.) | 10927 (Nat'l Bd. No.) | 2008 (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, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 2007 (Year)

to - (Addenda (Date)) | - (Code Case Nos.) | - (Special Service per UG 120(d))

6. Shell: SA-516 70 (Matl. (Spec. No., Grade)) | 1.25" (Nom. Thk. (in.)) | 0.0625" (Corr. Allow. (in.)) | n/a (Diam. I.D. (ft. & in.)) | 13'-9.25" (Length (overall) (ft. & in.))

7. Seams: CORNER (Long. (Welded, Dbl., Sngl., Lap, Butt)) | NONE (R.T. (Spot or Full)) | n/a (Eff. (%)) | n/a (H.T. Temp (°F)) | n/a (Time (hr)) | n/a (Girth (Welded, Dbl., Sngl., Lap, Butt)) | NONE (R.T. (Spot, Eff.(%) or Full)) | n/a (No. of Courses)

8. Heads: (a) Matl. SA-516 70 (Spec No., Grade) (b) Matl. SA-516 70 (Spec No., Grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	Top/Bottom	1.25"	0.0625"	n/a	n/a	n/a	n/a	n/a	n/a	Flat
(b)	End	0.875"	0.0625"	n/a	n/a	n/a	n/a	n/a	n/a	Flat

If removable, bolts used (describe other fastenings) None (Matl., Spec. No., Gr., Size, No.)

9. MAWP 550 (internal) - (external) psi at max. temp. 225 (internal) - (external) °F

Min. design metal temp. -20 °F at 550 psi. Hydro., ~~pneu~~, ~~pneumatic~~ test pressure 715 psi.

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Matl.	Nom. Thk.	Reinforcement Matl.	How Attached	Location
INLET/OUTLET	4	12"-300#	RFWN/Pipe	SA-105/SA-106-B	XS	Integral	UW16.1a	Wrapper
Auxilary	2	1"	Cplg	SA-105	6000#	Integral	UW16.1a	Pipe
Inspection	564	1.125"	NF	SA-105	n/a	n/a	n/a	Plugsheet

11. Supports: Skirt No (Yes or no) Lugs 8 (No.) Legs None (No.) Other Nameplate Bracket (Describe) Attached Header/Welded (Where and how)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report: -

none
(Name of part, item number. Mfgr's name and identifying stamp)

[1] NO RELIEVING DEVICE PER UG-125. [2] CONSTRUCTED PER APPENDIX 28. [3] AIR-COOLED HEAT EXCHANGER
[4] TUBE: 1"ODX0.065" AW X 42' LG, SA-214, QTY-282. [5] IMPACT TEST EXEMPT PER UG-20(f) & UCS 66.
[6] SERVICE "EXPANDER COMPRESSOR". [7] HEADER OUTSIDE DIMENSIONS: 10.25" X 14.25" X 165.25"

CERTIFICATE OF SHOP / FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME Code for Pressure Vessels, Section VIII, Division 1. "U" Certificate of Authorization No. 28648 expires 10/10/2010.

Date 11-22-08 Co. Name CHART COOLER SERVICE COMPANY, INC. (Manufacturer) Signed Skip Fruge' (Representative)

CERTIFICATE OF SHOP / FIELD INSPECTION

Vessel constructed by CHART COOLER SERVICE COMPANY, INC. at 5500 E. INDEPENDENCE TULSA, OK 74115

I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and the State or Province of Oklahoma and employed by Hartford Steam Boiler Inspection & Insurance Co. of CT have inspected the component described in this Manufacturer's Data Report on 11/21/08, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the Inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel 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 11/24/08 Signed (Authorized Inspector) Commissions OK 11445 A OK 714 (Nat'l Board. (incl. endorsements) State, Prov. and No.)

Cooler Service Company Inc.

P.O. Box 581928 Tulsa, Ok 74158 Ph 918.834.0002 Fax 918.834.0128

AIR COOLED HEAT EXCHANGER SPECIFICATION SHEET

					Date:	6/10/08 Rev.
Customer	Exterran Energy Solutions				Item No.	A-321
Plant Location	125 MMSCFD "GSP" Cryogenic Plant		Job No. US-106521		Ref. No.	33408
Service	Expander Compressor Discharge Cooler (HP Case				P.O. No.	4634152
Size and Type	Model: H156-2-42	FORCED Draft	No. Bays	1		
Surface/Unit - Finned Tube	65801.2 ft2		;Bare Tube	3,101 ft2		
Heat Exchanged	6,241,000 Btu/h		MTD, Eff.	23.21 ºF		
Transfer Rate-Finned Tube	4.086	;Bare Tube, Service	86.719	Clean	96.316	Btu/h.ft2.F

PERFORMANCE DATA - TUBE SIDE

Fluid Name		Natural Gas	**Vapor Ref. Temp.**	ºF	166.1 / 120.0	
Total Fluid In	lb/h	242215	Specific Heat	Btu/lb.F	0.568 / 0.557	
Vapor	lb/h	242215	Viscosity	cP	0.0133 / 0.0125	
Liquid	lb/h	0	Conductivity	Btu/h.ft.F	0.0236 / 0.0215	
Noncond	lb/h		Molecular Weight		18.2 / 18.2	
Steam	lb/h		**Liquid Ref. Temp.**	ºF	0.0 / 0.0	
Water	lb/h		Specific Heat	Btu/lb.F	0.0 / 0.0	
Fluid Cond./Vapzd.	lb/h	0	Viscosity	cP	0.0 / 0.0	
Temperature In/Out	ºF	166.1 / 120.0	Conductivity	Btu/h.ft.F	0.0 / 0.0	
Pressure	psia	406.9	Density	lb/ft3	0.0 / 0.0	
Velocity In/Out	ft/s	50.22 / 47.1				
Press. Drop Allow/Calc	psi	5.0 / 2.926	Fouling resistance	h.ft2.F/Btu	0.001	

PERFORMANCE DATA - AIR SIDE (Air)

Air Quantity, Total	lb/h	1570731	Altitude above Sea Level	ft	7500
Air Quantity/Fan	acfm	249619.9	Temperature In (Dry Bulb)	ºF	105
Actual Static Press	in H2O	0.614	Temperature Out	ºF	121.4
Face Velocity	sfm	608	Min. Design Ambient	ºF	-20
Max Mass Velocity	lb/h.ft2	5,870	Fan Air Temperature	ºF	105

DESIGN - MATERIALS - CONSTRUCTION

Design Pressure	550.0	psig	Test Pressure	Per Code	Design Temperature	225 / -20		ºF
TUBE BUNDLE			**HEADER, Type**	Plug Box	**TUBE, Material**	SA-214		
Size	13.685 x42.0		Material	SA-516-70		Wld		
No./Bay 1	No. Rows 4		No. Passes 1		OD	1 Thick	0.065	in
Arrangement			Slope	0 in/ft	No./Bundle	282		
Bundles	1 Parallel		Plug Material	SA-105	Length	42		ft
Bays	1 Parallel		Gasket Material	CS	Pitch	2.313		in
MISCELLANEOUS			Corrosion Allow.	0.0625 in	**Fin, Type**	TWF		
Struct. Mount	Grade c/c		No. Size In Nozz.	2 - 12" 300# RF-WN	Material	Aluminum		
Surf Prep	SSPC-2		No. Size Out Nozz.	2 - 12" 300# RF-WN	OD	2.25 Thk.	0.015	in
Surf Finish	Galvanize		Vent and Drain	1" 6000#	No./in	10 Fin Design Temp		
Hail Guards	Integral w/ Louvers		TI	PI	Code -	ASME Stamp	Yes	
Louvres / Actuators	Manual		Header Prep	SSPC-SP-5	X-RAY	NO PWHT	NO	
Vibration Switches	Murphy VS2-EX		Header Finish	Metalize	SPECS.	API-661	No	

MECHANICAL EQUIPMENT

Fan Mfg	Moore		**Driver**		**Speed Reducer**			
Model Class 10000	Series 42 SC		Type	Electric Motor	Type	HTD		
No./ Bay 2	Rev/Min 294		Mfg.	Siemens or Equal	Mfg.	Gates		
Dia. ft 13	No. Blades 7		No/Bay 2	Frame 326T	Model	14MGT-3500-20	F14M-224S-20	
Pitch 23.29 (18.7 @ 3000')	Manual		hp /Driver	50	No/Bay	2	PB14MX-37S-90	
Mat'l:Blade	AL	Hub AL	Rev/Min	1750	AGMA Rating, hp	1.8		
hp/Fan, Design	38.9 (34.02 @ 3000')		Enclosure	TEFC Ins F TR B	Ratio	5.952		
hp/Fan, Min Amb			Volt;Phase;Cycle	460/3/60	Support	Structure		
Plot Area	42 x 13.8020	ft2	Total Weight (per bay	39930	Dry	Coil Vol	546	Gal
Walkways	Width	Type	Recirculation		Wind Load	Per Specs		
Inlet					Seismic Zone	Per Specs		
Outlet								
Drive								

10% added to flow and duty; Unit designed for LP and HP cases

Motor suitable for VFD and includes 120V space heater

Chart Cooler Service Company, Inc.
3515 Dawson Road
Tulsa, Oklahoma 74115
(918) 834-0002

Customer: **Exterran Energy Solutions, L.P.** Date: **6/16/2008** Approved: _____
Customer P.O. No.: **4634152**
Item No.: **A-321**
Service: **Expander Compressor Discharge Cooler**

Header Design Calculations
Per 2007 ASME Code Section VIII Division 1 Appendix 13
Fig. 13-2(a) Vessels of Rectangular Cross Section - Sketch (1)
UG-22 has been considered for specified loadings and no additional calculations are required.

Job No.: **33408-01 Inlet-Outlet**
Short Side: **TubeSheet**
Design Press. (P): **550 PSI** Test Press.: **715 PSI**
Design Temp.: **225 °F** / -20 °F MDMT
Material: **SA-516 - 70 (UNS No. K02700)**
Allow. Membrane Stress: **20000 PSI**
Allow. Bending and Total Stress: **30000 PSI** (1.5 x Membrane Stress)
Corrosion Allowance: **0.0625 in.**
Long side Sheet Thickness: **1.25 in.**
Long side Sheet Thickness Less Corr. Allow.= t_2 = **1.1875 in.**
Short side Thickness: **1.25 in.**
Short side Thickness Less Corr. Allow. = t_1 = **1.1875 in.**
H (corroded) = **7.875 in.**
h (corroded) = **11.875 in.**
Horizontal Tube Pitch (***pitch***) = **2.3125 in.**
D (Hole diameter) = **1.09375 in.**
E = 1.0 (see 13-4-g-1)

Bending and Membrane Efficiencies, $e_b = e_m = \frac{pitch - D}{pitch}$ = **0.52703**

Short side $e_b = e_m$ = **0.52703**
Long side $e_b = e_m$ = **1**

c = (c_1 or c_2); $c_1 = t_1/2$ = **0.59375**; $c_2 = t_2/2$ = **0.59375**

$\alpha = H/h$ = **0.66316**

$I_1 = t_1^3/12$ = **0.13955 in.^4**

$I_2 = t_2^3/12$ = **0.13955 in.^4**

$K = \left(I_2/I_1\right)\alpha$ = **0.66316**

Job No.: **33408-01 Inlet-Outlet**

(1) Membrane Stress

Short-Side Plates $S_m = Ph/2t_1e_m$ = **5218 PSI**

Long-Side Plates $S_m = PH/2t_2e_m$ = **1824 PSI**

(2) Bending Stress

Short-Side Plates $(S_b)_N = \pm\frac{Pc_1}{12I_1e_b}\left[-1.5H^2 + h^2\frac{(1+\alpha^2K)}{1+K}\right]$ = **6103 PSI**

$(S_b)_Q = \pm\frac{Ph^2c_1}{12I_1E}\left(\frac{1+\alpha^2K}{1+K}\right)$ = **21357 PSI**

Long-Side Plates $(S_b)_M = \pm\frac{Ph^2c_2}{12I_2e_b}\left[-1.5 + \frac{(1+\alpha^2K)}{1+K}\right]$ = **-19893 PSI**

$(S_b)_Q = \pm\frac{Ph^2c_2}{12I_2E}\left(\frac{1+\alpha^2K}{1+K}\right)$ = **21357 PSI**

(3) Total Stress

Short-Side Plates $(S_T)_N = S_m + (S_b)_N$ = **11320 PSI**

$(S_T)_Q = S_m + (S_b)_Q$ = **26575 PSI**

Long-Side Plates $(S_T)_M = S_m + (S_b)_M$ = **21717 PSI**

$(S_T)_Q = S_m + (S_b)_Q$ = **23181 PSI**

(4) End Plate Stress (per UG 34)

d (corroded) = **7.875 in.**

D (corroded) = **11.875 in.**

c = 0.2 (see 13-4(f))

End Plate Thickness: **0.875 in.**

End Plate Thickness Less Corr. Allow. = t_{ep} = **0.8125 in.**

$Z = 3.4 - 2.4\left(\frac{d}{D}\right)$ = **1.80842** Max 2.5

$S = \frac{cd^2ZP}{t_{ep}^2}$ = **18687 PSI**

Chart Cooler Service Company, Inc.
3515 Dawson Road
Tulsa, Oklahoma 74115
(918) 834-0002

Customer: **Exterran Energy Solutions, L.P.** Date: **6/16/2008** Approved:
Customer P.O. No.: **4634152**
Item No.: **A-321**
Service: **Expander Compressor Discharge Cooler**

Tube and Nozzle Design Calculations
Per 2007 ASME Code Section VIII Division 1

UG-22 has been considered for specified loadings and no additional calculations are required.

Job No.: **33408-01**

Design Press. (P): **550 PSI**
Design Temp.: **225 °F** / -20 °F MDMT
Corrosion Allowance (CA): **0.0625 in.**
Weld Efficiency (E): **1.0**

Tubes

Tube Material: **SA-214 - (UNS No. K01807)**
Allowable Stress (S): **11400 PSI**
Tube Outside Diameter: **1 in.**
Tube Outside Radius (R_o): **0.5 in.**

$$t_{req'd} = \frac{PR_0}{SE + 0.4P} = \textbf{0.0237 in.}$$

Tube thickness used: **0.058 in.**

Nozzles

Nozzle Material: **SA-106 - B (UNS No. K03006)**
Nozzle Allowable Stress (S): **17100 PSI**

Inlet Nozzle

Inlet Nom. Pipe Size: **12"**
Inlet Outside Radius (R_o): **6.375 in.**

$$t_{req'd} = \left(\frac{PR_0}{SE + 0.4P} + CA \right) \div 0.875 = \textbf{0.3028 in.}$$

Uncorroded Inlet Nozzle thickness used: **0.5 in.**

Outlet Nozzle

Outlet Nom. Pipe Size: **12"**
Outlet Outside Radius (R_o): **6.375 in.**

$$t_{req'd} = \left(\frac{PR_0}{SE + 0.4P} + CA \right) \div 0.875 = \textbf{0.3028 in.}$$

Uncorroded Outlet Nozzle thickness used: **0.5 in.**

CHART COOLER SERVICE COMPANY, INC.
5500 E. INDEPENDENCE • TULSA, OK 74158
PHONE: 918.834.0002 • FAX: 918.834.0128

HYDROSTATIC TEST CERTIFICATION

CUSTOMER	Exterran	**CCSC SERIAL NO.**	**33408-1**
P.O. NO.	4634152	**SERVICE**	EXP. COMP.
REF. NO.	US-106521	**TAG NO.**	A-321

On this Date	11-21-08
Test Pressure	715 PSI
Duration	1 HOUR

COMMENTS

CERTIFIED BY	R.Smith	11-21-08
	CCSC INSPECTOR	*DATE*

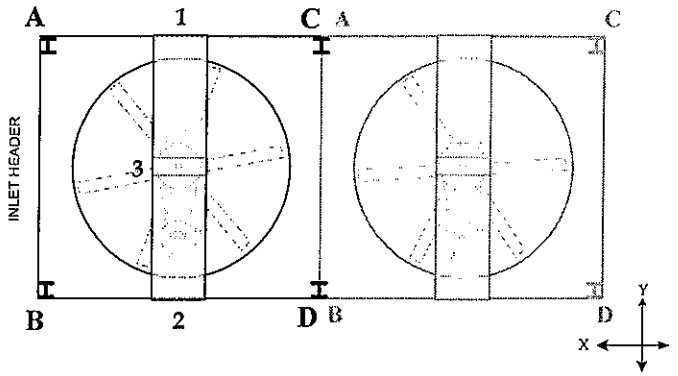
CHART COOLER SERVICE COMPANY, INC.
5500 E. INDEPENDENCE · TULSA, OK 74158
PHONE: 918.834.0002 · FAX: 918.834.0128

RUN-TEST INSPECTION
H-MODEL AIR-COOLERS

CUSTOMER	EXTERRAN	CCSC SERIAL NO.	33408
MODEL	H156	PO. NO.	4634152
REF. NO.	US-106521	TAG NO.	A-321

VIBRATION RECORDINGS (mils)

FAN - 1 | FAN - 2 / 3



ELECTRIC MOTOR SPECIFICATION

HP	50	
Phase	3	
Frequency	60	Hz
Speed @ rated load	1750	RPM
Voltage	460	V
Current @ rated load	58.0	Amps
Notes Fan RPM 294		

Vibration Locations	FAN - 1		FAN - 2		FAN - 3	
	X-axis	Y-axis	X-axis	Y-axis	X-axis	Y-axis
COLUMN – A	1.4	.5	1.0	1.3		
COLUMN – B	1.7	1.8	1.5	1.4		
COLUMN – C	1.0	1.3	1.3	1.2		
COLUMN – D	1.5	1.4	1.7	1.5		
DRIVE FRAME - 1	1.1	1.4	1.7	1.9		
DRIVE FRAME - 2	1.2	1.5	1.6	1.8		
DRIVE FRAME - 3	1.8	---	1.7	---		---

0.70

MOTOR AMP. (actual)	45.0	45.0	
MOTOR RPM (actual)	1789.6	1789.6	
FAN RPM (actual)	295.7	295.7	

COMMENTS
3:30pm

1) Unit run on inside CSCI's facility- Tulsa, OK; Elevation: 675 ft above sea level.
2) Ambient Air Temperature – deg. F.
3) Degree of Assembly during test: *(Check all that apply)*

- ☐ Shipping timbers attached
- ☑ Lower Stub Columns & Knee Braces attached
- ☐ Header Walkway(s) attached
- ☐ Recirculation System Assembled

RESULTS RECORDED		
	Ryan Smith (CSCI INSPECTOR)	11/21/08 (DATE & TIME)

CHART COOLER SERVICE COMPANY, INC.
5500 E. INDEPENDENCE · TULSA, OK 74158
PHONE: 918.834.0002 · FAX: 918.834.0128

CERTIFICATE OF COMPLIANCE

CUSTOMER	Exterran	CCSC SERIAL NO.	33408
P.O. NO.	4634152	REF. NO.	US-106521
MODEL	H156	TAG NO.	A-321

To the best of our knowledge, the material supplied is in full compliance with all applicable standards, specifications, and conditions established on the referenced purchase order.

All materials used in the fabrication and assembly of the equipment are new. Neither used, nor remanufactured, nor reconditioned materials were utilized in the manufacture of the equipment.

The undersigned certifies that the subject equipment was inspected and satisfactorily passed all required tests and examinations.

COMMENTS

CERTIFIED BY	R. DAVIS	11-21-08
	CCSC QUALITY CONTROL MANAGER	*DATE*

Moore Fans LLC Rating

Phone: (660) 376-3575 www.moorefans.com Fax: (660) 376-2909

Version 2.02

5/7/2008 20:13

Exterran Energy Solutions			Ref No.:			Item No:	**A-321**
Class:	**10000**		Hub Type:	**HD**		Blade Type:	**SC**
Blade Tip:	**0**		Adjustment:	**MAN**		Rotation:	**RH**
Series:	**42**		Diameter:	**13** feet		Blades:	**7**
Temperature:	**105** Deg. F		Elevation:	**7500** feet		Density Ratio:	**0.711**
Volume:	**792606** Lb/Hour		Air Vel.:	**1967.15** fpm		Speed:	**294** RPM
Static Pressure:	**0.61368086** in H2O		Pv:	**0.171** in H2O		Pt:	**0.836** in H2O
Power Reqd.:	**38.90** bhp		Motor:	**50** bhp		Total Eff:	**83.9%**
						Static Eff:	**61.6%**
Blades Required:	**6.66**		API Blds Req.:	**8.00**		Blade Load:	**0.951**
Tip Speed:	**12007.2** fpm		Deflection Angle:	**52.6** deg.		Pitch Number:	**1.91**
Entry Correction:	**1.3**		Tip Clearance:	**0.5** inches		Design Angle:	**23.3** deg
Exit Correction:	**1**		Draft:	**FORCED**			
Starting Torque:	**2**		Max Torque:	**1786** ft. lbs		Torq/Bld:	**255** ft. lbs
Appr fan weight:	**182** lbs		**83** kg			Bore Size:	**2.4375** inches
WR2	**1284** lb-ft2		**54.2** kg m2			Bushing Type:	**U**
Thrust Load:	**577** lbs		**262** kg			Qty required:	**1**

Noise Levels Per Fan (Forced Draft)

Sound Power Level

dBA	HZ 63	125	250	500	1000	2000	4000	8000
103.5	**109.5**	**108.5**	**105.5**	**100.5**	**98.5**	**92.5**	**86.5**	**80.5**

Sound Pressure Level 1 meter below fan

88.9	**94.9**	**93.9**	**90.9**	**85.9**	**83.9**	**77.9**	**71.9**	**65.9**

Sound Pressure Level 1 meter from blade tip

84.1	**90.1**	**89.1**	**86.1**	**81.1**	**79.1**	**73.1**	**67.1**	**61.1**

Fan Selected

Class 10000, Series 42, 13 feet Diameter, 7 Blades

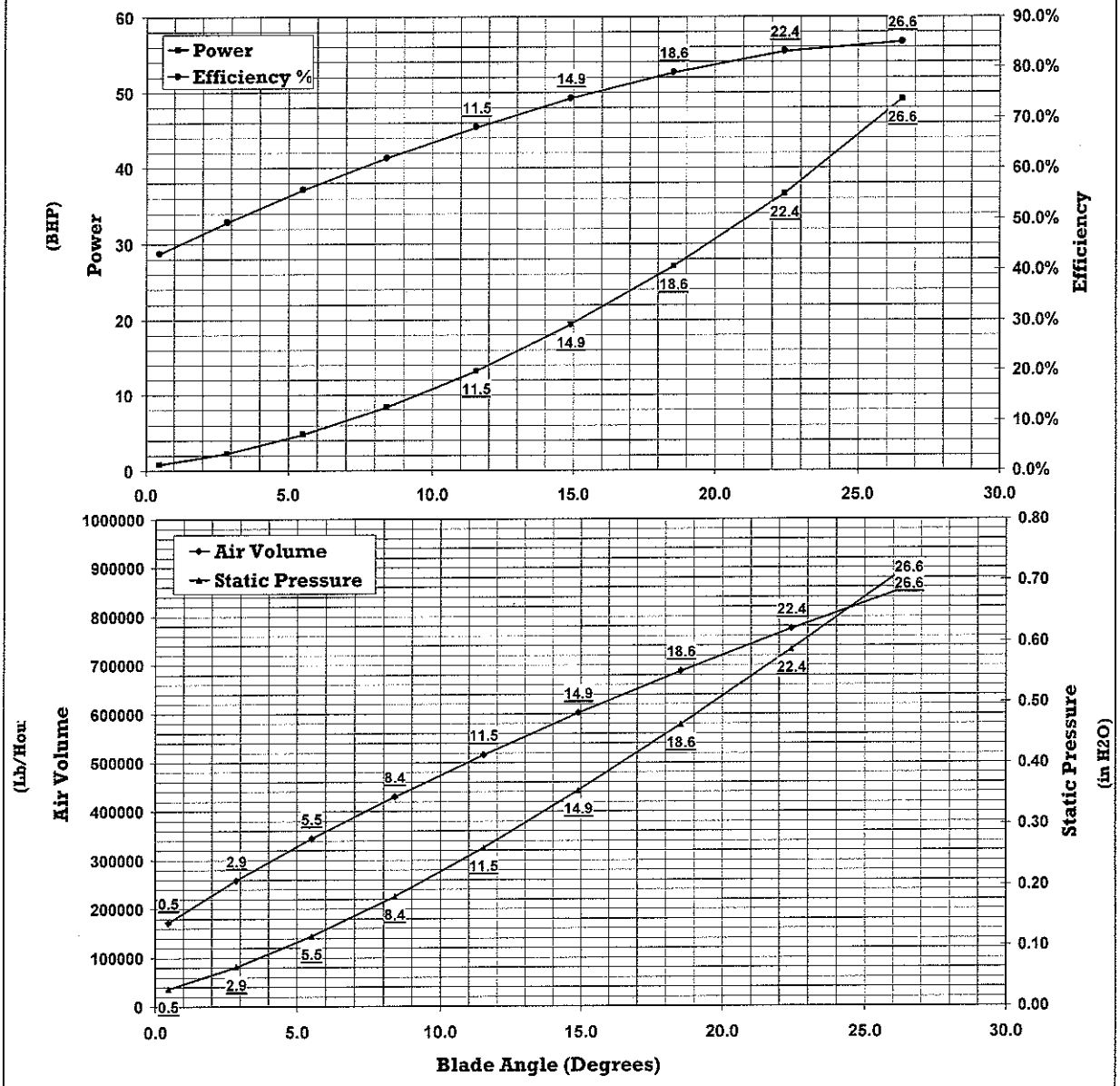
Manual Adustment, Heavy Duty, Standard Chord, Right Hand Rotation

Moore Fans LLC

Phone: (660) 376-3575 www.moorefans.com Fax: (660) 376-2909

Exterran Energy Solutions **Reference No.** **Item No.** **A-321**

System Performance Curve



Design Angle= 23.3

Design Conditions

Class:	10000	**Blade Type:**	SC	**Temperature:**	105 Deg. F	**Static Pr.:**	0.61368 in H2O
Series:	42	**Blade Tip:**	0	**Elevation:**	7500 feet	**Power Req'd:**	38.90 bhp
Diameter:	13.00 feet	**Adjustment:**	MAN	**Density Ratio:**	0.711	**Design Angle:**	23.3 deg
RPM:	294	**Blades:**	7	**Air Volume:**	792606.00 Lb/Hour	**Weight:**	182 lbs

Moore Fans LLC Rating

Phone: (660) 376-3575 www.moorefans.com Fax: (660) 376-2909

Version 2.02

5/7/2008 20:15

Exterran Energy Solutions		Ref No.:		Item No:	**A-321**
Class:	**10000**	Hub Type:	**HD**	Blade Type:	**SC**
Blade Tip:	**0**	Adjustment:	**MAN**	Rotation:	**RH**
Series:	**42**	Diameter:	**13** feet	Blades:	**7**
Temperature:	**105** Deg. F	Elevation:	**3000** feet	Density Ratio:	**0.840**
Volume:	**792606** Lb/Hour	Air Vel.:	**1665.43** fpm	Speed:	**294** RPM
Static Pressure:	**0.61368086** in H2O	Pv:	**0.145** in H2O	Pt:	**0.802** in H2O
Power Reqd.:	**34.02** bhp	Motor:	**40** bhp	Total Eff:	**77.9%**
				Static Eff:	**59.6%**
Blades Required:	**5.41**	API Blds Req.:	**6.00**	Blade Load:	**0.772**
Tip Speed:	**12007.2** fpm	Deflection Angle:	**51.5** deg.	Pitch Number:	**1.62**
Entry Correction:	**1.3**	Tip Clearance:	**0.5** inches	Design Angle:	**18.7** deg
Exit Correction:	**1**	Draft:	**FORCED**		
Starting Torque:	**2**	Max Torque:	**1429** ft. lbs	Torq/Bld:	**204** ft. lbs
Appr fan weight:	**182** lbs	**83** kg		Bore Size:	**2.4375** inches
WR2	**1284** lb-ft2	**54.2** kg m2		Bushing Type:	**U**
Thrust Load:	**553** lbs	**251** kg		Qty required:	**1**

Noise Levels Per Fan (Forced Draft)

Sound Power Level

dBA	HZ 63	125	250	500	1000	2000	4000	8000
102.9	**108.9**	**107.9**	**104.9**	**99.9**	**97.9**	**91.9**	**85.9**	**79.9**

Sound Pressure Level 1 meter below fan

88.3	**94.3**	**93.3**	**90.3**	**85.3**	**83.3**	**77.3**	**71.3**	**65.3**

Sound Pressure Level 1 meter from blade tip

83.5	**89.5**	**88.5**	**85.5**	**80.5**	**78.5**	**72.5**	**66.5**	**60.5**

Fan Selected

Class 10000, Series 42, 13 feet Diameter, 7 Blades

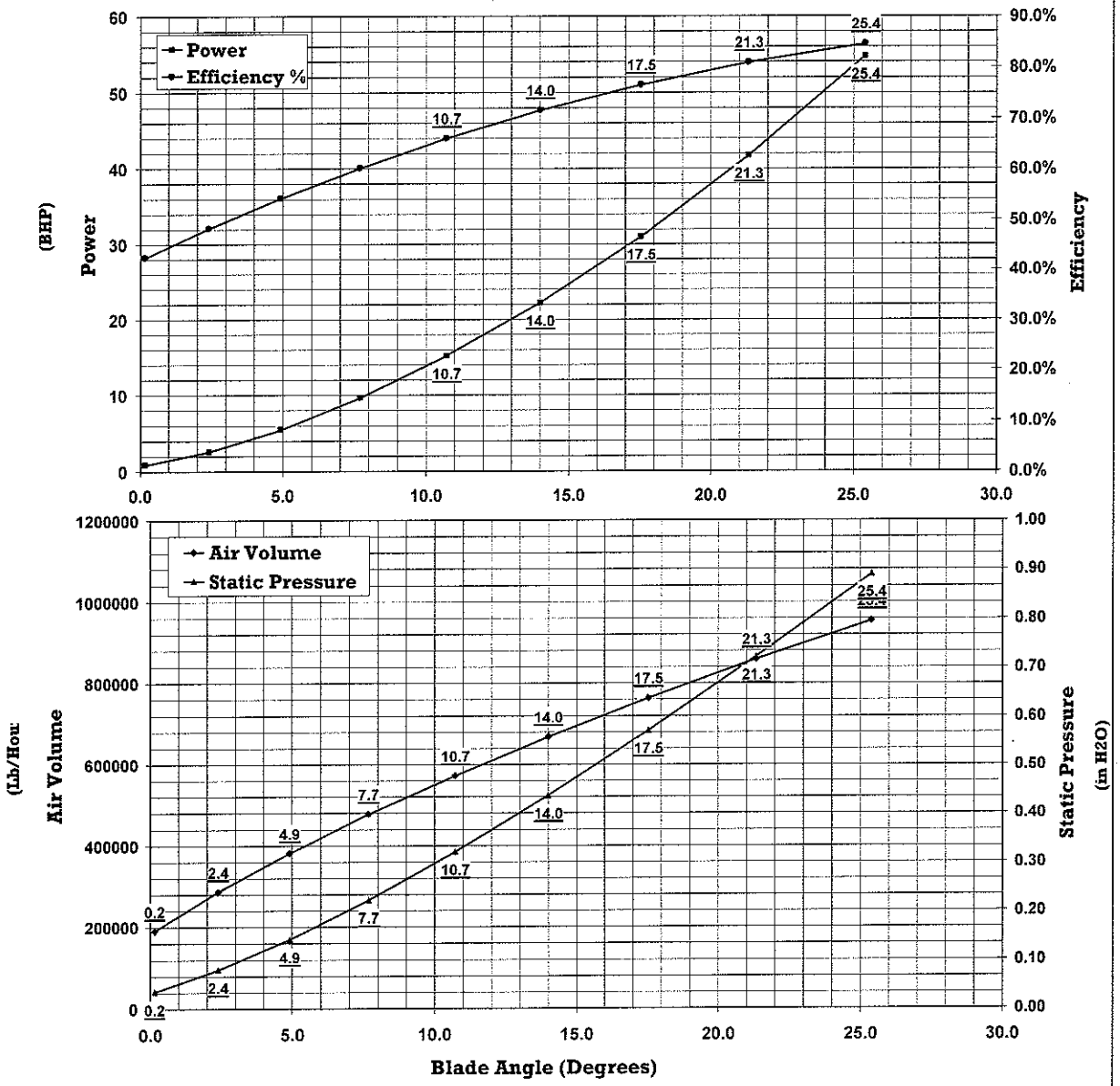
Manual Adustment, Heavy Duty, Standard Chord, Right Hand Rotation

Moore Fans LLC

Phone: (660) 376-3575 www.moorefans.com Fax: (660) 376-2909

Exterran Energy Solutions **Reference No.** **Item No.** **A-321**

System Performance Curve



Design Angle= 18.7

Design Conditions

Class:	10000	**Blade Type:**	SC	**Temperature:**	105 Deg. F	**Static Pr.:**	0.61368 in H2O
Series:	42	**Blade Tip:**	0	**Elevation:**	3000 feet	**Power Req'd:**	34.02 bhp
Diameter:	13.00 feet	**Adjustment:**	MAN	**Density Ratio:**	0.840	**Design Angle:**	18.7 deg
RPM:	294	**Blades:**	7	**Air Volume:**	792606.00 Lb/Hour	**Weight:**	182 lbs

MATERIAL TEST REPORT

Sold To: 61162	Ship To: 61866
CHART COOLER SERVICE COMPANY, INC. PLANT 2 5500 E. INDEPENDENCE TULSA OK 74115 US	CHART COOLER SERVICE COMPANY, INC. PLANT 1 3515 DAWSON ROAD TULSA OK 74115 US

Purchase Order:	33408 / 2702574
Sales Order:	109478
Material:	A13110000650 A/SA 214/178-A ERW 1000D 065A
Delivery:	80165034

Description: ASTM/ASME A/SA 214-96(05) ERW

Test: NDT ELECTRIC TESTED TO ASTM A450 OR A1016 & APPLICABLE TEST METHOD E309 OR E426. FLANGE TEST PASSED. FLATTENING TEST PASSED. REVERSE FLATTENING TEST PASSED.

Heat Number: WE82207

CARBON	Idl	0.1000
MANGANESE	Idl	0.4300
PHOSPHORUS	Idl	0.0140
SULFUR	Idl	0.0100
SILICON	Idl	0.0300
NICKEL	Idl	0.0400
CHROMIUM	Idl	0.0800
MOLYBDENUM	Idl	0.0100
COPPER	Idl	0.1500
ALUMINUM	Idl	0.0310
BORON	Idl	0.0001
NITROGEN	Idl	0.0085
TITANIUM	Idl	0.0020
VANADIUM	Idl	0.0040
Ultimate (PSI)		
Yield (PSI)		
Elongation (%)		
Hardness (RB)		60 / 63
Manufactured in		USA

Inspected By Marcy Arnold CCS 10/29/08

Webco Industries, Inc. certifies that the material described was manufactured and tested and/or inspected in accordance with the specification and fulfills requirements in such respect.
This document conforms to the requirements ofSpecification EN 10204 Inspection Document Type 3.1.
This document was prepared by means of electronic processing and is valid without signature.

Date: 10/15/2008

Tim Benear
Quality Manager

J# 33408 (-1)

G-9 CS

Carol

Hascall STEEL COMPANY
1125 RIVER STREET BENTON AR 72015
(501) 778-1600 - FAX (501) 778-2152

Shipped Date	Shipper No
7/2/2008	226509

FREIGHT COLLECT - CLASS 50

BILL OF LADING - (CUSTOMER COPY) BENTON - SALES

Sold To:
SUN MANUFACTURING
P.O. BOX 1960
BROKEN ARROW OK 74013
(918) 486-4515 / FAX (918) 486-4663 USA

Ship To:
CUSTOMER PICK UP
SUN MFG.
12232 S. STATE HWY 51
COWETA OK 74429
(918) 486-4515 / FAX (918) 486-4663 USA

Confirm To WAYNE
Terms 1% DISCOUNT 10 DAYS, NET 30
Loading Spec. FORK REAR

Ship VIA CUSTOMER PICKUP
F.O.B. HASCALL - BENTON PLANT

Ship	Load	Check

HSC ITEM	RELEASE NO	PART NO	PURCHASE ORDER NO
001 - 84415		00601500	10381

TAG NO.	PIECES	WEIGHT	GAUGE	X	WIDTH	X	LENGTH	TYPE / QUALITIES
889462	11	2,860	.060 NOM	X	1.5000	X	COIL	Cold Rolled / CQ

C	Mn	P	S	Si	Al
0.0320	0.1930	0.0110	0.0010	0.0360	0.0210

Heat Number	Rockwell
FY1493	51 / 54

TAG NO.	PIECES	WEIGHT	GAUGE	X	WIDTH	X	LENGTH	TYPE / QUALITIES
889496	11	2,855	.060 NOM	X	1.5000	X	COIL	Cold Rolled / CQ

C	Mn	P	S	Si	Al
0.0320	0.1930	0.0110	0.0010	0.0360	0.0210

Heat Number	Rockwell
FY1493	51 / 54

TAG NO.	PIECES	WEIGHT	GAUGE	X	WIDTH	X	LENGTH	TYPE / QUALITIES
889497	10	2,590	.060 NOM	X	1.5000	X	COIL	Cold Rolled / CQ

C	Mn	P	S	Si	Al
0.0320	0.1930	0.0110	0.0010	0.0360	0.0210

Heat Number	Rockwell
FY1493	51 / 54

Inspected By
Marcy Arnold

** ALL LOADS MUST BE TARPED - NO EXCEPTIONS **

Received By : Date :

ALL MATERIAL RECEIVED IN GOOD CONDITION

"CUSTOMS CHARGES" TO FOREIGN COUNTRY ARE THE RESPONSIBILITY OF THE "SOLD TO", NOT HASCALL STEEL.

HASCALL STEEL ENCOURAGES RECYCLING. WE WOULD BE HAPPY TO CONSIDER RECYCLING YOUR SKIDS. PLEASE SEE OUR DRIVER.

gail, 7/3/2008 - 11:55:12 AM

J#33408

1 3/8" H&K SA105

NIAGARA LASALLE CORPORATION

LaSalle Steel Co.
1412 150th Street
Hammond IN 46327-1799

CERTIFICATION

CERTIFICATE	Rev
H109192	2
DATE	
05/30/08	
PAGE	
1	

SHIP TO
RAM MACHINE PRODUCTS LLC
9818 S 219TH E AVE
BROKEN ARROW OK 74014
USA

PURCHASE ORDER 8024
ORDER 585188-1
CUSTOMER ITEM 91-13-000-0200 ITEM 411375132184D
GRADE 1018 SHAPE Hexagon
SIZE 1.3750 SIZE MM 34.9250 MM
LENGTH 11' 0" / 12' 6" LENGTH MM 3352.8 / 3810

1018 Si .10/.35 (TO CHEM & MECH OF ASTM A105-05) COLD DRAWN HIGH STRESS RELIEVE 70K TS 36K YS 22% EL 30% R/A HBN 187 MAX MAG TEST ASME SA-105 ROLL MARK "A105" Spec/Rev: Spec/Rev: A108-03E1 Spec/Rev: A29-05

HEAT	GRAIN PRACTICE	SOURCE / MELTED	CAST	REDUCTION RATIO	DI
896502	FINE(5-8)	MITTAL - EC-IND. (USA)	STRAND	27.5:1	

CHEMISTRY

C	MN	P	S	SI	NI	CR	MO	CU	AL	V
0.19	0.78	.007	.024	0.200	0.08	0.12	.030	.180	.028	.004

N	TE	AS	PB	SE	BI	B	NB
N/A	N/A	N/A	N/A	N/A	N/A	N/A	.0030

MECHANICAL

JOB	TENSILE	.2% YIELD	ELONG	R OF A	HARDNESS	.02% YIELD	COMMENT
H739310	86,808 PSI	72,261 PSI	22.70	57.90	HRB = 87		

LOT

LOT	JOB	WEIGHT (LBS)	PIECES
2989958	H739310	3,800	57
2989964	H739310	3,800	57
2989979	H739310	3,800	57
2990005	H739310	3,800	57
2990030	H739310	3,800	57
2990050	H739310	3,800	57
2989960	H739310	3,800	57
2989970	H739310	3,800	57
2989994	H739310	3,800	57
2990019	H739310	3,800	57
2990043	H739310	3,800	57
2990077	H739310	3,890	58

CHARPY IMPACT @ -50F = 6-6-5

Inspected By: Marcy Arnold QC 10/30/08

WE, hereby certify that these goods were produced in compliance with all applicable requirements of sections 6, 7, and 12 of the Fair Labor Standards Act, as amended, and all regulations and orders of the United States Department of Labor issued under section 14 thereof. Material was not exposed to mercury or any metal alloy that is liquid at ambient temerature during processing or while in our possession. No weld repairs performed on the above material.

CERTIFICATE OF TEST By: Walter P. Kretzler - Director of Q.A./Chief Metallurgist

33408

W8F643 B22 ID#2058

SSAB

Test Certificate

Form TC1: Revision 1: Date 31 Oct 2000

12400 Highway 43 North, Axis, Alabama 36505

Customer:
METALS USA PLATES & SHAPES SOU
P.O. BOX 3528
101 EAST ILLINOIS
ENID
OK 73702

Customer P.O. No.: MUS-227485 | **Mill Order No.:** 41-215299-12 | **Shipping Manifest :** AR058754

Product Description: ASME SA516-70/SA516-65/SA516-60(07ED.)
ASTM A516-70/A516-65/A516-60(06)
LCVN 15/12 FT.LBS @ -50F/A673-P
NORMALIZED

Ship Date: 30 Jun 08
Cert Date: 30 Jun 08

Cert No: 081142697
(Page 1 of 1)

Size: 1.250 X 120.0 X 480.0 (IN)

Heat Id	Piece Id	Piece Dimensions	Tst Loc	YS (PSI)	UTS (PSI)	%RA	Elong % 2in	Elong % 8in	Tst Dir	Average Hardness	Charpy Impact Tests: Abs. Energy(FTLB) 1	2	3	Avg	% Shear 1	2	3	Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp	BDWTT %Shr
W8F643	B21	1.254 X 120.0 (DISCRT)	L	46000	71000			31	T		82	40	70	64.0					-50F	L	10.		
W8F643	B22	1.255 X 120.0 (DISCRT)	L	47000	72000			28	T		85	55	52	47.3					-50F	L	10.		

Chemical Analysis

Heat Id	C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	CEV	ORGN
W8F643	.18	1.07	.011	.004	.20	.028	.025	.25	.17	.12	.06	.005	.006	.020	.42	USA

MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED
DURING THE MANUFACTURE OF THIS PRODUCT
CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15
100% MELTED AND MANUFACTURED IN THE USA. MTR DIN EN10204 TYPE 3.1 COMPLIANT.
NORMALIZED PLATES. HEATED AT 1650F FOR 52 MINUTES.
W8F643 B22 6087562 PCES: 1, WGT: 20601
W8F643 B21 6087559 PCES: 1, WGT: 20518

W8F643 B21 6087561 PCES: 1, WGT: 20523

COOLER HT#W8F643
PO#2702570 SL#B22
SO#143600 ITEM#SEE CUT LIST

Inspected By
Marcy Arnold
10/3/08

Q.A. APPROVED
By mlk Date 7-23-08

(P) Cust Part # :

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH THE APPROPRIATE SPECIFICATION

Jason Thomas
SENIOR METALLURGIST

J#-35408 (-1)

PortCity
METAL SERVICES

CERTIFICATE OF COMPLIANCE

DATE: 17 SEPTEMBER, 2007
SUBJECT: NACE

GENTLEMEN:

I HEREBY CERTIFY THAT THE MATERIAL LISTED HEREIN HAS BEEN INSPECTED AND TESTED IN ACCORDANCE WITH PRESCRIBED METHODS IN THE GOVERNING SPECIFICATIONS AND BASED UPON THE RESULTS OF SUCH INSPECTION AND TESTING DOES CONFORM TO THE BHN REQUIREMENT OF NACE MR 01-75.

PLATE: ASTM A516-70N AND ASME SA516-70N LATEST EDITION.
SIZE: 1-1/4" NOMINAL
MILL CERTIFIED: SSAB
HEAT: W8F643
SLAB: B22

Specification: NACE MR 01-75

Hardness, ASTM E18-97a	Results, HRC	Hardness, ASTM E10-96	Results, BHN
			170,179,176

WE HEREBY CERTIFY THE ABOVE INFORMATION IS CORRECT.

Inspected By
Marcy Arnold
CCSC

Marty L Eubanks

MARTY L. EUBANKS
QUALITY ASSURANCE MANAGER
(918) 583-2222

P7143 819546 1404

384762 · 4

METALLURGICAL SERVICES: MILL INSPECTION CERTIFICATE AS PER EN10204:2004;TYPE 3.1

Material manufacturer certified to European Directive 97/23/EC

HIGHVELD STEEL AND VANADIUM CORPORATION LIMITED
Registration No. 1960/001900/06
P.O. Box 111 ,Witbank,1035
Telephone: National (013) 6909911 Fax (013) 690 9556
International 27 13 6909911

TO WHOM IT MAY CONCERN
Test Certificate No: P000184100
Product: STEEL PLATES
Dimensions: 7/8" X 96" X 425.444 KG/M
Length: 480"
Total Pieces: 19

Account No: OREP 04
Customer Order: 0189-P LOT 4
Sales Order No: 202678 . / 1 Packing List No: 17172
Date: 2006-02-07
Quality: ASME SA516 GRADE 70 (IMPACTS)
ASTM A516 GRADE 70 (IMPACTS) - 2005

Cast No:	Slab No:	C	Si	S	P	Mn	V	Ni	Cr	Cu	Al	N	Mo	Nb	Ti	W.C.E.	PIECES
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	PCS
	Min	*0,000*	*0,150*	*0,000*	*0,000*	*0,850*	*0,000*	*0,000*	*0,000*	*0,000*	*0,020*	*0,000*	*0,000*	*0,000*	*0,000*		
	Max	*0,280*	*0,400*	*0,035*	*0,035*	*1,200*	*0,030*	*0,400*	*0,300*	*0,400*	*0,100*	*n/a*	*0,120*	*0,020*	*0,030*		
P7143	819542	0,172	0,254	0,014	0,009	1,069	0,016	0,123	0,054	0,071	0,055	0,008	0,000	0,000	0,002	0,377	1
P7143	819543	0,172	0,254	0,014	0,009	1,069	0,016	0,123	0,054	0,071	0,055	0,008	0,000	0,000	0,002	0,377	1
P7143	819546	0,172	0,254	0,014	0,009	1,069	0,016	0,123	0,054	0,071	0,055	0,008	0,000	0,000	0,002	0,377	1
P7143	819547	0,172	0,254	0,014	0,009	1,069	0,016	0,123	0,054	0,071	0,055	0,008	0,000	0,000	0,002	0,377	1
P7143	819548	0,172	0,254	0,014	0,009	1,069	0,016	0,123	0,054	0,071	0,055	0,008	0,000	0,000	0,002	0,377	1
P7143	819549	0,172	0,254	0,014	0,009	1,069	0,016	0,123	0,054	0,071	0,055	0,008	0,000	0,000	0,002	0,377	1
P7143	819550	0,172	0,254	0,014	0,009	1,069	0,016	0,123	0,054	0,071	0,055	0,008	0,000	0,000	0,002	0,377	1
P7143	819551	0,172	0,254	0,014	0,009	1,069	0,016	0,123	0,054	0,071	0,055	0,008	0,000	0,000	0,002	0,377	1
P7143	819552	0,172	0,254	0,014	0,009	1,069	0,016	0,123	0,054	0,071	0,055	0,008	0,000	0,000	0,002	0,377	1
P7143	819553	0,172	0,254	0,014	0,009	1,069	0,016	0,123	0,054	0,071	0,055	0,008	0,000	0,000	0,002	0,377	1
P7144	819554	0,171	0,261	0,016	0,012	1,114	0,027	0,126	0,073	0,070	0,050	0,008	0,000	0,000	0,002	0,390	1
P7144	819555	0,171	0,261	0,016	0,012	1,114	0,027	0,126	0,073	0,070	0,050	0,008	0,000	0,000	0,002	0,390	1
P7144	819556	0,171	0,261	0,016	0,012	1,114	0,027	0,126	0,073	0,070	0,050	0,008	0,000	0,000	0,002	0,390	1
P7144	819557	0,171	0,261	0,016	0,012	1,114	0,027	0,126	0,073	0,070	0,050	0,008	0,000	0,000	0,002	0,390	1
P7144	819559	0,171	0,261	0,016	0,012	1,114	0,027	0,126	0,073	0,070	0,050	0,008	0,000	0,000	0,002	0,390	1
P7144	819561	0,171	0,261	0,016	0,012	1,114	0,027	0,126	0,073	0,070	0,050	0,008	0,000	0,000	0,002	0,390	1
P7144	819562	0,171	0,261	0,016	0,012	1,114	0,027	0,126	0,073	0,070	0,050	0,008	0,000	0,000	0,002	0,390	1
P7144	819642	0,171	0,261	0,016	0,012	1,114	0,027	0,126	0,073	0,070	0,050	0,008	0,000	0,000	0,002	0,390	1
P7144	819563	0,171	0,261	0,016	0,012	1,114	0,027	0,126	0,073	0,070	0,050	0,008	0,000	0,000	0,002	0,390	1

Inspected By
Marcy Arnold
QC
10/2/08

Q.A. APPROVED
By MK Date 6-27-08

REMARKS GL = GAUGE LENGTH, YP = YIELD POINT, UTS = ULTIMATE TENSILE STRENGTH, ELG = ELONGATION , W.C.E. = WELDABILITY CARBON EQUIVALENT, C1 = CHARPY TEST 1, C2 = CHARPY TEST 2, C3 = CHARPY TEST 3

JONAS SKHOSANA (SUPERINTENDENT OPERATIONS)

IN ANY DISPUTE RELATING TO THIS TEST CERTIFICATE THE ORIGINAL FORMAT AND DATA AS RETAINED BY HIGHVELD IN ELECTRONIC FORMAT WILL CONSTITUTE PRIMA FACIE PROOF OF THE FORMAT AND CONTENT OF THE CERTIFICATE.

COOLER HT#P7143
PO#2702570 SL#819546
SO#143600 ITEM#SEE CUT LIST

METALLURGICAL SERVICES: MILL INSPECTION CERTIFICATE AS PER EN10204:2004;TYPE 3.1

Material manufacturer certified to European Directive 97/23/EC

HIGHVELD STEEL AND VANADIUM CORPORATION LIMITED
Registration No. 1960/001900/06
P.O. Box 111 ,Witbank,1035
Telephone: National (013) 6909911 Fax (013) 690 9556
International 27 13 6909911

TO WHOM IT MAY CONCERN
Test Certificate No: P006104100
Product: STEEL PLATES
Dimensions: 7/8" X 96" X 425.444 KG/M
Length: 480"
Total Pieces: 19

Account No: OREP 04
Customer Order: 0189-P LOT 4
Sales Order No: 202678 / 1 Packing List No: 17172
Date: 2006-02-07
Quality: ASME SA516 GRADE 70 (IMPACTS)
ASTM A516 GRADE 70 (IMPACTS) - 2005

Cast No:	Slab No:	AREA	GL	YP	UTS	ELG	C1	C2	C3	AVG CHARPY	TEMP
		SQ IN	INCH	KSI	KSI	%	J	J	J	J	DEG C
	Min			38	70	17	20	20	20		
	Max			90	90	50	400	400	400		
P7143	819542	0,667	2	57	76	28	54	52	71	59	- 46
P7143	819543	0,724	2	50	72	28	66	58	51	58	- 46
P7143	819546	0,714	2	57	72	31	126	111	119	119	- 46
P7143	819547	0,720	2	57	72	30	122	159	97	126	- 46
P7143	819548	0,746	2	47	72	29	92	107	87	95	- 46
P7143	819549	0,720	2	56	72	31	97	96	103	99	- 46
P7143	819550	0,775	2	48	75	26	101	99	111	104	- 46
P7143	819551	0,752	2	47	70	28	99	86	80	88	- 46
P7143	819552	0,738	2	46	73	24	80	66	74	73	- 46
P7143	819553	0,739	2	49	71	25	71	89	91	84	- 46
P7144	819554	0,790	2	46	74	26	54	59	56	56	- 46
P7144	819555	0,711	2	48	71	27	67	69	74	70	- 46
P7144	819556	0,739	2	46	72	26	66	76	78	73	- 46
P7144	819557	0,791	2	48	71	24	111	108	108	109	- 46
P7144	819559	0,723	2	57	73	30	97	126	159	127	- 46
P7144	819561	0,747	2	46	72	28	59	62	66	62	- 46
P7144	819562	0,792	2	47	71	27	95	108	101	101	- 46
P7144	829642	0,743	2	47	76	27	119	130	129	126	- 46
P7144	829663	0,735	2	47	74	26	93	97	94	95	- 46

REMARKS: SLAB 819542/A WAS NORMALISED AT 905°C FOR 0 HR 45 MIN
SLAB 819543/A WAS NORMALISED AT 942°C FOR 0 HR 45 MIN

Inspected By
Marcy Arnold
CCS 10/3/06

Q.A. APPROVED
By MM Date 6-2-06

REMARKS GL = GAUGE LENGTH, YP = YIELD POINT, UTS = ULTIMATE TENSILE STRENGTH, ELG = ELONGATION , W.C.E. = WELDABILITY CARBON EQUIVALENT, C1 = CHARPY TEST 1, C2 = CHARPY TEST 2, C3 = CHARPY TEST 3

JONAS SKHOSANA (SUPERINTENDENT OPERATIONS).

METALLURGICAL SERVICES: MILL INSPECTION CERTIFICATE AS PER EN10204:2004;TYPE 3.1

Material manufacturer certified to European Directive 97/23/EC

HIGHVELD STEEL AND VANADIUM CORPORATION LIMITED
Registration No. 1960/001900/06
P.O. Box 111, Witbank, 1035
Telephone: National (013) 6909911 Fax (013) 690 9556
International 27 13 6909911

TO WHOM IT MAY CONCERN

Test Certificate No:	**P900184180**	Account No:	OREP 04
Product:	STEEL PLATES	Customer Order:	0189-P LOT 4
Dimensions:	7/8" X 96" X 425.444 KG/M	Sales Order No:	202678 / 1 Packing List No: 17172
Length:	480"	Date:	2006-02-07
Total Pieces:	19	Quality:	ASME SA516 GRADE 70 (IMPACTS)
			ASTM A516 GRADE 70 (IMPACTS) - 2005

SLAB 819546/A WAS NORMALISED AT 917°C FOR 0 HR 45 MIN
SLAB 819547/A WAS NORMALISED AT 919°C FOR 0 HR 45 MIN
SLAB 819548/A WAS NORMALISED AT 890°C FOR 0 HR 45 MIN
SLAB 819549/A WAS NORMALISED AT 922°C FOR 0 HR 45 MIN
SLAB 819550/A WAS NORMALISED AT 915°C FOR 0 HR 45 MIN
SLAB 819551/A WAS NORMALISED AT 911°C FOR 0 HR 45 MIN
SLAB 819552/A WAS NORMALISED AT 919°C FOR 0 HR 45 MIN
SLAB 819553/A WAS NORMALISED AT 913°C FOR 0 HR 45 MIN
SLAB 819554/A WAS NORMALISED AT 911°C FOR 0 HR 45 MIN
SLAB 819555/A WAS NORMALISED AT 918°C FOR 0 HR 45 MIN
SLAB 819556/A WAS NORMALISED AT 926°C FOR 0 HR 45 MIN
SLAB 819557/A WAS NORMALISED AT 911°C FOR 0 HR 45 MIN
SLAB 819559/A WAS NORMALISED AT 903°C FOR 0 HR 45 MIN
SLAB 819561/A WAS NORMALISED AT 927°C FOR 0 HR 45 MIN
QUALITY PLAN PM
SLAB 819562/A WAS NORMALISED AT 923°C FOR 0 HR 45 MIN
SLAB 829642/A WAS NORMALISED AT 890°C FOR 0 HR 45 MIN
SLAB 829663/A WAS NORMALISED AT 931°C FOR 0 HR 45 MIN
WE HEREBY CERTIFY THAT THE MATERIAL HAS BEEN TESTED PRIOR TO DESPATCH FROM MILL
MATERIAL TESTED AND SUPPLIED IN THE NORMALISED CONDITION
IMPACT DIMENSION: 10MM X 10MM X 55MM
PRODUCED IN REPUBLIC OF SOUTH AFRICA.

Q.A. APPROVED
By MM Date 6-27-06

REMARKS GL = GAUGE LENGTH, YP = YIELD POINT, UTS = ULTIMATE TENSILE STRENGTH, ELG = ELONGATION, W.C.E. = WELDABILITY CARBON EQUIVALENT, C1 = CHARPY TEST 1, C2 = CHARPY TEST 2, C3 = CHARPY TEST 3

JONAS SKHOSANA (SUPERINTENDENT OPERATIONS)

IN ANY DISPUTE RELATING TO THIS TEST CERTIFICATE THE ORIGINAL FORMAT AND DATA AS RETAINED BY HIGHVELD IN ELECTRONIC FORMAT WILL CONSTITUTE PRIMA FACIE PROOF OF THE FORMAT AND CONTENT OF THE CERTIFICATE.

Inspected By Marcy Arnold 10/3/06

Piping Products, Inc.

FORGED STEEL FLANGES AND SPECIAL FITTINGS
1681 Kress St., Houston, Texas 77020
Phone: 713-675-5374, 800-775-5374, Fax: 713-675-7910

*** MILL TEST REPORT ***

S MATTSCO
O PO BOX 2925
L
D TULSA, OK 74101

S MATTSCO
H 5740 E. ADMIRAL PL
I
P TULSA, OK 74115

CUST #: MAT01
CUST PO: 889-S-08
DATE: 09/03/08
PPI S/O #: 248016
TAG #:

09/30/2008 From:MATTSCO SUPPLY CO.
Our# :28139
To: :CHART COOLER SERVICE
CPO# :2702567
Line# :1
QTY: :2
To: CHART COOLER SERVICE CO., INC.

ITEMS

ITM	DESCRIPTION	
30	4 300 WN RF XH	SA105 125-250 AARH
30	4 300 WN RF XH	SA105 125-250 AARH
60	12 300 WN RF XH	SA105 125-250 AARH

CHEMICAL PROPERTIES

ITM	HEAT NO.	C	SIL	MN	PHOS	SUL	CR	NI	MO	N	CO	CU	V	AL	NB	C/EQ
30	CORE	0.210	0.190	0.920	0.019	0.018	0.200	0.080	0.020	0.000	0.000	0.290	0.001	0.000	0.002	0.432
30	CFOT	0.190	0.210	0.900	0.016	0.009	0.160	0.070	0.014	0.000	0.000	0.250	0.002	0.000	0.002	0.397
60	CHLP	0.210	0.240	0.780	0.013	0.024	0.100	0.070	0.021	0.000	0.000	0.230	0.006	0.000	0.005	0.385

PHYSICAL PROPERTIES

ITM	YIELD STRENGTH	TENSILE STRENGTH	ELONG. % IN 2 "	RED. AREA	BHN HARDNESS	CHARPY TEST	LAT. EXPAN	SHEAR FRAC.	TEST TEMP
30	50,900	84,200	29.00	49.00	187-187			0.00	
30	47,600	77,600	38.00	66.24	156			0.00	
60	39,600	75,900	38.10	59.14	159			0.00	

ITEM NOTES

30
30
60

ORDER NOTES

Additional Notes or Comments:

We hereby certify that all test results and process information contained herein are correct and true as contained in the records of the company.

Quality Assurance Asst. Mgr.

J# 33408 (-1)

Inspected by
Marcy Arnold
10/3/08

09/30/2008 From: MATTSCO SUPPLY CO. To: CHART COOLER SERVICE CO., INC.
Our# :28139 Line# :3 QTY: :2
To: :CHART COOLER SERVICE
CPO# :2702567

Phoenix * Capitol * Camco
Cap Products

Commanding a Higher Standard℠

Certified Mill Test Report

9/16/2008

Customer
MATTSCO SUPPLY CO
PO BOX 2925
TULSA, OK 74101

P.O. 904-S-09

Heat No 4168
Heat Code 4168
Phoenix Order # 572961

Material ASTM A105-2005 / ASME SA105-2007 Edition, No Addenda

Part Number
12302210

Description
1 FS 6M THD HALF CPL

Chemical Properties

C	Mn	P	S	Si	Cu	Cr	Ni
0.200	1.060	0.010	0.019	0.240	0.090	0.040	0.020

C Eq. Long
0.394

Mo	V	Co	Al	Cb	N	Pb	Sn	Ta	Ti
0.010	0.000		0.023	0.012					

Additional Chemical Properties

Cr + Cu + Ni
0.150

Mechanical Properties

Tensile (PSI)	Yield (PSI)	Elong. % in 2 in.	R of A	BHN
76,261	49,181	30.0%	49.0%	146

Charpy Minimum Impact -

Test 1	Test 2	Test 3	Average
N/A	N/A	N/A	N/A

This material meets the requirements of the governing specifications. We certify that the above material has been inspected and tested in accordance with the methods prescribed in the governing specification and the results of such inspections and test conform with applicable requirements.
We further certify this material was inspected with independent inspectors conforming to the requirements of EN 10204 Section 3.1B.
Comments:

MEETS HARDNESS REQUIREMENTS OF NACE MR0175 LATEST EDITION AND ASME SA-181-70 2001

Capitol Manufacturing
1125 Capitol Road
Crowley, LA 70526

Inspected By
Marcy Arnold
10/9/08

09/26/2008 From:MATTSCO SUPPLY CO. To:CHART COOLER SERVICE CO., INC.
Our# :28139 Line# :2 QTY: :2
To: :CHART COOLER SERVICE
CPO# :2702567

VOLZHSKY TRUBNY

"VOLZHSKY PIPE PLANT"
OJSC

404119, Volzhsky, Volgograd region, Russia

Fax: (78443) 25-69-02
E-mail: VTZ @ SPRINT-V.com.ru

MANUFACTURER:

VOLZHSKY PIPE PLANT OJSC
404119, VOLZHSKY
VOLGOGRAD REGION
RUSSIA

MILL TEST CERTIFICATE

SPEC 982/72/PC SF2232/TMK PO NO. 06-253

DESCRIPTION OF GOODS:
CARBON STEEL SEAMLESS PIPES ACCORDING TO API 5L PSL1 (43RD EDITION/ YEAR 2004)GR.B/ASTN A106(2002 EDITION)GR.B/C/ASTM A53 (2002 EDITION) GR.B/C/ASME SA 106(1998 EDITION)/ASME SA53 (1990 EDITION), BEVELLED ENDS.
12 3/4" x 0.500" (323.9 x 12.70 MM)

CERTIFICATE # 2134 DATE OF ISSUE 29.08.2006

SIZE	HEAT No: HEAT TREATMENT LOT No	LOT No	QUANTITY, PIPES	LENGTH, FEET	NET WEIGHT TONS	CHEMICAL COMPOSITION, % C	Si	Mn	P	S	Cr	Ni	Cu	Mo	Ti	Nb	MILL CONTROL PROT. No	ORIENTATION	TENSILE TEST SPECIMEN	GL. 'C' YS MPA	GL. 'C' UTS MPA	EL. %	HARDNESS TEST HRC	IMPACT TEST ORIENTATION	NO-TCH	SIZE	TEST TEMP °C	IMPACT VALUE	FRACTURE %	HEAT TREATMENT	No OF T	HYDROSTATIC TEST DURATION (SECONDS)	PRESSURE KG/CM2 (MPa)	NOTE
						* x 100	28 max	10 min	29 max	30 max	30 max	40 max	40 max	40 max	15 max	4 max			* 2	* 3	* 4	min 290.00	min 485.00	min 30.0	max 22.00	* 3	* 5	* 6	* 7		* 8	* 9 (10)	min 5	min 196.86 (19.30)	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
GRADE B/C/ X42 12.75"x 0.500"(323.9 x 12.7 MM) API 5L PSL1 ASTM A106 ASTM A53 ASME SA-106 ASME SA-53	263271	3-13271	80	3222.12	97.863	R 19	24	44	6	4	7	12	18	4	0	0	6223		L	R													G	G	GARBON STEEL SEAMLESS PIPES ACCORDING TO API 5L (2004) ASTN A106(2002); ASTN A53(2002) ASME SA-106(1998) ASME SA-53(1998) LENGTH: RUK 80±-38-41 FT MAX 20±-36-38 FT MINIMUM HYDROSTATIC PRESSURE P= 2800 PSI HARDNESS TEST MAX.22 HRC IS IN ACCORDANCE WITH NACE MR0175.
						D 18	24	44	5	3	8	12	18	3	0	0	6223																		
						D 19	25	44	5	4	8	12	18	3	0	0	6223																		
																	5693	L				358	517	38.4	1.0									

DESCRIPTION OF TESTS	VISUAL AND DIMENSIONS	REVERSING INSPECTION	END'S PROTECTORS		COATING						FLATTENING TEST	MARKING: STENCILING	STEEL MAKING PROCESS -
	G	G	G		G						G	G	ELECTRIC FURNACE

NOTES: G: GOOD
*1: H: HEAT ANALYSIS, P: PRODUCT ANALYSIS, C: CONTROL ANALYSIS, R: RECHECK ANALYSIS
*2: T: LOT TEST, H: HEAT CONTROL TEST, A: ADDITION TEST, R: RECHECK TEST
*3: L: LONGITUDINAL, T: TRANSVERSE
*4: STRIP C: 1/2 in, H: 3/4 in, R: 1 in, K: 1 1/2 in, S: 12 mm.
*5: V: 2mm V, U: 2mm U, B: 3mm U, C: 4mm U, E: 2mm U PASE NOTCH, F: 2mm V PASE NOTCH
*6: F: 10x10mm, 7: 10x7.5mm, 6: 10x6.7mm, 5: 10x5mm, 3: 10x3.3mm, 2: 10x2.5mm
*7: E - EACH VALUE, A - AVERAGE VALUE
*8: HEAT TREATMENT. Q&T: QUENCHED & TEMPERED
*9: M: WET FLUORESCENT MAGNETIC PARTICLE TEST. EMI: ELECTROMAGNETIC TEST.UT: ULTRASONIC TEST
UTS: PIPE BODY UT FOR LAMINATION. UTE: PIPE ENDS UT FOR LAMINATION
UTS: PIPE WALL THICKNESS UT
*10: S - NOTCH 5x, 12 - NOTCH 12.5x

TOTAL: QUANTITY OF PIPES 80 PCS NET WEIGHT 97.863 T LENGTH 3222.12 FT

ENDORSEMENT BY THIRD PARTY INSPECTION AGENCY

(STAMP)

NAME
SIGNATURE
DATE

WE CONFIRM THAT PIPES COVERED BY THIS CERTIFICATE ARE MANUFACTURED TESTED AND INSPECTED IN ACCORDANCE WITH APPLICABLE STANDARDS AND SPECTECATION.

ОТК для поставки

MANAGER - INSPECTION VOLZHSKY PIPE PLANT
DATE 29.08.06

Inspected By
Marcy Arnold
10/3/08

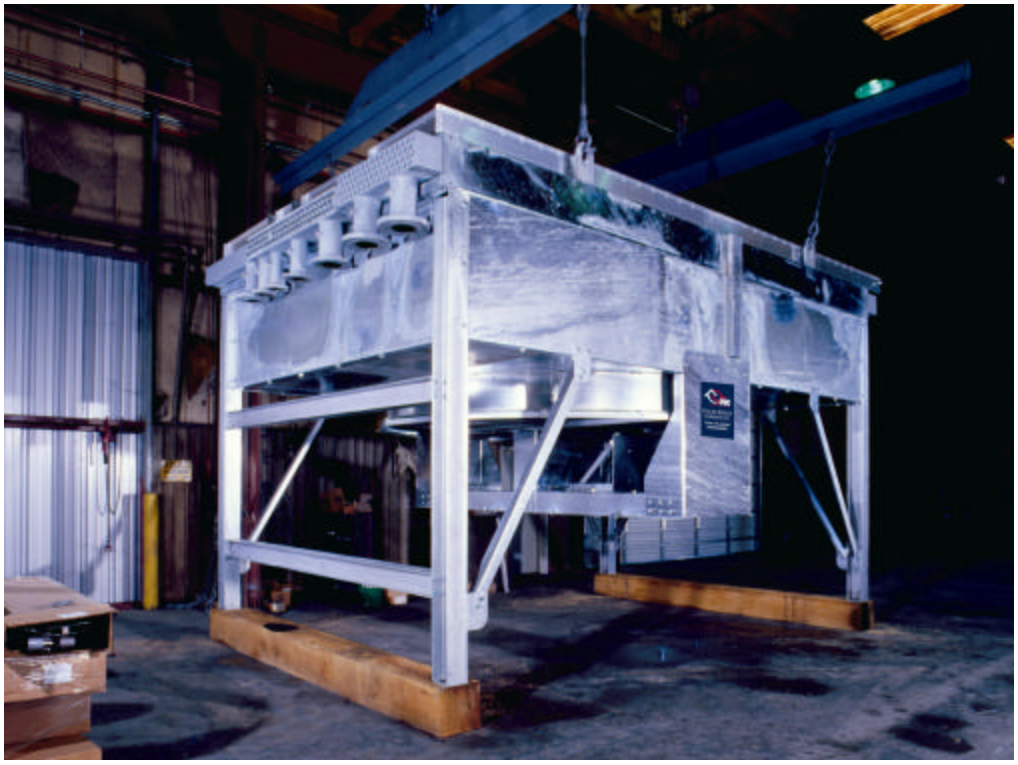
CHEMICAL
COMPOSITION,%

	V % ×100	B % ×1000	Nb+V+Ti % ×100	Cu+Cr+Mo+Ni+V % ×100
	9 max		15 max	100 max
H	3	3	3	44
P	3	2	3	44
P	3	2	3	44

ENDORSEMENT BY THIRD PARTY INSPECTION AGENCY	(STAMP)	NAME SIGNATURE DATE	WE CONFIRM THAT PIPES COVERED BY THIS CERTIFICATE ARE MANUFACTURED TESTED AND INSPECTED IN ACCORDANCE WITH APPLICABLE STANDARDS AND SPECIFICATION.	MANAGER - INSPECTION VOLZHSKY PIPE PLANT DATE: 19.06.06

Волжский трубный завод ОТК для сертификатов

Inspected By
Marcy Arnold
10/3/08



AIR COOLED HEAT EXCHANGERS

Cooler Service Company Inc.

OPERATION AND MAINTENANCE MANUAL

www.coolerservice.com

AIR COOLED HEAT EXCHANGERS

GENERAL INFORMATION

The **CSCI** Air Cooled Heat Exchanger should be inspected thoroughly by receiving personnel. Damage in transit will be the result of dropping or being struck by heavy objects. Observe sub-skid flanges, plenum side panels and coil sections for obvious physical damage. Dents, bent flanges, crushed tubes, damaged instruments or piping among other things should be described on receiving documents presented by the carrier. Prompt claim filing will expedite early compensation from the offending carrier.

The unit should be placed on its foundation as soon as practical after being received.

Basically this unit is a completely shop assembled cooling unit. Occasionally special accessory devices will be required which must be shipped disassembled to meet height or width limitations of the carrier.

In the event some assembly of this type is required, the appropriate assembly instructions will accompany the shipment. Detail parts to be installed will normally be secured in place on the skid base (if the unit is so designed) or in the plenum chamber. Examine the interior of the plenum for any storage.

Coil piping should be installed in accordance with engineering instructions supplied in connection therewith. Attention is invited to the approved cooler drawings, which identify the "INLET" and "OUTLET" nozzles.

START UP PROCEDURE

Prior to Run-In:

It is imperative that the units be checked for good working order prior to run-in. The following general check list is provided to insure that all equipment has been properly installed and is ready to go on stream.

1. HYDROSTATIC TEST

CSCI tube bundles are hydrostatically tested to one and a half times the design pressure before being released for shipment. To ensure that no damage has been done during shipment and/or erection, it is good practice to hydrostatically test the entire system, including piping, heat exchangers, pumps, etc., prior to start-up.

2. BEARINGS

Check bearings for lubrication. **Caution**: Do not over grease. Manufacturer greased the bearings and no additional grease is necessary to start. Remote lubrication lines when provided should be loosened at the bearing end, and then filled with grease from fitting end. This will ensure that the lube lines are full of grease and free of air and debris.

Check bearing flange bolts and set screws for tightness.

3. FANS

The fan should be rotated by hand to ensure that the shaft, speed reducer and driver turn freely.

The fan should also be checked for adequate fan blade tip clearance. To measure this, first move all blades past a fixed point on the inside of the fan ring and observe which blade has the least amount of clearance at that point. Then move the blade selected 360 degrees to the point of minimum clearance. Refer to section on fans.

Switch on the fan driver momentarily to check for proper direction of rotation and fan blade orientation. The leading edge of the fan blade is the thick edge. When properly pitched, this leading edge will be the lower edge.

If the starting torque trips the vibration switch turn the adjusting screw located on the right hand side of the vibration switch to the right (clockwise) for a heavier setting. Please see the section on vibration switches.

4. V-BELT DRIVES (when applicable)

Check V-Belt tension in accordance with V-Belt tensioning section of this manual.

5. GEAR BOX

Check gearbox for oil. Gears are shipped without oil and must be filled and serviced in accordance with the instructions contained later in this operating manual.

6. LOUVERS

Check all mounting brackets and bolts for tightness. On manually operated units, manual operator should be moved from full open to full closed several times to ensure proper linkage adjustment and that louvers will operate freely. On air motor operated (automatic) units, all air supply line fittings should be checked for tightness and air motor should be energized to ensure proper linkage adjustment and that louvers operate freely with sufficient air supply.

7. STURCTURES (Field Erection)

Bolt-up structures are to be erected per erection drawing furnished. All pieces should be installed per position shown on drawing and part number marked on piece.

Bolt-up structures are to be erected with bolts loose then plumbed, and finally all bolts thoroughly tightened.

Some structures are primed with structural steel primers, but most units are galvanized. When repainted, outdoor paints or enamels should be used along with good preparation and painting practices.

Bolting should be periodically checked for loose bolts.

8. FLOATING HEADER BOLTS TO BE REMOVED PRIOR TO BEING PUT IN SERVICE.

Bolts attaching return header(s) to sideframe(s) must be removed prior to this unit being put in service, to allow for the thermal expansion of the bundle(s)**.**

Failure to remove these bolts may result in serious damage to the bundle.

PERFORMANCE

Prior to or following the initial "start-up" and the final determination that the mechanical equipment is performing as designed, the product to be cooled may be valved into the cooling coils. The temperature-indicating equipment should be observed closely to detect the anticipated temperature drop, which should occur at a time interval dependent on proper response of temperature control equipment, louver settings (if any), piping distances, previous temperature and heat rejection rates.

In the event it appears that the product is not being cooled as designed, the following inspections should be made. Any one or a combination of the following could impact the equipment performance:

1. Check valving to insure proper circulation.

2. By-pass equipment, if any, should be checked for proper flow control for the existing conditions.

3. Endeavor to confirm that the temperature-indicating equipment is functioning normally, and the product temperature is in the range which would require cooling.

4. Carefully analyze the temperature control system to ensure that temperature sensing elements are properly installed and calibrated, and that the electrical circuits are sound and energized. Where temperature sensing equipment is designed to cause a reactive response in the product flow, motor speeds, fan pitch or louver settings, such reaction should be examined to determine that the reaction is correct as to proportion, direction or amount. The operational instructions provided by the control equipment supplier should provide troubleshooting procedures, which will expose a malfunction, if one exists.

5. Louvers should be checked for full open position of proportional setting if required by the temperature control equipment.

6. Fan speed should be checked and compared to design speeds shown on data sheet.

7. Fan blade pitch settings should be inspected and confirmed on data sheets.

8. Direction of rotation of the fan should be compared to the design drawings.

9. The coils should be inspected for obstructions such as protective panels which have not been removed, weeds, lint, and matted insects. If such an obstruction does exist, the drive equipment should be shut down and the obstruction removed.

10. To isolate the cause if the equipment fails to cool, a simple test may be made by disabling the temperature control equipment and manually positioning the louvers and motor speed setting to design maximum. If this does not produce the desired cooling response and the foregoing items have revealed no cause for malfunction, the system should be shut down and the factory notified for instructions.

    It is important for the operating personnel to know that the probability of the cooling elements of the equipment being defective is extremely remote based on improbability of error and past performance records. Usually, a methodical examination of the elements mentioned above will reveal the cause of the malfunction, and following correction, the continued year-in and year-out reliable performance, as designed, will result.

RUN-IN

1. Start fan driver and check as outlined in general motor information section of this operating manual.

2. Check unit for excessive vibration. When vibration is present, check bolting for tightness.

3. V-belt drives (when applicable)
   Run fan for several hours; observe driver and bearings carefully during this period for abnormal heating (see section on V-belts for maximum allowable start-up and operating temperatures). Tighten V-Belts as required in accordance with V-Belt tensioning information contained in component equipment section. Belts may continue to stretch during the first 30 days of operation.

4. Gear Drives (when applicable)
   Run fan for several hours; observe driver, gear and bearings carefully during this period for abnormal heating. See section on gear drives for maximum allowable start-up and operating temperatures.

5. Tube Bundles

   A. On plug type headers, plugs are installed at room temperature in our plant. Frequently, it is necessary to tighten plugs in the field when coils are hot to avoid minor leaking through plugs.

   B. Fins should be kept as free as possible of excessive debris, oil, bugs, and other fouling material. This may be done by steam cleaning or directing a stream of hot water over outside of coil.

PROCESS START-UP

1. The process start-up procedure should be conducted in a manner that will minimize thermal shock of the tube bundles and prevent overcooling of critical services during periods of low ambient temperature and low heat load.

2. For low pour point and low viscosity services, admit the process fluid at a low rate, and gradually increase the flow to the design rate. Start the fans one at a time as the process fluid begins to exceed the design operating temperature, until all the fans are on or the process fluid is at the design temperature.

3. Special precautions should be observed in starting up units with process streams of (a) high viscosity fluids and (b) fluids with pour points above the prevailing air temperature. For units of either type, admit the process stream to the tube bundle readily to prevent excessive cooling of the first liquid to reach the cold tubes. Care must be exercised to prevent undue shock from causing a "hammering" effect. When normal flow is attained, start the fans one at a time until the desired fluid outlet temperature is reached.

INTERNAL CLEANING OF TUBES

The internal cleaning of air cooler tubes used the same method as conventional shell and tube units.

These cleaning methods fall into three types:

1. **MECHANICAL CLEANING**

   This consists of using drills, (or wire brushes), on long rods, and rotating the rods with air or electric motors. This type of cleaning is usually followed by water wash or air purge. This type of cleaning is not good for "Tarry" materials.

   The Elliot Company handles a complete line of these cleaners and will be glad to furnish recommendations on inquiry.

2. **CHEMICAL CLEANING**

   This consists of circulating hot chemical solutions through the tubes. The solutions contain inhibitors to avoid corrosion of the tube walls.

   Among the companies specializing in this work are: Dowell, Halliburton, and the Oakite Company. They require a sample of the fouling material to determine the required chemical solution to be used in cleaning.

   One and one-half inch to three-inch inlet and outlet nozzles to each bundle are required for circulation of the solutions. They also require a solution makeup tank and circulating pump. In some localities these companies have portable equipment on trucks.

   The use of chemical cleaning is growing rapidly in process plants, as it saves downtime and disassembly of units. It is not suitable with plugged tubes.

3. **HIGH PRESSURE WATER SPRAYS**

   The use of high-pressure water sprays of "Hydro Jets" has been increasing in the United States and Europe. In the United States, several service companies specialize in cleaning tubes with portable high pressure pumps mounted on trucks. Water capacity is usually 25 gpm with pump discharge pressure up to 9,000 psig.

   The high pressure water jet heads are placed on the ends of hollow rods, similar to mechanical cleaning, and pushed through the individual tubes. The correct water pressure to the jet is determined by trial. Usually, the softer the fouling deposit, the lower the required jet pressure. For instance, an amine cooler deposit can usually be cleaned at about 2,000 psig. A water carbonate scale requires higher pressure in the range of 6,000 - 9,000 psig. Again it should be stated that this process won't work on plugged tubes. They must be drilled out mechanically.

   Among the service companies who specialize in "Hydro Jet" cleaning are:

Chemical Cleaning, Inc.	New Orleans, La.
Chemical Cleaning, Inc.	Beaumont, Texas
Ohmstede Machine Works	LaPorte, Texas
The Halliburton Company	Duncan, Oklahoma, and Nationally

INSTRUCTIONS FOR FIELD INSTALLATION OF TUBES IN A SECTION

1. Shut off flow and let section drain through outlet connection.

   a. Vent headers so that the section may drain.

   b. ***Completely*** drain section either through drain provided in header or by removing a plug in the bottom row of tubes.

2. Remove plugs opposite both ends of bad tube and for 3 or 4 tubes all around faulty tubes to allow ample working space.

3. The section will not need to be removed from the top of the structure if the faulty tube is close to the top of the section.

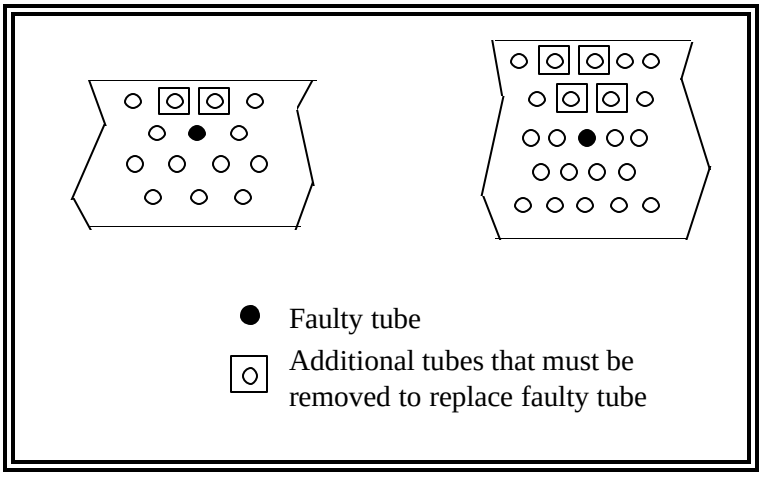
   If the tube is closer to the bottom of the section it is advisable to remove the section from the structure and turn it upside down, thus minimizing tube replacement.

4. If louvers or recirculation panels are on top of the section, these must be removed.

   In some cases, not all of the recirculation panels will need to be removed unless the section is to be removed from the structure.

   If the unit is an induced draft type, everything above the section must be removed.

5. Tubes to be removed are determined by the figures below:



FIELD INSTALLATION cont.

6. Now remove 2 bolts in each end of each tube binder and remove each tube binder on the ***top*** only.

   If the section has been removed from the structure, be sure that it is supported well so that no damage will be done to the fins and that it cannot "fall."

   If the section has been turned over (bottom side up) remove the tube binder on the top ***only***.

NOTICE:	**DO NOT loosen the supports on the "down" side as this will allow the tubes to "sag."**

7. You are now ready to remove the tubes from the section:

   a. To determine which tubes must be removed, refer to the diagram in step 5.

   b. Cut off both ends of each tube to be removed, about 1/8" to 1/4" back from tube sheet and lift out the tubes in top row.

   c. Cut off the ends in the next row in a similar manner.

   d. With an abrasive grinder or hack saw, cut the tube support bars on top of the tubes on inner rows, then lift out tubes.

   e. After all required tubes have been cut off and taken out, remove the short pieces from each tube sheet as follows:

      1). Select a "drift pin" about .010" smaller than the O.D. of the tube with a shoulder 1/2" long and the same I.D. as the tube.

      2). Insert the drift pin through the plug hole and into the end of the tube and force the tube end out of the tube sheet, either with a pneumatic tool or a hammer.

8. After all tube ends have been removed from the tube sheets, install new tubes in the section:

   a. "Bow" tube up in the middle and place each end in hole in tube sheet. Keep a slight upward "bow" in the tube until it is determined that each end of the tube protrudes through the tube sheet about equal on each end, then press the tube down firmly on the support bar beneath it. It may be necessary to take a screwdriver and push 1 or 2 fins apart to allow the tube to rest securely on the support bar.

FIELD INSTALLATION cont.

b. Where support bars were cut out, cut a new piece of similar metal long enough to extend over one tube on each side of tubes removed. Slide the new piece between the tubes and then back so that it will rest on the tube on each side and be next to the original bar.

   Put in new pieces at each tube support where the original bar was put.

c. Repeat steps 7a and 7b until all tubes have been installed.

d. If the protrusion of the tube ends through the tube sheets are not equal (1/16"), "drift" the tube from the ***longer*** end until equal (1/16").

9. Replace the top tube keepers and bolt the end tightly to side frame.

   Be sure support is pressed down securely against top of the tubes and held until the bolts in the ends are tightened.

10. Roll tubes into tube sheets in accordance with "**INSTRUCTIONS FOR TUBE EXPANDING BY HAND"** (next section). The same rolling procedure is followed for a power roller.

11. Replace plugs in headers and hydrostatically test section at 1.5 times the design pressure shown on the name plate and check new tubes for leaks. If a leak appears, re-roll tube end and test again.

12. The section is now ready to be put back into service.

If any serious problems arise while performing this procedure, contact:

CSCI
5500 E Independence
Tulsa, OK 74115
918-834-0002 Phone
918-834-0128 Fax

INSTRUCTIONS FOR TUBE EXPANDING BY HAND

1 Remove plug opposite the tube end.

2. Set the expander for the proper location in the tube sheet. The end of the rolls should be set flush with the tube side of the tube sheet. The adjustment can be visualized by holding the tube expander on top of the header and parallel to the tube axis with the bearing collar against the plug sheet, similar to the cross section view below. If the rolls protrude through the tube sheet, the rolls will tend to cut the tube on the inside.

   If the rolls do not protrude in the tube sheet far enough, there is danger of getting inadequate surface bond.

   To set the rolls: loosen the Allen screw on the thrust collar and screw in or out to position the rolls.

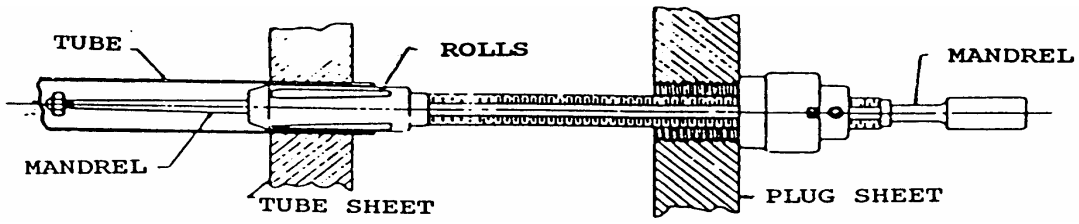
3. After inserting the tube expander into the tube, turn the Mandrel clockwise. This rotation progresses the Mandrel forward.

   Since the Mandrel is tapered, this forward progression forces the rolls against the tube wall.

   To determine the proper amount of expansion:

- A few rotations of the Mandrel begin to bring the rolls up against the tube. At this point the Mandrel gets harder to turn. **From this initial point of contact, expanding is in progress.**
- Continue to turn the Mandrel in a clockwise direction as many turns as is required to progress the Mandrel 1/4" beyond the point of the initial contact.
- In installing a new tube that has not been previously expanded, progress the Mandrel 3/8" beyond the point of the initial contact.

4. Tubes are originally expanded in our plant to a specified torque rating by electronically



controlled equipment.

START-UP PROCEDURES FOR CHECO FANS

SETTING THE BLADE ANGLE

a)Set the blade angle as marked on the blade or on the certified outline drawing. To accomplish this:

b) Set the correct angle on the machinist's protractor.

c)Place protractor on position indicated by label on blade.

d) Observing the bubble on the protractor, tap the blade shank with a rubber mallet until bubble centers.

e)To tighten the blade bolts, torque ½" nut to 45 ft-lbs.

f) Recheck the blade angle with the protractor.

Follow the above procedure for all blades. Be sure that blades are installed in pairs as marked in order to assure perfect balance.

CHECK ROTATION

a)Recheck all bolts and centering of fan in fan ring.

b) Check to make sure the motor and gear or belt sheave speeds are correct.

c)"Bump" the motor to make sure it is turning in the direction required.

MAINTENANCE

Your Checo fan, properly installed, requires little if any maintenance. However, all bolts and clamps should be checked occasionally to ensure tightness. At the same time, inspect blades for any nicks or cracks. For greatest air movement efficiency, blades should be kept clean.

START-UP PROCEDURES FOR MOORE FANS

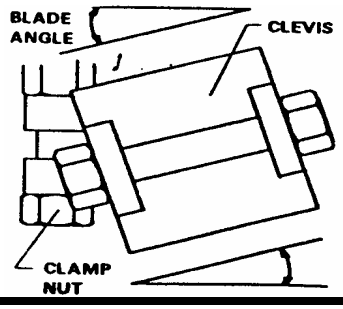
ADJUST BLADE ANGLE (EXCEPT SERIES 19)

Hubs are shipped from the factory with the clevises set for the blade angle indicated by the design performance. A change in the blade angle is usually necessary to adjust to actual site conditions. Failure to adjust the blade angle when required may result in motor overload. To check, measure the input amps to the motor while the fan is operating. See "Start-up Procedures" below. If the current draw is higher or lower than desired, slightly decrease or increase the blade angle.

WARNING! The fan is designed to consume the horsepower stated on the Fan Specification Sheet. This is not necessarily the full load horsepower of the motor. Increasing the blade angle to fully load an oversize motor can cause serious blade overload, which will stall the blades. In this condition, the fan will actually deliver less air and blade life may be shortened.

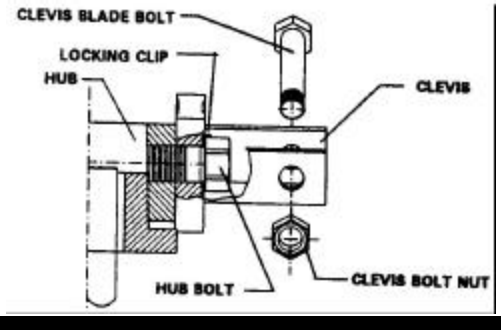
NOTE: If the hub is not level, the blade angles will not be accurately measured. To check, rotate the fan while checking the angle of a blade. If the measured angle varies as the fan is rotated, find the two locations, 180° apart, where the angles are identical. Only at these two points will the angle measured be accurate. Set each blade angle with the blade rotated to one of these two positions.

Place a protractor level on the flat upper or lower surface of the clevis as shown in the illustration below. (This is the point of measurement of the blade angle stated on fan specifications.) Make a permanent record of the final clevis angle selected and take care that all blades on the fan are set at the same angle. A typical adjustment may be ± 3°. The maximum recommended clevis angle is 15°. For all fans except Series 19, the blade angle is changed by loosening the clamp nut, rotating the clevis and retightening. Torque all clamp nuts to 50 ft.-lb (7m-kg).



ADJUST BLADE ANGLE ON SERIES 19

Read the previous section and follow all the precautions stated. To adjust, remove the blade, Flatten the tab on the locking clip and loosen the hub bolt just enough to allow the clevis to be turned. Place a protractor level on the flat upper side of the clevis and rotate the clevis in the desired direction. Retighten the hub bolt to 90 to 100 ft-lb (12.5 to 13.8 m-kg) of torque. Recheck the angle after tightening. Bend one corner of the locking tab against a flat side of the bolt head to secure the bolt from turning. Operate the fan and recheck the current draw. Repeat adjustment if necessary until amperage readings are as desired.



START-UP PROCEDURES

Before starting the fan, manually check all bolts or nuts to see if they are tightened. Take care not to exceed the stated torque limits.

Lift each blade to the horizontal position and walk the blade around while checking for proper clearance.

For API 661 coolers, the radial clearance between the fan tip and the fan orifice ring shall not exceed 1/2 percent of the fan diameter or 3/4 inch (19mm), whichever is smaller; in no case shall the clearance be less than 3/8 inch (9mm).

To check for compliance, raise the blade to 1/2 the distance between the stop droop position and the horizontal position (approx. 2-1/2" $\pm$ 1/2"). This will simulate the fan position under load.

Start the fan and watch it in operation. All blades should lift to the same operating position, indicating that the blade angles are properly set and that all blades are equally loaded.

If vibration or unbalance is evident, see maintenance section.

After the fan has been operating for several minutes, stop the fan and observe the blades as the fan comes to rest. All of the blades should fall to their droop position at the same rate.

Inspect the inner surface of the fan ring and the blade tips for any indications of scoring.

Check the motor amperage and consult the motor manufacturer's specification sheet for the actual motor output horsepower for that amperage. The HP given on the Fan Specifications is the calculated HP (at the fan shaft) that is required for the specified performance. The motor output HP may be allowed to be 3% or 5% above the specified fan HP to allow for gear drive or belt drive losses respectively.

Consult the factory or the fan curve before increasing the blade angle for the fan to consume more than the specified HP.

MAINTENANCE

PURPOSE

Fan failure is most likely the result of destructive repetitive stress acting over a period of time. These stresses may be caused by mechanical abuse, e.g., rough gears or drive shaft imbalance or by aerodynamic abuse such as blade overload or abnormal flow conditions. Fortunately, these stresses manifest themselves in typical ways that may easily be detected on inspection, if one knows what to look for. The purpose of this section is to describe the symptoms of potentially damaging mechanical problems and how they can be corrected.

FREQUENCY OF INSPECTION

The frequency of inspection varies widely in accordance with the severity of service and a suitable inspection schedule should be developed with experience over time. During the first week of operation, at least one inspection should be made. At these initial inspections, in addition to the items listed below, check all nuts for tightness to make certain that all were tightened properly at installation (but do not re-torque already tightened nuts). Following the first week, it is probable that inspections of the fan need be made no more frequently than inspection of the drive.

CHECK BLADE DROOP AND ANGLE

Turn off the unit and watch the blade tips. A looseness of the clamp nut will permit a blade to flatten in angle. This usually can be detected by looking at the tips of the blades while the fan is slowing down. At the same time, before the unit comes to a complete stop, watch the track of the blade tips to see that all blades have the same droop. If one or more blades has a substantially different droop than the other blades, or if all of the blades show a greater droop than at the last inspection, investigate further. Excessive droop has two possible causes:

1. A damaged resilient mount that requires replacement.

2. Wear at the end of the box section against the clevis, indicating that the box section has been riding against the clevis during operation. This type of wear indicates that the blade is not rising a sufficient distance during operation to clear the stop. If only one blade is affected, that blade is set at a steeper angle than the other blades. This should be checked and corrected.

CHECK FOR WEAR ON CLEVISES

Clevises should be examined at each inspection for possible wear against the end of the box section. Since contact between the box section and the face of the clevis provides a stop to prevent excessive droop when the fan is shut down, there will undoubtedly be a mark on the face of the clevis at the point of contact. There should, however, be no evidence of wear which would indicate repetitive contact between the two parts during operation. If wear at this point is indicated, a check should be made of blade loading. If blade overload is not responsible, the end of the box section can be dressed off with a file to permit greater blade droop when the fan is not operating so long as the greater droop will not cause the blade to hit an obstruction. If the fan has been operating for a considerable length of time and previous inspections have not disclosed wear at this point, it is possible that a recent unusually high wind condition might have disturbed the blades sufficiently to cause them to temporarily make repetitive contact with the clevis while in operation.

OPERATION BY VARIABLE SPEED MOTORS

Moore fans are ideal for use with variable speed motors. The resilient blade mounting, unique with these fans, eliminates resonant frequencies. There are no critical speeds to be avoided. There is, however, a minimum RPM below which there is not enough centrifugal force to lift the blades enough to prevent their repeatedly striking the clevis during operation. This is a cause of damaging clevis wear in addition to the causes discussed in the preceding paragraph.

The minimum RPM should be no less than 10% of full RPM or the minimum recommended by the motor or drive manufacturer, whichever is greater. The fan

should be shut off rather than reducing the motor speed beyond this point.

CRACKS, DENTS AND CORROSION

Skin cracking may be caused by the tips dragging on the fan ring, or it may be the result of long-term fatigue due to continued operation under conditions of vibration or unbalance. Skin cracking can also be caused by continued operation under overload conditions.

Cracking in air seals can occur if the air seal has been improperly installed. Check to be sure the resilient washers are present and the nuts properly tightened.

The fatigue strength of materials, whether metal or plastic may be lowered by long-term exposure to water.

Dents in blades are caused by objects falling into the fan or the fan striking some obstacle. Minor dents may sometimes be repaired by drilling a small hole in the center of the dent and pulling outward on the blade skin. Blades may be ordered from the factory for replacement. If there is any evidence of this type of damage, the hub should be carefully inspected.

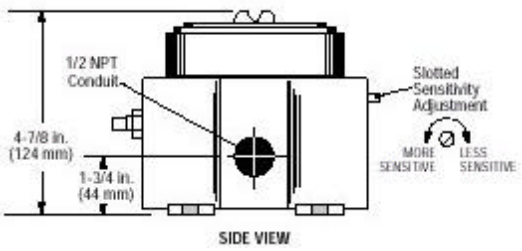
The type 5052 aluminum, a marine alloy, used as the blade material on Moore fans works well with either fresh or sea water. Waters that are acid, alkaline or contain copper salts, however, should be avoided for all aluminum alloys. If you have questions regarding the suitability of the fan materials under certain water conditions, please contact the factory.

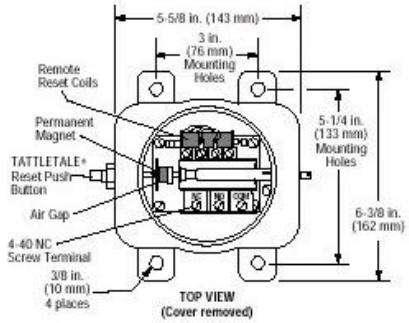
VIBRATION SWITCH INSTALLATION INSTRUCTIONS

Vibration switches are available in a variety of models for application on machinery or equipment where excessive vibration or shock can damage equipment or otherwise pose a threat to safe operation.

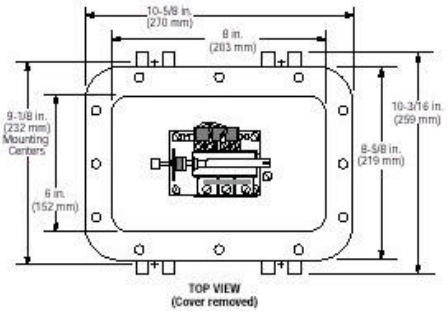
Murphy Models

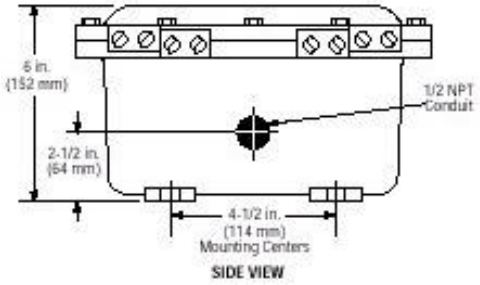
VS2-EX/VS2-EXR





VS2-EXR-B





ELECTRIC MODELS

Make the necessary electrical connections to the vibration switch. Do not exceed voltage or current rating of the contacts. Follow appropriate electrical codes/methods when making electrical connections. Be sure that the run of electrical cable is secured to the machine and is well insulated from electrical shorting. Use of conduit is recommended.

PNEUMATIC MODELS

Attach a pressure source of 20-80 psig (138-552 kPag) to the supply port. Best operation is obtained with 60 psi (414 kPag). Pressure medium must be clean, dry air or gas. Use a filter and pressure regulator as necessary.

Connect an exhaust line to the exhaust port and to the equipment shutdown device to be operated.

SENSITIVITY ADJUSTMENT

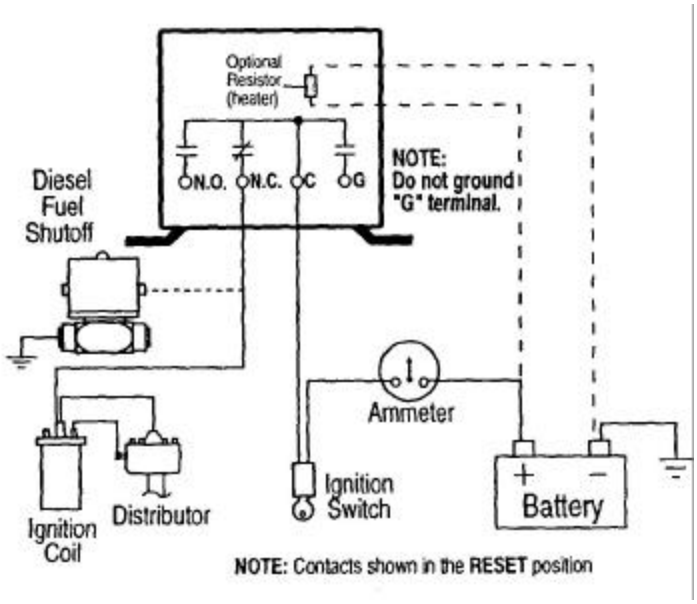
1. Replace all covers, lids, and electrical enclosures.

2. If the vibration switch trips on start-up, allow the machine to stop. Turn the sensitivity adjustment ¼ turn clockwise. Depress the reset button and restart the machine. Repeat process until the vibration switch does not trip on start-up.

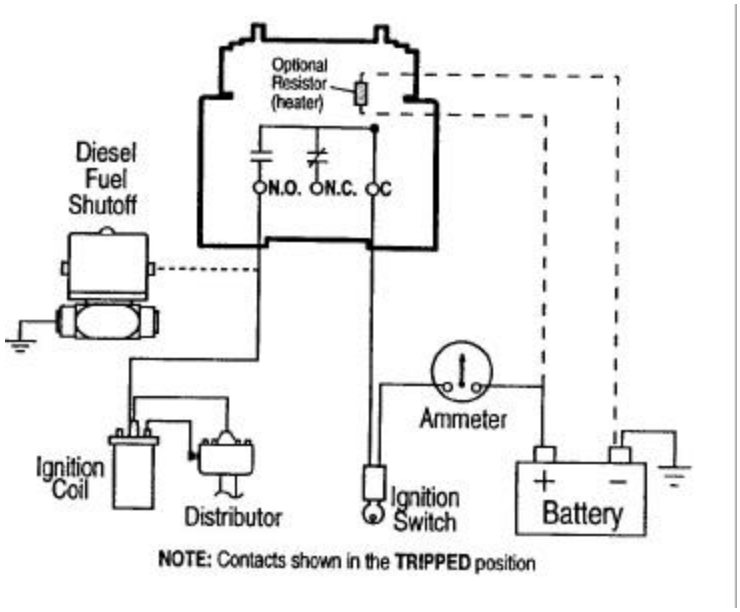
3. If the vibration switch does not trip on start-up, stop the machine. Turn the sensitivity adjustment ¼ turn counter clockwise. Repeat start-up/stop process until the vibration switch trips on start-up. Turn the sensitivity adjustment ¼ turn clockwise (less sensitive). Restart the machine to verify that the vibration switch will trip when abnormal shock or vibration exists.

TYPICAL WIRING DIAGRAMS

VS2 MODEL TYPICAL WIRING DIAGRAM FOR ELECTRIC MOTOR



VS2-EX, VS92, AND VS92-EX MODELS TYPICAL WIRING FOR ELECTRIC MOTOR



HTD AND V-BELT INSTRUCTIONS

SIMPLIFIED BELT TENSIONING METHOD

This tensioning method assumes average static tensions for drives, thereby eliminating the need for calculating static tension. Use this method if the small sheave diameter, small sheave rpm and speed ratio fall within the limits as given in table number 1; the number of belts used corresponds to the number recommended in this manual; and the drive has at least 2 belts.

Step 1: Determine the force required to deflect one belt 1/64" per inch of span length

- Measure the span length (t) or your drive.
- At the center of the span measure the force required to deflect one belt on the drive 1/64 per inch of span length from its normal position. The adjacent belt can be used as a reference for measuring the deflection. (see figure pg. 22) Be sure to apply the force perpendicular to the belt.
- Measure the force required to deflect a band of belts 1/64 per inch of span length as discussed above. Divide the value by the number of belt strands in the band to find the deflection force per belt.

Note: Lay a steel bar or a narrow block of wood across the belt and apply the deflection force to the bar so that all of the individual strands in the band are deflected the same amount. If more than one belt is used in the drive, the neighboring band can be used as a reference for measuring the deflection, just as is done with individual belts. If only one band is used, lay a straightedge or stretch a string from sheave-to-sheave to use as a reference for measuring the deflection. Lay the straightedge or string across the back of the belt on the sheaves.

Step 2: Compare this deflection with the range of forces given in TABLE NUMBER 1.

- If it is less than the minimum recommended force, the belts should be retensioned.
- If it is more than the maximum recommended force, the drive is tighter than it needs to be.

TABLE NUMBER 1

RECOMMENDED DEFLECTION FORCE PER BELT

Cross Section	Smallest Sheave Diameter Range	RPM Range	Belt Deflection Force				Cross Section	Smallest Sheave Diameter Range	RPM Range	Belt Deflection Force			
			S-L Classic & Polyband		Classic Cog					D-V Wrapped		D-V Cog	
			Normal	New Belt	Normal	New Belt				Normal New	New Belt	Normal	New Belt
A, AX	3.0-3.6	1000-2500 2501-4000	3.7 2.8	5.5 4.2	4.1 3.4	6.1 5.0	3VX	2.2-2.4	1000-2500 2501-4000			3.3 2.9	4.9 4.3
	3.8-4.8	1000-2500 2501-4000	4.5 3.8	6.8 5.7	5.0 4.3	74 6.4		2.65-3.65	1000-2500 2501-4000	3.6 3.0	5.1 4.4	4.2 3.8	6.2 5.6
	5.0-7.0	1000-2500 2501-4000	5.4 4.7	8.0 7.0	5.7 5.1	9.4 7.6		4.12-6.90	1000-2500 2501-4000	4.9 4.4	7.3 6.6	5.3 4.9	7.9 7.3
B, BX	3.4-4.2	860-2500 2501-4000			4.9 4.2	7.2 6.2	5V, 5VX	4.4-6.7	500-1749 1750-3000 3001-4000			10.2 8.8 5.6	15.2 13.2 8.5
	4.4-5.6	860-2500 2501-4000	5.3 4.5	7.9 6.7	7.1 7.1	10.5 9.1		7.1-10.9	500-1740 1741-3000	12.7 11.2	18.9 16.7	14.8 13.7	22.1 20.1
	5.8-8.6	860-2500 2501-4000	6.3 6.0	9.4 8.9	8.5 7.3	12.6 10.9		11.8-16.0	500-1740 1741-3000	15.5 14.6	23.4 21.8	17.1 16.8	25.5 25.0
C, CX	7.0-9.0	500-1740 1741-3000	11.5 9.4	17.0 13.8	14.7 11.9	21.8 17.5	8V	12.5-17.0	200-850 851-1500	33.0 26.8	49.3 39.9		
	9.5-16.0	500-1740 1741-3000	14.1 12.5	21.0 18.5	15.9 14.6	23.5 21.6							
D	12.0-16.0	200-850 851-1500	24.9 21.2	37.0 31.3				18.0-22.4	200-850 851-1500	39.6 35.3	59.2 52.7		
	18.0-20.0	200-850 851-1500	30.4 25.6	45.2 38.0									

HTD BELT INSTALLATION PROCEDURE

BELT TENSION

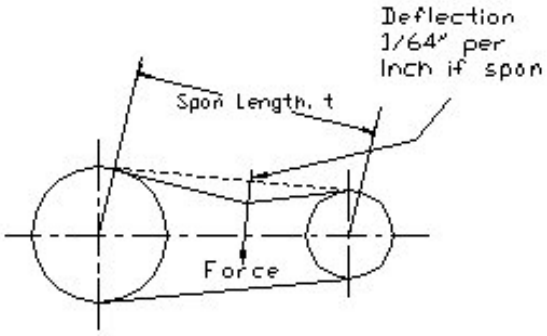
HTD drives do not require as much tension as other belt drives that depend on friction to transmit the load. HTD belts should be installed with a snug fit, neither too taut nor too loose. After the belt has been so tensioned, a force to deflect the belt by a certain amount to assure proper tension can be measured. Stop the drive and measure the belt span (see sketch). Using a spring scale, apply a perpendicular force to the center of the belt width and the center of the belt span. Measure the force required to deflect the belt 1/64" for each inch of belt span. For example, the deflection for a 32" belt span is 32 x 1/64 = 1/2" deflection. The force required to deflect the belt this amount at the proper tension is listed in table below.

DEFLECTION FORCE FOR HTD BELTS

PITCH	WIDTH	FORCE
8mm	20mm	4 lbs.
	30mm	6 lbs.
	50mm	11 lbs.
	85mm	19 lbs.
14mm	40mm	11 lbs.
	55mm	16 lbs.
	85mm	26 lbs.
	115mm	37 lbs.
	170mm	58 lbs.

NOTE: For belts wider than 2", it is suggested that a strip of keystock, or something similar, be placed across the belt under the point of force to prevent distortion.

For drives with shock loading or other unusual conditions, the force may have to be increased for proper operation of the drive.



GENERAL MOTOR INFORMATION

MOTOR STORAGE PROCEDURES

ATMOSPHERE

Controlled	Partially Controlled
Required: Even temperatures, 10°F or more above dew point; relative humidity 50% or less; little dust, no harmful fumes.	Desired: Clean and dry as possible.

BEARINGS:

Nothing required. Ball bearings grease-packed at factory.

SHAFT, FLANGE SURFACES:

Coat with easily removable rust-preventative Tectyl No. 502-C, mfd by Ashland Oil and Refining Co., Ashland, KY or equal.

RODENTS:

Prevent rodents or other small animals from nesting inside motor.

LONG STORAGE:

(Over six months)

If in an controlled environment - nothing more is required.

If stored in a partially controlled environment, the following applies:

1. Disassemble main parts and clean thoroughly.

2. Repaint previously painted surfaces before reassembly.

3. Remove condensation drain plugs (if present). Insert silica gel (desiccant) plugs in openings.

4. Cover completely to exclude dirt, dust, moisture and foreign materials. If possible, insert motor in strong transparent plastic bag. Attach moisture indicator to side of motor, place several bags of silica-gel inside, then seal plastic bag.

5. If motor cannot be sealed in bag and relative humidity exceeds 50%, use space heaters (installed inside motor when possible) to keep it at least 10°F above ambient air.

EXTERNAL WIRING

Starting and over-load control devices must be matched to motor rating. For safety or convenience they may need to be installed some distance from the motor. Follow the control manufacturer's instructions to make proper installation and connections.

Observe the following:

Connect electrical power supply to conform with National Electrical Code and any local regulations. Line voltage and wire capacity must match motor rating stamped on the nameplate.

Only when the drive is disconnected, momentarily energize the motor to check that rotation is in the proper direction.

If motor is three-phase type, reverse rotation (if required) by interchanging any two of the three power leads.

If two-phase, interchange stator leads of either phase, being careful not to interchange leads from one phase to the other.

OPERATION

A. INITIAL START

After installation is completed, but before motor is put into regular service, make an initial start as follows:

1. Motor starting and control device connections must agree with wiring diagrams.

2. Voltage, phase and frequency of line circuit (power supply) must agree with motor nameplate.

3. Check motor service record and tags accompanying motor to be certain bearings have been properly lubricated. Bearings should be lubricated when shipped from factory to give six months of satisfactory service.

4. If possible, remove external load (disconnect drive) and turn shaft by hand to insure free rotation.

- If drive is disconnected interrupt the starting cycle after motor has accelerated to low speed. Carefully observe for unusual conditions as motor coasts to a stop. Repeat several times if necessary.

- If drive is not disconnected, interrupt the starting cycle after motor has accelerated to low speed. Carefully observe for unusual conditions as motor coasts to a stop. Repeat several times if necessary.

CAUTION! Repeated trial starts can overheat the motor (particularly for across the line starting). If repeated trial starts are made, allow sufficient time between trials to permit heat to dissipate from windings or rotor to prevent overheating. Starting currents are several times running currents and heating varies as the SQUARE of the current.

B. NORMAL OPERATION

Start the motor in accordance with standard instructions for the starting equipment used. Some loads should be reduced to the minimum, particularly reduced voltage starts and/or high inertia connected loads.

Run high temperature motors (Class H insulation) at reduced load until bearings reach operating temperature.

C. VOLTAGE REGULATION

Motors will operate successfully under the following conditions of voltage and frequency variation, but not necessarily in accordance with the standards established for operating under rated conditions:

- When the variation in voltage does not exceed 10% above or below normal, with all phases balanced.

- When the variation in frequency does not exceed 5% above or below normal.

- When the sum of the voltage and frequency variations does not exceed 10% above or below normal (provided the frequency variation does not exceed 5%).

REGULAR MAINTENANCE

Several of the more important items of good maintenance are discussed in the following paragraphs. Others should be added when adverse or unusual conditions exist.

Inspection:

Each motor should be inspected at regular intervals. The frequency and thoroughness will depend on the amount of operation, nature of service and the environment.

Cleanliness:

The motor exterior should be kept free of oil, dust, dirt, water and chemicals. For fan-cooled motors, it is particularly important to keep the air intake opening free of foreign material. Do not block air outlet.

Moisture:

On non-explosion proof TEFC motors, a removable plug in the bottom center of the motor frame permits removal of any accumulated moisture. Drain regularly.

Lubrication Schedule:

Relubricate bearings each six months (more often if conditions require) as follows:

MOTOR SPEED (R.P.M.)	RELUBRICATING FREQUENCY
3600	6 Months (4,000 Hours)
1800 or Less	12 Months (8,000 Hours)

(Operating environment may dictate more frequent lubrication)

1. Stop the motor. Lock out the switch, particularly if end shield is to be withdrawn.

2. Thoroughly clean off and remove the pipe plugs from bearing housing.

3. Remove hardened grease from drains with stiff wire or rod.

4. Add grease to inlet with hand gun until small amount of new grease is forced out drain. Catch used grease in suitable container.

For best results, grease should be compounded from a lithium soap base and a good grade of petroleum oil. It should be of No. 2 consistency and stabilized against oxidation. Operating temperature range should be from -15°F to +250°F for Class B insulation and to +300°F for Class F and H. Most major oil companies have special bearing greases that are satisfactory.

CAUTION! Adding grease to bearing when motor is operating will cause grease to go thru clearance around inside end cap and be slung onto motor windings.

NOTE:

For vertical shaft motors, it is wise to check the inner cap of the top bearing for grease slumping through the bearing and filling the inner cap grease reservoir. Since it is necessary to remove the housing, this check is best done during periodic shut down inspections. (Bottom bearing inner cap should be 2/3 full.)

5. Remove excess grease from ports, replace inlet plugs and run motor 1/2 hour before replacing drain plug.

6. Put motor back into operation.

INSTRUCTIONS FOR BEARINGS

WARNING! ***To ensure that drive is not unexpectedly started, turn off and lock out or tag power source before proceeding. Failure to observe these precautions could result in bodily injury.***

The bearing has been greased at the factory and is ready to run. The following table is a general guide for relubrication. However, certain conditions may require a change of lubricating periods as dictated by experience.

Many ordinary cup greases will disintegrate at speeds far below those at which bearings will operate successfully if proper grease is used. Bearings have been lubricated at the factory with number two consistency lithium base grease which is suitable for normal operating conditions. Relubricate with lithium base grease or a grease which is compatible with original lubricant and suitable for ball bearing service. In unusual or doubtful cases the recommendation of a reputable grease manufacturer should be secured.

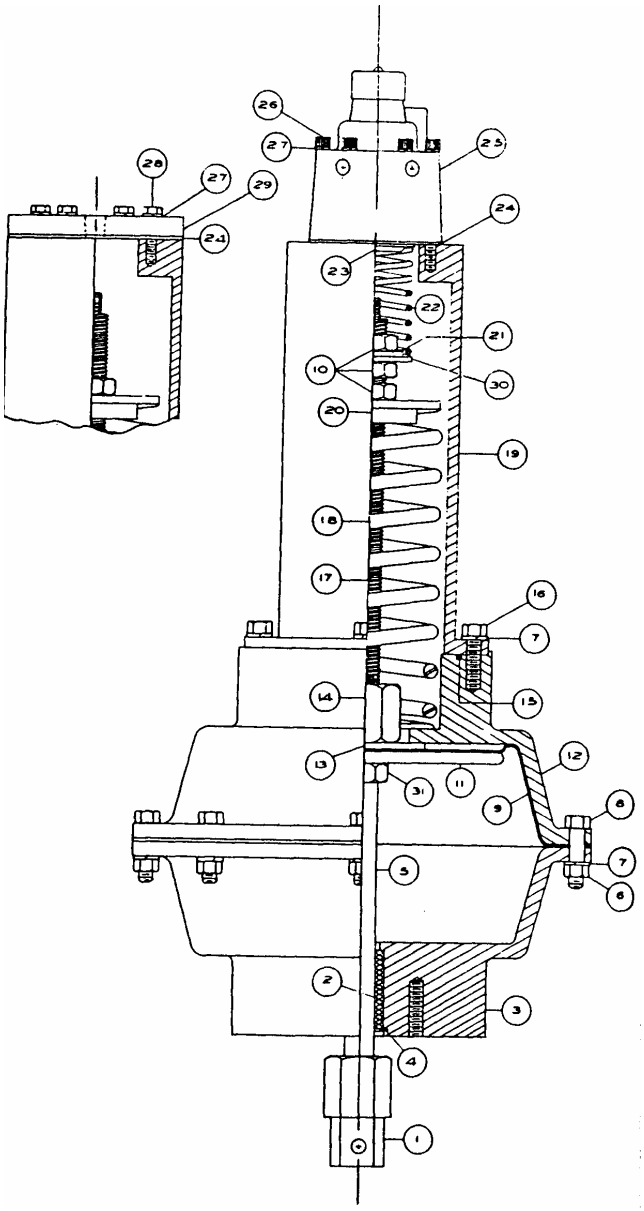
LUBRICATION GUIDE

Read Preceding Paragraphs Before Establishing Lubrication Schedule.

Hours Run Per Day	Suggested Lubrication Period In Weeks							
	1 to 250 RPM	251 to 500 RPM	501 to 750 RPM	751 to 1000 RPM	1001 to 1500 RPM	1501 to 2000 RPM	2001 to 2500 RPM	2501 to 3000 RPM
8	12	12	10	7	5	4	3	2
16	12	7	5	4	2	2	1	1
24	10	5	3	2	1	1	1	1

CHECO ACTUATOR

ITEM	QTY	DESCRIPTION
1	1	CLEVIS
2	1	GUIDE BUSHING
3	1	LOWER HOUSING
4	1	SNAP RING
5	1	STEM
6	8	HOUSING NUT
7	12	LOCKWASHER
8	12	HOUSING SCREW
9	1	DIAPHRAGM
10	3	LOCKNUT
11	1	DIAPHRAGM PLATE
12	1	UPPER HOUSING
13	1	DIAPHRAGM WASHER
14	1	CONNECTOR NUT
15	1	O-RING
16	4	SPRING COVER SCREW
17	1	SPRING ROD
18	1	MAIN SPRING
19	1	SPRING COVER
20	1	SPRING WASHER
21	1	WASHER
22	1	POSITIONER SPRING
23	1	POSITIONER WASHER
24	1	GASKET
25	1	POSITIONER
26	6	POSITIONER SCREW
27	6	LOCKWASHER
28	6	COVER PLATE SCREW
29	1	COVER PLATE
30	1	WASHER
31	1	LOCKNUT



FISHER ACTUATORS

INSTALLATION

If the actuator is mounted on a valve body, follow the specific valve body instruction sheet when installing the control valve in the pipeline. For actuator's that are shipped separately, four holes are tapped in the yoke boss to provide a method of securing it to a mounting plate or bracket (factory will supply mounting plate or bracket when specified).

A ¼" npt loading pressure connection is located in the top of the upper diaphragm case. Using either pipe or tubing, connect either the loading pressure connection or valve positioner input connection (if a valve positioner if furnished, the loading pressure connection to the actuator will be made at the factory) to the output pressure connection on the controller. Keep the length of the pipe or tubing as short as possible to avoid transmission lag in the control signal.

ADJUSTMENT

When the actuator is completely installed and connected to the controller, it should be checked for correct travel, freedom for friction, and correct action "push-down-to-open" or "push-down-to-close".

The actuator spring and diaphragm have been selected to meet the requirements of the application. It should be noted that the actuator spring has a constant rate of compression, and that adjustment of the spring compression merely shifts the initial spring set point up or down to make the actuator travel within the initial spring set point and the maximum diaphragm pressure indicated on the actuator nameplate.

INSERT FISHER STUFF HERE

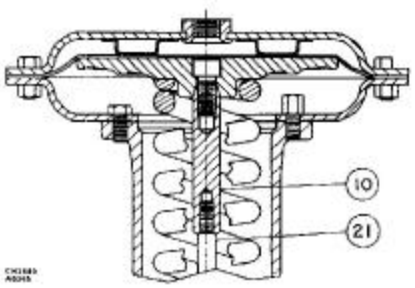
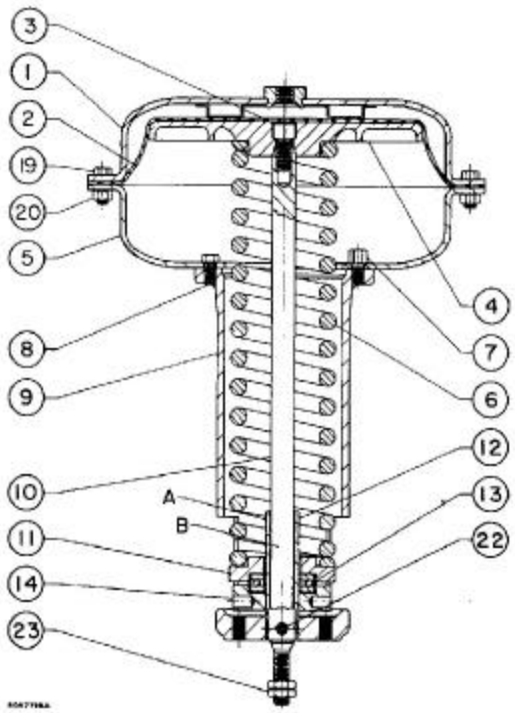


Figure 5. Type 656 (Size 30)



APPLY LUBRIPLATE NO. 130AA ON SURFACES A & B

Figure 6. Type 656 (Sizes 40 & 60)

Parts Reference

Types 650 & 656

Key	Description	Part Number
1	Diaphrgm Case Assembly, steel	
	Standard	
	Size 30	2J7138 28992
	Size 40	2L4418 28992
	Size 60	30A005 5X012
	For top-mounted handjack	
	Size 30	2E7922 25062
	Size 40	2E8063 25062
	Size 60	2E8474 25062
2*	Diaphragm	
	Size 30	2E7919 02202
	Size 40	2E6700 02202
	Size 60	2E8597 02022
3	Cap Screw, steel	
	Sizes 30 & 40	1E7604 32992
	Size 60	1E7754 32982
4	Diaphragm Plate, cast iron	
	Size 30	2F6483 19042
	Size 40	2V9399 19042
	Size 60	20A133 6X012
5	Lower Diaphragm Case, steel	
	Size 30	2E7922 25062
	Size 40	2E8063 25062
	Size 60	2E8474 25062
6	Actuator Spring	
	Steel	See following table
7	Down Travel Stop, steel	
	Size 30 (3 req'd)	1F8429 24092
	Size 40 (3 req'd)	1F8428 24092
	Size 60 (4 req'd)	1E7979 24092
8	Cap Screw, steel	
	Sizes 30 & 40 (3 req'd), 60 (4 req'd)	
	All sizes	1A3684 24052
9	Yoke, cast iron	
	Type 650	
	Size 30	20A518 2X012
	Size 40	30A463 7X012
	Size 60	40A005 0X012
	Type 656	
	Size 30	2F9986 19042
	Size 40	3L4404 19042
	Size 60	4L9191 19042
10	Actuator Stem, steel	
	Type 650	
	Size 30	20A518 1X012
	Size 40	20A463 8X012
	Size 60	20A133 5X012

Key	Description	Part Number
10	Actuator Stem (Continued)	
	Type 656	
	Size 30	1F9994 24102
	Size 40	1L4502 24102
	Size 60	2L9192 24102
11	Lower Spring Seat, steel	
	Type 650	
	Size 30	10A517 8X012
	Size 40	10A464 0X012
	Size 60	10A005 2X012
	Type 656	
	Size 30	1F9990 24102
	Size 40	10A702 1X012
	Size 60	1L9193 24272
12	Adjusting Screw, brass	
	Type 650	
	Size 30	10A518 0X012
	Size 40	10A463 9X012
	Size 60	10A005 3X012
	Type 656	
	Size 30	1J9924 14012
	Size 40	1L4501 14012
	Size 60	1L9194 14012
13	Thrust Bearing, steel	
	Type 650	
	Sizes 30 & 40	10A463 6X012
	Size 60	1N8887 99012
	Type 656 (ball bearing)	
	Sizes 30 & 40	1F9992 28992
	Size 60	1L9195 28992

Key	Description	Part Number
14	Lower Bearing Seat, steel	
	Type 650	
	Size 30	10A517 9X012
	Size 40	10A464 1X012
	Size 60	10A005 4X012
	Type 656	
	Sizes 30 & 40	1F9991 24012
	Size 60	1L9196 24272
15	Thrust Bearing Race, steel	
	Type 650 Only (2 req'd all sizes)	
	Sizes 30 & 40	10A463 5X012
	Size 60	1N8888 99012
17	Nameplate, SST	
	Standard	
	Size 30	1H9038 38992
	Sizes 40 & 60	1U9615 38982
	Butterfly valves	1U6136 38982
18	Drive Screw, SST	
	(4 req'd)	1A3682 28982
19	Cap Screw, steel	
	Size 30 (12 req'd)	1E7603 24052
	Size 40 (16 req'd)	1E7603 24052
	Size 60 (24 req'd)	1A6751 24052
20	Hex Nut, steel	
	Size 30 (12 req'd)	1A3465 24122
	Size 40 (16 req'd)	1A3465 24122
	Size 60 (24 req'd)	1A3465 24122

*Recommended Spare Part

Key	Description	Part Number
21	Valve Stem, 316 SST	
	Type 656	
	(Size 30 only)	1J9925 35162
22	Set Screw, steel	
	Type 650	
	Sizes 30 & 40	1C3451 28992
	Size 60	1H1999 28992
	Type 656	
	(All sizes)	1H1999 28992
23	Hex Nut, steel	
	Type 650	
	Size 30	1A9463 24122
	Size 40	1A3537 24122
	Size 60	1A3540 24122
	Type 656 (2 req'd)	
	Size 30	1A3537 24122
	Sizes 40 & 60	1A3511 24122

Key 6 Actuator Spring, steel

Actuator Size	Spring Rate (Lb/In)	Spring Color Code	Part Number
30	125	Aluminum & Orange	1F3616 27032
	170	Aluminum & Dark Green	1K5098 27032
	238	Aluminum & Red	1N7515 27032
	275	Tan	1F1770 27092
	370	Brown	1F1771 27092
	460	Pink	1F1772 27092
40	145	White	1L2174 27042
	205	Yellow	1P6371 27082
	335	Dark Green	1L2173 27042
	455	Nonet	1N8440 27082
60	280	Nonet	1K1627 27082
	400	Nonet	1N9373 27082
	610	Nonet	1K1628 27082
	860	Nonet	1P2702 27042
Type 656 Only			
30	40	Aluminum & Lt. Blue	1H8262 27032
	80	Aluminum & Purple	1H8261 27032

† These springs have part numbers stamped on the side of the tapered spring ends.

POSITIONER INSTRUCTIONS

Reconnect the flexible air lines. The supply line enters the top of the union.

Turn on air pressure and check for leaks.

The positioner must be adjusted for proper operation. First, remove the small adjustment cover on the top of the positioner. This cover is held in place with a small screw. Set the instrument air pressure to 4 psi*. With the adjustment cover removed you will see a brass hexagonal shaft with a slot in it. The shaft must be turned until the blades just begin to move (because the positioners very, the shaft may have to be adjusted either up or down.) When the adjustment is made, change the instrument pressure to 15 psi*. The blade should cycle through a full pitch change. If not, repeat the zero adjustment.

*__NOTE__: If the instrument air signal range is not 3-15 psig, choose the beginning pressure 1 psig over your minimum and adjust the pressure to your maximum to check change in pitch.

GEAR INSTRUCTIONS

LUBRICATION INSTRUCTIONS

Type of oil:

Lubricating oil for use in air-cooled heat exchangers should be an extreme pressure type lubricant compounded with sulfur phosphorous in a well-refined oil. The lubricant must not be corrosive to gears or roller bearings; must be neutral in reaction; contain no grit, abrasive or other foreign material; should have good de-foaming properties and moisture resisting characteristics. It must have good resistance to oxidation and a pour point of 0° F to 5° F. It must not be corrosive to a copper strip at 212° F.

Recommended lubricants are as follows:

AMBIENT-DEGREES F	15-50	50-125
AGMA NUMBER	4EP	5EP
VISCOSITY RANGE	626-755 SSU @ 100°F	918-1122 SSU @ 100°f

The user should consult his regular lubricant supplier for recommendations of brand names to meet the above specifications.

For units equipped with a backstop, do not use EP-type oil as this may cause the backstop to become ineffective. Use only straight mineral oil of the same viscosity.

SYNTHETIC GEAR LUBRICANTS

Synthetic oils have been used in enclosed gear drives for special operating conditions. Synthetic lubricants can be advantageous over standard oils in that they are generally more stable, have a longer life, and operate over a wider temperature range.

INSTRUCTIONS FOR INSTALLATION AND STARTING NEW UNIT

1. When units leave the factory, the internal parts are protected by a polar rust preventive film. Flushing of this film is not required since it is soluble in the lubricant. Merely fill the case with the recommended lubricant to the proper oil level. **NOTE: units are shipped without oil and must be filled before starting**.
2. The gears are carefully set-up with respect to each other during factory assembly to give proper tooth contact. Nothing should be done to disturb this factory setting.
3. Gear units are shipped with the breather port plugged. Prior to operation, a breather type plug (supplied with the unit) must be installed in the upper housing.
4. Each unit is given a short run-in at the factory as part of the inspection procedure. When circumstances allow, it is recommended that the fan blades be set at a minimum output pitch and the reducer operated for one or two days to allow final "break-in" of gears. After this "break-in" period, fan blades can be set to produce rated load on unit.
5. Coupling connections should be aligned for minimum parallel and angular misalignment.
6. Where it is required to shim the unit for alignment, care must be taken to prevent distortion of the housing. **Note: coupling and unit alignment should be rechecked after two weeks operation**.
7. When units furnished with force feed lubrication are first started up, it should be observed that oil is being pumped.
8. For cold temperature operation where oil viscosity on starting is greater than 5,000 SUV, heaters must be used. For units with pressure lubrication systems, check that pump is pumping cold oil.
9. Minimum viscosity required under operating conditions ranges from 150 to 400 SUV. Oils having this viscosity under operating conditions are not normally satisfactory for cold temperature starting and heaters must be used.
10. Where unit will not heat up under intermittent operating conditions, low-viscosity oil may be selected for cold temperature operation.

OIL CHANGES

After a gear unit is first installed, the first oil should be changed after two weeks of operations. If desired, the original oil may be strained and replaced. Do not use a strainer finer than 25 microns to avoid filtering out the additives. After the original oil has been drained, fill the case to the indicated level with SAE-10 straight run mineral flushing oil containing no additives. Fan should be started, brought up to speed and shut down immediately as a flushing procedure. Drain off flushing oils and fill with recommended lubricant to the proper level.

After this initial oil change, an oil change every six months should be sufficient unless there are unusually high temperature conditions combined with intermittent high loads where the temperature of the gear case rises rapidly and then cools off quickly. This condition may cause sweating on the inside wall of the unit thus contaminating the oil and forming sludge. Under these conditions, or if the oil temperature is continuously above 200°F, or if the unit is subjected to an unusually moist atmosphere, oil changes may be necessary at one, two or three month intervals, as determined by field inspection of the oil.

Every precaution should be taken to prevent any foreign matter from entering the gear case. Dust, dirt moisture, and chemical fumes form sludge – the biggest enemy of proper and adequate lubrication.

INSTRUCTIONS FOR MAINTENANCE

1. Check oil level once a week. Level should be checked with unit stopped since the indicated oil level will rise when unit is running. Lubricant level should not be more than ¼" below specified level.
2. The lubrication instructions for oil change and for shutdown periods should be followed.
3. Units should be given daily routing inspection consisting of visual inspections and observations for oil leaks or unusual noises. If either occurs, unit should be shut down, cause of leakage or noise found and corrected.
4. The operating temperature of the unit is the temperature of the oil inside the housing. The maximum operation should not exceed 200°F.
5. This sump temperature is considered maximum because many lubricants lose stability properties when exposed to temperatures above the stated maximum.

INSTRUCTIONS FOR SHUTDOWN PERIODS

If unit will be idle for a period longer than one week, it will be necessary to run the unit for ten minutes every week it is idle. This short operation will keep the gears and bearings coated with oil and prevent rusting due to condensations of moisture resulting from temperature changes.

COUPLINGS

EQUIPMENT ALIGNMENT

Coupling alignment is directly related to equipment and coupling life.

Although couplings can withstand gross misalignment, care should be taken for best possible alignment to assure optimum performance. The caliper/straightedge alignment procedure is described below. If greater alignment accuracy is desired, a dial indicator method is recommended. There are occasions when equipment manufactures require more specific alignment tolerances, in which case the manufacture's recommendations should be followed.

1. To correct for angular misalignment use calipers to check toe gap between hubs. Adjust or shim equipment until the gap is the same at all points around the hubs.

2. To correct parallel offset, place a straightedge across the hub flanges in two places at 90 degrees to each other. Adjust or shim equipment until the straightedge lays flat on both sides.

3. Tighten down connected equipment and recheck alignment.

4. Install elastomer element, tightening all capscrews to the values shown in Table.

5. If practical, recheck and tighten capscrews after several hours of operation.

RECOMMENDED CAPSCREW TORQUES FOR PROPER INSTALLATION

Important! Capscrews have self-locking patches which should not be reused more than twice.

Capscrews can be further used with application of a thread-locking adhesive. **DO NOT LUBRICATE CAPSCREW THREADS.**

DRY TORQUE TABLE

COUPLING SIZE	INCH-LBS.	FOOT-LBS.	N-M
2 3 4 5 10	204	17	23
20 30 40 50	360	30	56
60 70 80	900	75	100
100 120	3240	270	440

OPERATING INSTRUCTIONS LOUVERS

Louvers are shipped assembled, which makes them easier to install. Due to aluminum construction, louvers are lightweight and can easily be handled by two men.

When lifting equipment is required to move large sections of louvers, it is suggested that two pieces of crating lumber be placed beneath the section at 1/3 and 2/3 the length. Then slings may be used to lift the louver section to the top of the cooler on which they are to be used. Spreader bars must be used to prevent damage to the louver sideframe.

Manually operated louvers are furnished with an operating handle, which may be adjusted to the preferred position. To adjust this handle simply loosen the tightening bolts, reset handle to desired position and then re-tighten. Automatically operated louvers are shipped with operator bracket already mounted. The operator will be in a separate crate. Bolts are furnished for bolting this operator to the bracket. Connecting link should be attached, adjusted and then tightened.

For louvers to be connected end-to-end, a connecting link is furnished. This link connects the actuating rods of each set together.

For louvers to be connected side-by-side, a torque tube clamp is provided. Place clamp on torque tubes to be connected and close all blades. Then tighten the bolts provided. Any end-to-end adjustment in tourque tubes must be made by loosening collars and the actuator levers. Slide torque tube to desired position and retighten collars and actuator lever. If both sections do not close evenly, adjust actuator lever and/or clamps. **DO NOT OVER-TIGHTEN BOLTS**.

Plywood or boards of some type should be placed on CLOSED blades for walking on.

VS-7037N
Revised 09-06
Section 20
(00-02-0185)

Shock/Vibration Control Switches Installation Instructions

Models: VS2, VS2C, VS2EX, VS2EXR, VS2EXRB and VS94

Please read the following instructions before installing. A visual inspection of this product for damage during shipping is recommended before mounting. It is your responsibility to have a qualified person install the unit, and make sure installation conforms with NEC and local codes.

GENERAL INFORMATION

WARNING

BEFORE BEGINNING INSTALLATION OF THIS MURPHY PRODUCT

- ✔ Disconnect all electrical power to the machine.
- ✔ Make sure the machine cannot operate during installation.
- ✔ Follow all safety warnings of the machine manufacturer.
- ✔ Read and follow all installation instructions.

LISTED*

Model VS2EX

Description

The Murphy shock and vibration switches are available in a variety of models for applications on machinery or equipment where excessive vibration or shock can damage the equipment or otherwise poses a threat to safe operation. A set of contacts is held in a latched position through a mechanical latch and magnet mechanism. As the level of vibration or shock increases an inertia mass exerts force against the latch arm and forces it away from the magnetic latch causing the latch arm to operate the contacts. Sensitivity is obtained by adjusting the amount of the air gap between the magnet and the latch arm plate.

Applications include all types of rotating or reciprocating machinery such as cooling fans, engines, pumps, compressors, pump jacks, etc.

Models

VS2: Base mount; non hazardous locations.

VS2C: C-clamp mount; non hazardous locations.

VS2EX: Explosion-proof; Class I, Div. 1, Groups C and D.

VS2EXR: Explosion-proof with remote reset.

VS2EXRB: Explosion-proof; Class I, Div. 1, Group B; with remote reset.

VS94: Base mount; non hazardous locations, NEMA 4X/IP66.

Remote Reset Feature (VS2EXR, VS2EXRB and VS94 only)

Includes built-in electric solenoid which allows reset of tripped unit from a remote location. Standard on VS2EXR and VS2EXRB. Optional on VS94 (options listed below).

-R15: Remote reset for 115 VAC

-R24: Remote reset for 24 VDC

Time Delay Option (VS94 only)

Overrides trip operation on start-up. For VS94 series models, the delay time is field-adjustable from 5 seconds up to 100 seconds with a 20-turn potentiometer (5 seconds per turn approximately). Options listed below:

-T15: Time delay for 115 VAC

-T24: Time delay for 24 VDC

Space Heater Options (VS94 only)

This optional space heater board prevents moisture from condensing inside the VS94 Series case. Options listed below:

-H15: Space heater for 115 VAC

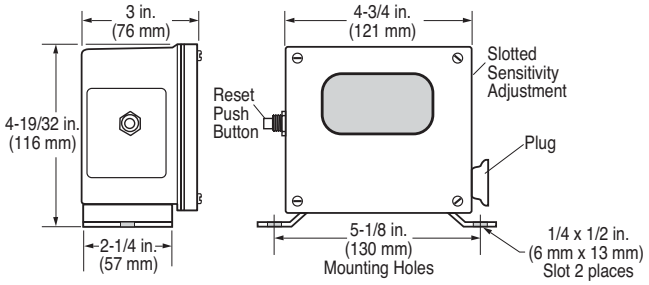
-H24: Space heater for 24 VDC

Warranty

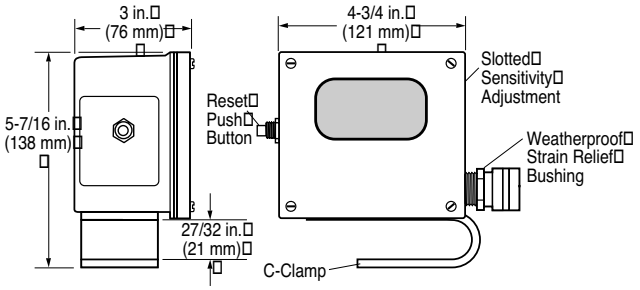
A limited warranty on materials and workmanship is given with this FW Murphy product. A copy of the warranty may be viewed or printed by going to www.fwmurphy.com/support/warranty.htm

DIMENSIONS

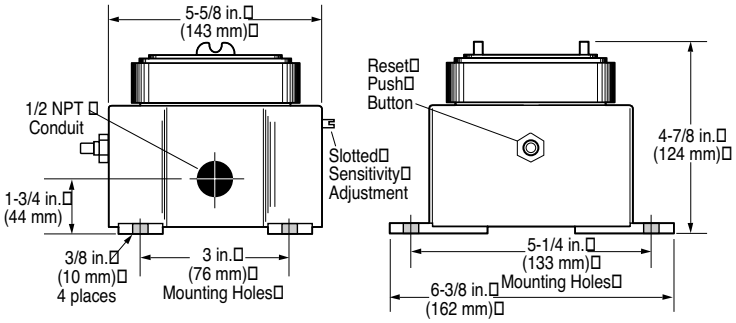
VS2



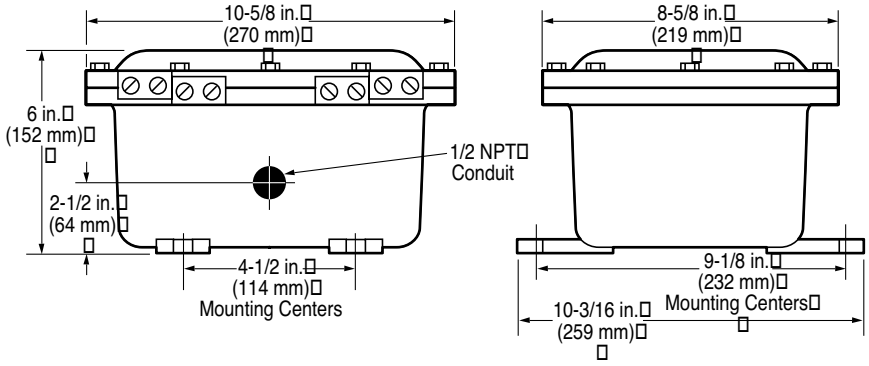
VS2C



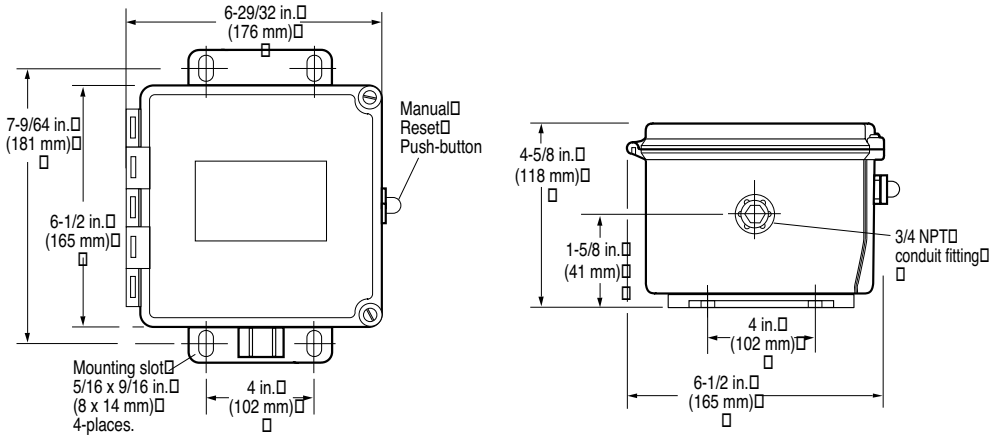
VS2EX and VS2EXR



VS2EXRB



VS94



SPECIFICATIONS

VS2 and VS2C

- **Case:** Weatherproof (equal to NEMA 3R) suitable for non-hazardous areas.
  VS2: *Base mount*
  VS2C: *C-clamp mount. Includes 45 feet (13.7 meters), 2-conductor 16 AWG, 30 strands/0.25 mm strand dia. (1.5 mm²) cable, and five cable hold down clamps.*
- **Contacts:** SPDT double make leaf contacts, 5A @ 480 VAC.
- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.

VS2EX

- **Case:** Explosion-proof and weatherproof aluminum alloy housing; meets NEMA 7/IP50 specifications; Class I, Division 1, Groups C & D; UL and CSA listed*
  VS2EX: *base mount.*
- **Snap-switches:** 2-SPDT snap-switches; 5A @ 480 VAC;* 2A resistive, 1A inductive, up to 30 VDC.
- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.
- **Normal Operating Temperature:** -40 to 140°F (-40 to 60°C).

VS2EXR

- **Case:** Same as VS2EX.
- **Snap-switch:** 1-SPDT snap-switch and reset coil; 5A @ 480 VAC;* 2A resistive, 1A inductive, up to 30 VDC.
- **Remote Reset (optional):**

Option	*Operating Current*
-R15:	*350 mA @ 115 VAC*
-R24:	*350 mA @ 24 VDC*

- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.
- **Normal Operating Temperature:** -40 to 140°F (-40 to 60°C).

VS2EXRB

- **Case:** Explosion-proof aluminum alloy housing; rated Class I, Division 1, Group B hazardous areas.
- **Snap-switch:** 1-SPDT snap-switch with reset coil (option available for additional SPDT switch); 5A @ 480 VAC; 2A resistive, 1A inductive, up to 30 VDC.
- **Remote Reset:**

Option	*Operating Current*
-R15:	*350 mA @ 115 VAC*
-R24:	*350 mA @ 24 VDC*

- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.

VS94

- **Case:** Polyester fiberglass reinforced; NEMA type 4 and 4X; IP66; CSA types 4 and 12.
- **Conduit Fitting:** 3/4 NPT conduit fitting connection.
- **Normal Operating Ambient Temperature:** 0 to 140°F (-18 to 60°C).
- **Snap-switches:** 2-SPDT snap acting switches; 5A @ 480 VAC; 2A resistive, 1A inductive, up to 30 VDC.
- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.
- **Heater (optional):**

Option	*Operating Current*
H15	*.023 A @ 115 VAC*
H24	*.12 A @ 24 VDC*

- **Remote Reset (optional):**

Option	*Operating Current*
R15	*.17 A @ 115 VAC*
R24	*.36 A @ 24 VDC*

- **Time Delay (optional):**

Option	*Operating Current*	*Standby Current*
T15	*.360 A @ 115 VAC*	*.01 A @ 115 VAC*
T24	*1.15 A @ 24 VDC*	*.01 A @ 24 VDC*

- **Time Delay/Remote Reset:** Adjustable 20-turn potentiometer from 5 seconds to 100 seconds (5 seconds per turn approximately).

*CSA and UL listed with 480 VAC rating.

INSTALLATION

WARNING: **STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING INSTALLATION.**

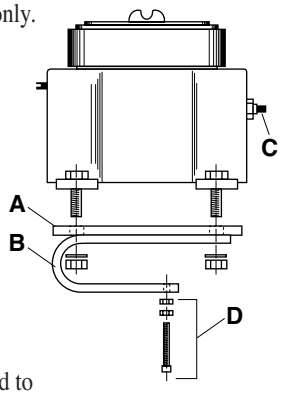
The VS2 and VS94 series shock switches are sensitive to shock and vibration in all three planes of motion - up/down, front/back and side/side. Front/back is the most sensitive (The reset pushbutton is located on the "front" of the unit). For maximum sensitivity mount the unit so that the front faces into the direction of rotation of the machine. (See Dimensions on page 2 for sensitivity adjustment location).

The VS2 and VS94 Series must be firmly attached/mounted to the machine so that all mounting surfaces are in rigid contact with the mounting surface of the machine. For best results, mount the instrument in-line with the direction of rotating shafts and/or near bearings. In other words, the reset push button should be mounted pointing into the direction of shaft rotation (see page 5). It may be necessary to provide a mounting plate or bracket to attach the VS2 and VS94 Series to the machine. The mounting bracket should be thick enough to prevent induced acceleration/vibration upon the VS2 or VS94 Series. Typically 1/2 in. (13mm) thick plate is sufficient. See illustrations on page 5 for typical mounting locations.

CAUTION: A dust boot is provided on the reset pushbutton for all series to prevent moisture or dust intrusion. The sensitivity adjustment for model VS2EX is not sealed; therefore, mounting orientation should be on a horizontal plane or with the sensitivity adjustment pointing down. Sensitivity adjustment for model VS2 is covered by a plug. The plug must be in place and tight to prevent moisture or dust intrusion.

C-Clamp Installation (VS2C model only)

A C-Clamp is supplied with the VS2C model only. The C-Clamp is shipped installed on the VS2C but must be installed on the VS2EX and VS2EXR switches.



1. The C-Clamp **(B)** will already be installed on a 1/4 in. (6 mm) thick steel mounting plate **(A)**. Bolt the VS2 switch to the mounting plate as illustrated — with four 5/16 in. bolts, nuts, and washers.
2. The mounting location should provide convenient access to the TATTLETALE® push button **(C)**.
3. The hardened set screw and nuts **(D)** are used to tighten the switch to an I-Beam or cross member such as a Sampson post of an oilwell pumpjack.

Continued on next page.

All Models

WARNING: **STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING INSTALLATION.**

1. Firmly secure the unit to the equipment using the base foot mount or C-Clamp if applicable. See ***C-Clamp Installation*** page 3.

For oilwell pumpjacks attach the VS2 and VS94 Series to the Sampson post or walking beam. See ***Typical Mounting Locations*** page 5.

2. Make the necessary electrical connections to the vibration switch. See ***Internal Switches,*** page 6 for electrical terminal locations and page 7 for typical wiring diagrams. **DO NOT EXCEED VOLTAGE OR CURRENT RATINGS OF THE CONTACTS.** Follow appropriate electrical codes/methods when making electrical connections. Be sure that the run of electrical cable is secured to the machine and is well insulated from electrical shorting. Use of conduit is recommended.

NOTE: If the electrical cable crosses a pivot point such as at the pivot of the walking beam, be sure to allow enough slack in the cable so that no stress is placed on the cable when the beam moves.

If conduit is not used for the entire length of wiring, conduit should be used from the electrical supply box to a height above ground level that prevents damage to the exposed cable from the elements, rodents, etc. or as otherwise required by applicable electrical codes. If conduit is not attached directly to the VS2 and VS94 Series switch, use a strain relief bushing and a weatherproof cap on the exposed end of the conduit. A "drip loop" should be provided in the cable to prevent moisture from draining down the cable into the conduit should the weathercap fail.

Sensitivity Adjustment

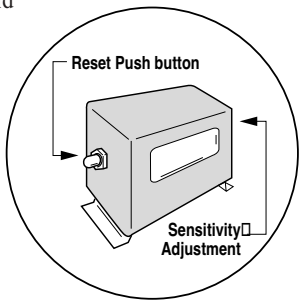
WARNING: **REMOVE ALL POWER BEFORE OPENING THE ENCLOSURE. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON PERFORM ADJUSTMENTS, AND MAKE SURE IT CONFORMS WITH NEC AND LOCAL CODES. DO NOT ADJUST SENSITIVITY WHILE THE MACHINE IS RUNNING. STAND CLEAR OF THE MACHINE AT ALL TIMES WHEN IT IS OPERATING.**

All models of the VS2 and VS94 Series cover a wide range of sensitivity. Each model is adjusted to the specific piece of machinery on which it is installed. After the switch has been installed in a satisfactory location (see page 5) the sensitivity adjustment will be increased or decreased so that the switch does not trip during start-up or under normal operating conditions. This is typically done as follows:

1. REPLACE ALL COVERS, LIDS, AND ELECTRICAL ENCLOSURES.

2. Press the reset push button to engage the magnetic latch. To be sure the magnetic latch has engaged, observe latch through the window on the VS2 and VS2C (see DETAIL "A"). On the VS2EX, VS94 series the reset button will remain depressed meaning the magnetic latch has engaged.

DETAIL "A"



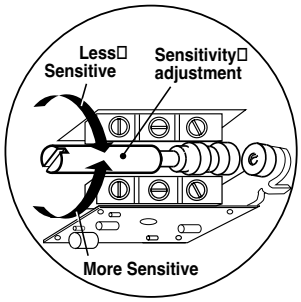
3. Start the machine.

4. If the instrument trips on start-up, allow the machine to stop. Turn the sensitivity adjustment 1/4 turn clockwise, (adjustment for VS94 and VS2EXRB models is located within the box, see DETAIL "B").

WARNING: **MAKE THE AREA NON-HAZARDOUS BEFORE OPENING THE EXPLOSION-PROOF (-EX) ENCLOSURES.**

Depress the reset button and restart the machine. Repeat this process until the unit does not trip on start-up.

DETAIL "B"



5. If the instrument does NOT trip on start-up, stop the machine. Turn the sensitivity adjustment 1/4 turn counter-clockwise. Repeat the start-up/stop process until the instrument trips on start-up. Turn the sensitivity adjustment 1/4 turn clockwise (less sensitive). Restart the machine to verify that the instrument will not trip on start-up.

6. Verify that the unit will trip when abnormal shock/vibration exists.

VS94 Time Delay Adjustment

1. Apply power to the time delay circuit. (see page 7 for time delay circuit). The time delay function will be initiated.

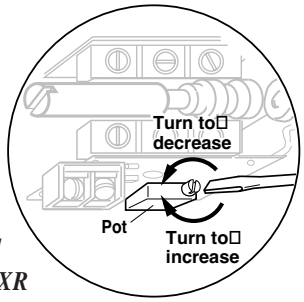
2. Time the length of the delay with a watch. Let time delay expire. After it expires, the override circuit will de-energize the solenoid, allowing the latch arm to trip. A clicking noise is heard.

WARNING: **REMOVE ALL POWER BEFORE OPENING ACCESS DOOR. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON ADJUST THE UNIT, AND MAKE SURE IT CONFORMS WITH NEC AND LOCAL CODES.**

3. TURN THE POWER OFF TO RESET THE TIME DELAY CIRCUIT.

NOTE: Allow 30 seconds bleed-time between turning the power "OFF" and "ON".

DETAIL "C"



4. Locate the time adjustment pot (DETAIL "C"). The time is factory-set at the lowest setting (5 seconds approximately). To increase time, rotate the 20-turn pot clockwise as needed (5 seconds per turn approximately).

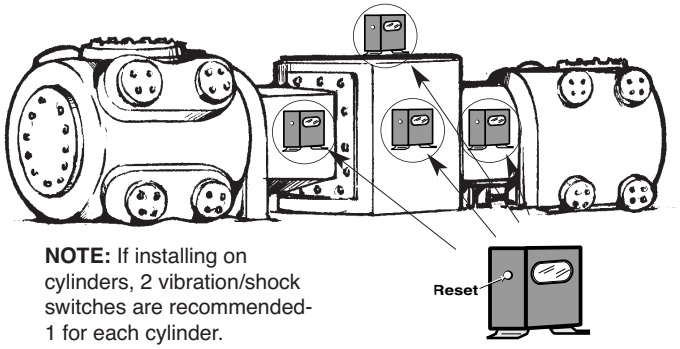
5. Repeat the above steps as necessary to obtain desired time delay.

NOTE: An external time delay can be used with the remote reset feature of the VS2EXR series to provide a remote reset and override of the trip operation on start-up. Time delay must automatically disconnect after equipment start-up.

TYPICAL MOUNTING LOCATIONS

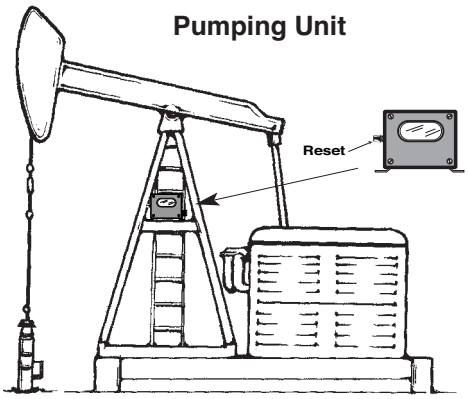
NOTE: These are typical mounting locations for best operation. Other mountings are possible. See *Installation* section on page 3.

2-Throw Balance-Opposed Compressor

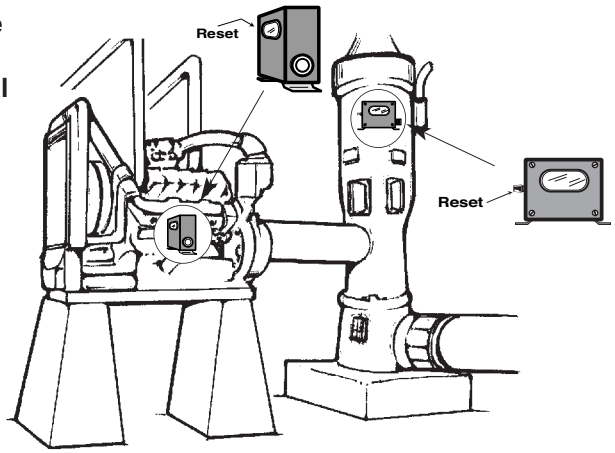


NOTE: If installing on cylinders, 2 vibration/shock switches are recommended- 1 for each cylinder.

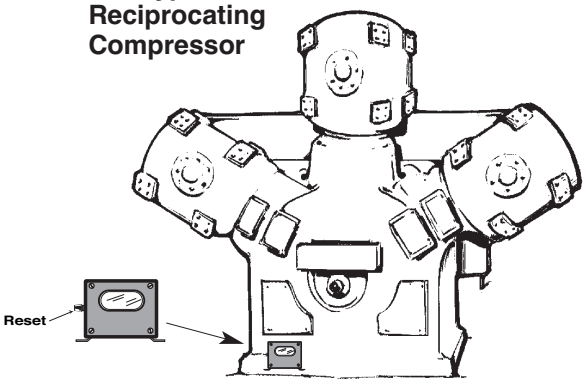
Pumping Unit



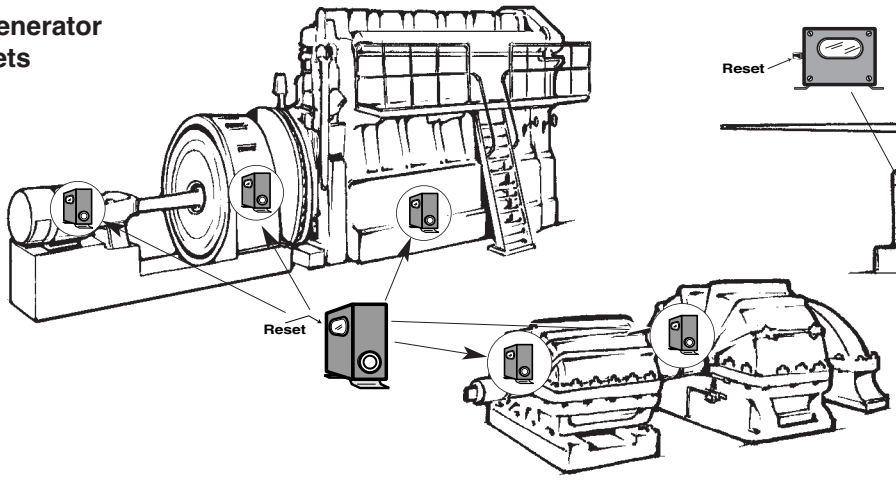
Engine and Vertical Shaft Pump



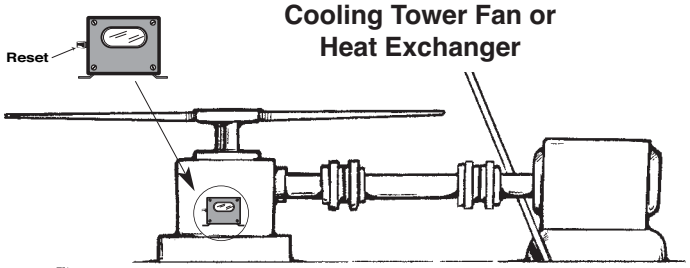
"Y" Type Reciprocating Compressor



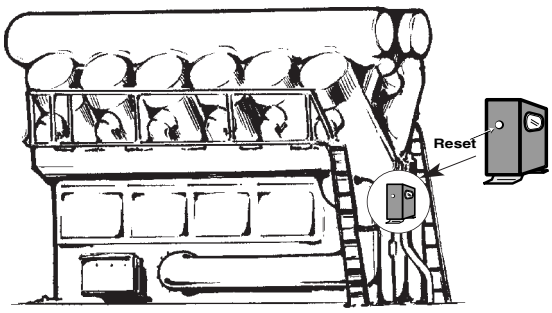
Generator Sets



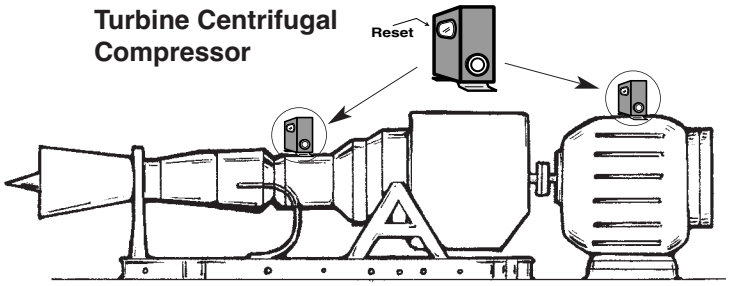
Cooling Tower Fan or Heat Exchanger



Engine Compressor

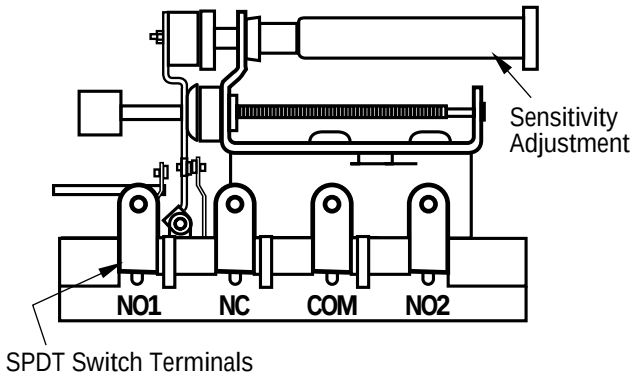


Turbine Centrifugal Compressor

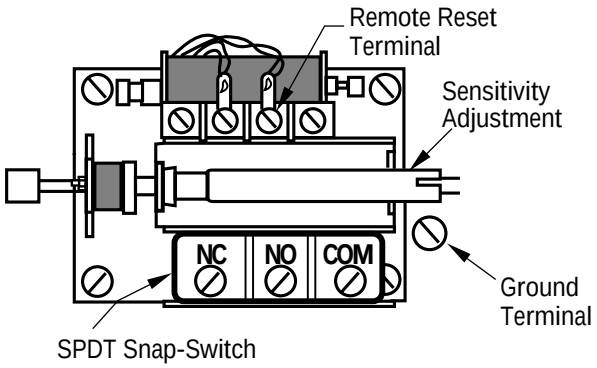


INTERNAL SWITCHES

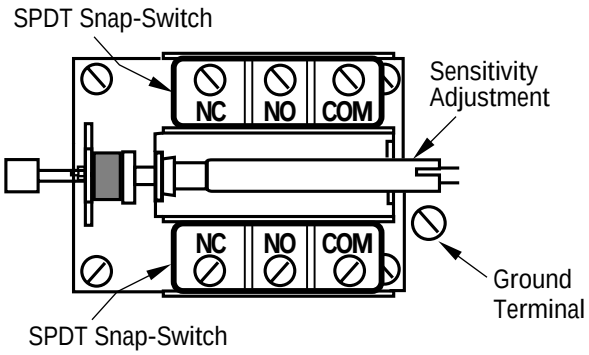
VS2 and VS2C



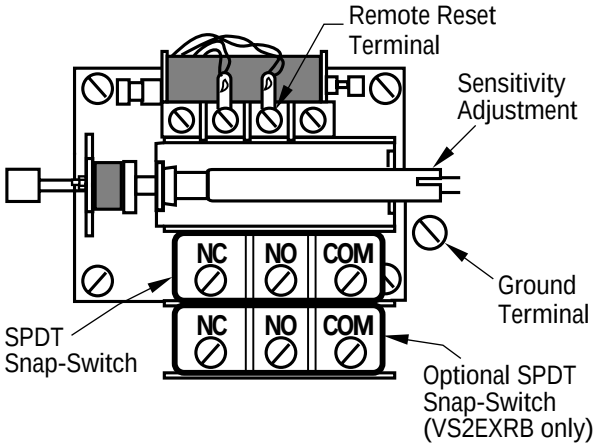
VS2EXR



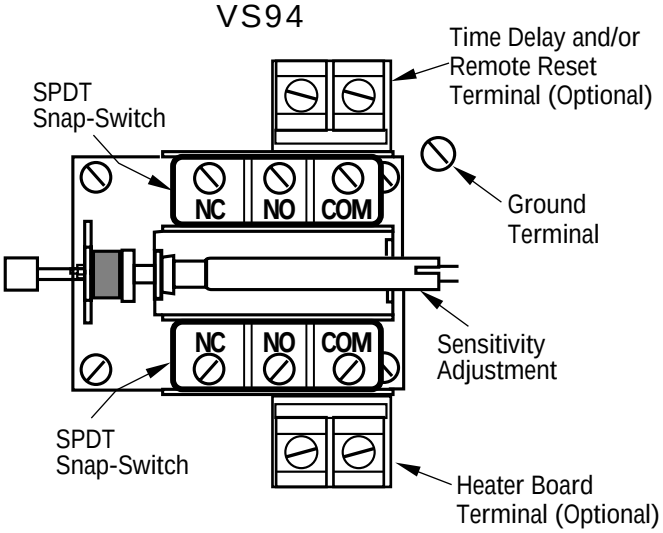
VS2EX



VS2EXB and VS2EXRB



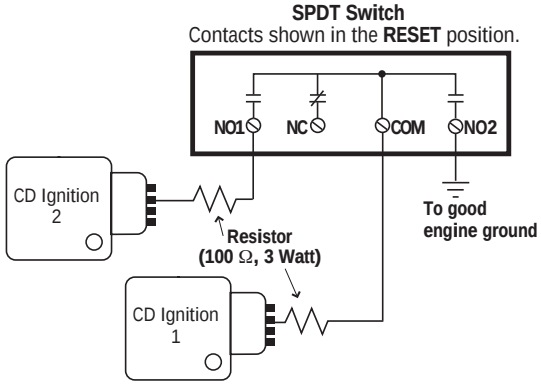
VS94



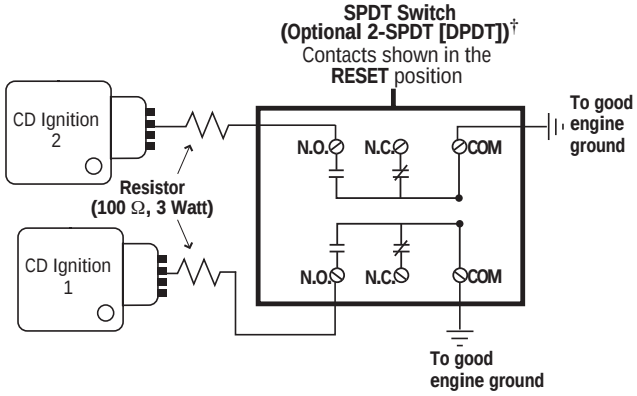
ELECTRICAL

WARNING: **REMOVE POWER BEFORE OPENING THE UNIT (ACCESS DOOR). STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING THE WIRING OPERATION. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON INSTALL AND WIRE THE UNIT, AND MAKE SURE IT CONFORMS WITH NEC AND APPLICABLE CODES.**

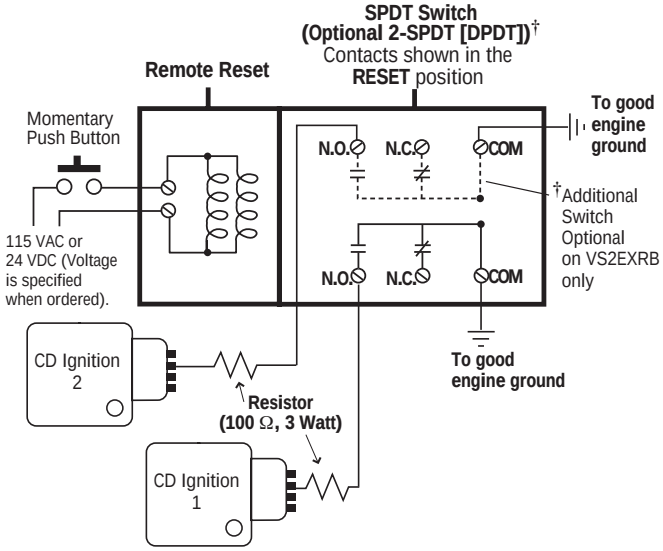
VS2 and VS2C
Typical Wiring Diagram for Single or Dual CD Ignition



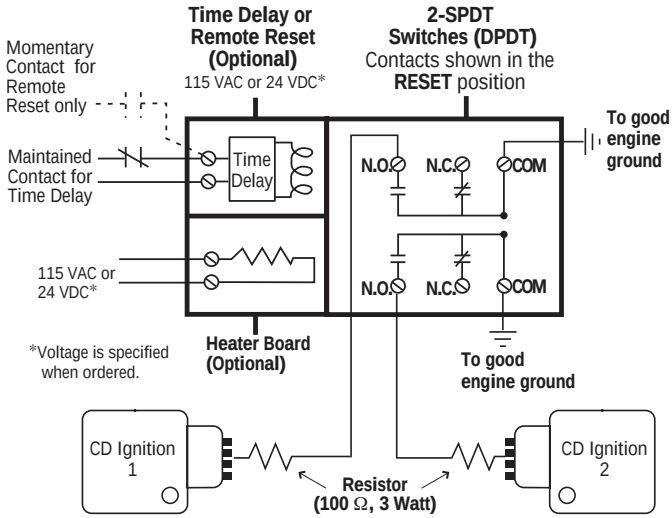
VS2EX
Typical Wiring Diagram for Single or Dual CD Ignitions



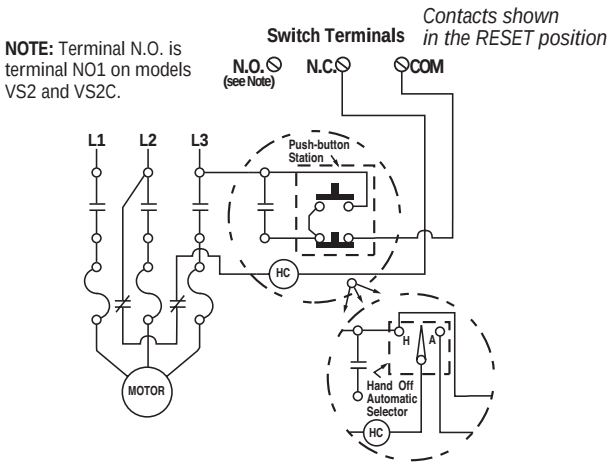
VS2EXR and VS2EXRB
Typical Wiring Diagram for Single or Dual CD Ignitions



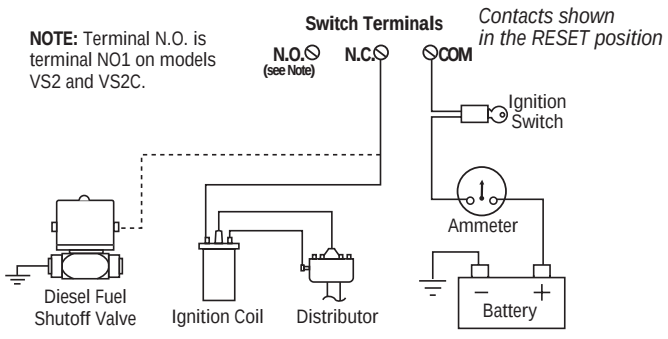
VS94
Typical Wiring Diagram for Single or Dual CD Ignitions



VS2, VS2C, VS2EX, VS2EXR, VS2EXRB and VS94
Typical Wiring Diagram for Electric Motors



VS2, VS2C, VS2EX, VS2EXR, VS2EXRB and VS94
Typical Wiring Diagram for Distributor Ignition or Diesel



SERVICE PARTS

PART NO.	DESCRIPTION
VS2	
20000030	Movement assembly
20000031	Glass and gasket assembly
20000032	Reset push button assembly
VS2C	
20000030	Movement assembly
20000031	Glass and gasket assembly
20000032	Reset push button assembly
20050021	Mounting clamp
20000185	VS2C 5-clamp hardware package assembly.
20050465	2-Conductor electrical cable, 45 feet (13.7 meters)
VS2EX	
20010091	Movement assembly
20050087	Cover
00000309	Cover gasket
20010090	Snap-switch and insulator kit (1 switch per kit) **prior to September 1, 1995.***
20000288	**Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.***
20000289	C-clamp conversion mounting kit
VS2EXR	
20000262	Movement assembly
20050087	Cover
00000309	Cover gasket
20010090	Snap-switch and insulator kit (1 switch per kit) **prior to September 1, 1995.***
20000288	**Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.***
20000049	Reset solenoid assembly (115 VAC)
20000234	Reset solenoid assembly (24 VDC)
20000289	C-clamp conversion mounting kit

PART NO.	DESCRIPTION
VS2EXRB	
20010090	Snap-switch and insulator kit (1 switch per kit) **prior to September 1, 1995.***
20000288	**Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.***
20000057	*Inside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D **prior to September 1, 1995.***
20000058	*Outside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D **prior to September 1, 1995.***
20000287	***Outside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D manufactured on September 1, 1995 or later.***
20000290	***Inside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D manufactured on September 1, 1995 or later.***
20050077	Adjustment shaft
20000262	Movement assembly
20000049	Reset solenoid assembly (115 VAC)
20000234	Reset solenoid assembly (24 VDC)
VS94 Series	
25050506	Dust boot
00000232	Conduit fitting
20010090	Snap-switch and insulator kit (1 switch per assembly) **prior to September 1, 1995.****
20000288	**Snap-switch and insulator kit (1 switch per assembly) for models manufactured on September 1, 1995 or later.*****

* If no date code is found, refer to the old switch. Models with date 0895 and before use old switch. Dated 0995 after, use straight snap-switch arm, no rollers.

** Models dated Q1 thru Q8 (formed snap-switch arm and rollers).

***Models date coded Q9 thru Q12 and R1 thru R12 (straight snap-switch arm, no rollers).

FW MURPHY
P.O. Box 470248
Tulsa, Oklahoma 74147 USA
+1.918.317.4100 Fax: +1.918.317.4266
E-mail: sales@fwmurphy.com

INDUSTRIAL PANEL DIVISION
Fax: 918.317.4124
E-mail: ipdsales@fwmurphy.com

MURPHY POWER IGNITION
Web site: www.murphy-pi.com

www.fwmurphy**.com**

CONTROL SYSTEMS & SERVICES DIVISION
P.O. Box 1819
Rosenberg, Texas 77471 USA
Phone: 281.633.4500 Fax: 281.633.4588
E-mail: sales@fwmurphy.com
Web site: www.fwmurphy.com

FRANK W. MURPHY, LTD
Church Rd Laverstock
Salisbury SP1 1QZ UK
Phone: +44 1722 410055 Fax: +44 1722 410088
E-mail: sales@fwmurphy.co.uk
Web site: www.fwmurphy.co.uk

COMPUTRONIC CONTROLS, LTD
41 - 43 Railway Terrace Nechells
Birmingham B7 5NG UK
Phone: +44 121 327 8500 Fax: +44 121 327 8501
E-mail: info@computroniccontrols.com
Web site: www.computroniccontrols.com

USA–ISO 9001:2000 FM 28221
UK–ISO 9001:2000 FM 29422

ISO 9001 REGISTERED

FW MURPHY INSTRUMENTS (HANGZHOU) CO. LTD
77 23rd Street
Hangzhou Economic & Technological Development Area
Hangzhou, Zhejiang, 310018, China
Phone: +86 571 8684 8886 Fax: +86 571 8684 8878

Printed in U.S.A. 078792

VS-96013B
Revised 01-00
Catalog Section 20
(00-02-0076)

Shock and Vibration Switch

VS2 Series

- Designed to Detect Shock/Vibration in 3-Planes of Motion
- Fully Adjustable
- Includes Magnetic Latching Feature
- Manual or Electric Reset

Description

The VS2 Series switches are shock sensitive mechanisms for shutdown of engine or electric motor powered equipment. These switches use a magnetic latch to ensure reliable operation. Explosion-proof "EX" models for hazardous locations are available.

Applications

Ideal for use on engines, pumps, compressors, heat exchangers and pumping units, the VS2 Series can be used anywhere shutdown protection from damaging shock/vibration is desired. Switches are field adjustable to sensitivity required in each application.

Specifications

VS2 and VS2C

Case: Equal to NEMA 3R. Suitable for non-hazardous areas.
VS2: *Base mount*
VS2C: *C-clamp mount, includes 45 ft. (13.7 m) 2-conductor cable, and 5 cable clamps.*

Contacts: SPDT-double make leaf contacts, 5A @ 480 VAC.

VS2EX

Case: Base mount, explosion-proof aluminum alloy housing; meets NEMA 7 specifications; Class I, Division 1, Groups C & D; UL and CSA listed.*

Snap-switches: 2-SPDT snap-switches; 5A @ 480 VAC;* 2A resistive, 1A inductive, up to 30 VDC.

VS2EXR

Case: Same as VS2EX.

Snap-switch: 1-SPDT snap-switch and reset coil; 5A @ 480 VAC;* 2A resistive, 1A inductive, up to 30 VDC.

Remote Reset : 115 VAC or 24 VDC (specify).

VS2EXRB

Case: Explosion-proof aluminum alloy housing; rated Class I, Division 1, Group B hazardous areas.

Snap-switch: 1-SPDT snap-switch with reset coil (option available for 2-SPDT switches); 5A @ 480 VAC; 2A resistive, 1A inductive, up to 30 VDC.

Remote Reset: 115 VAC or 24 VDC (specify).

Basic Operation

Pushing the reset button moves the tripping latch into a magnetically held position. A shock/vibration will move the magnet beyond this holding position, thus freeing the spring loaded tripping latch to transfer the contacts and shutdown the machinery (see dimensional diagrams in the following pages for visual representation of parts).

Remote Reset Option (VS2EXR and VS2EXRB)

The remote reset option includes a built-in electric solenoid which allows reset of tripped unit from a remote location. Available for 115 VAC or 24 VDC.

Warranty

A two-year limited warranty on materials and workmanship is given with this Murphy product. Details are available on request and are packed with each unit.

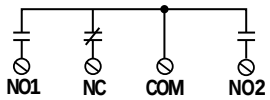
*CSA and UL listed with 480 VAC rating.

VS2 and VS2C

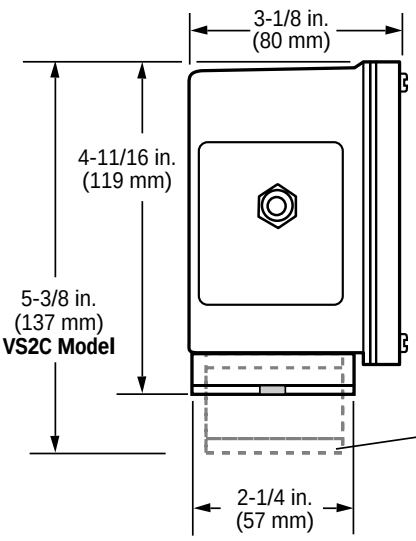
The VS2 and VS2C are designed for use in non-hazardous locations. They have leaf type SPDT, double make contacts that can be used for shutdown and/or alarm. They have a slotted sensitivity adjustment located on the side of the case (see drawing below).

ELECTRICAL

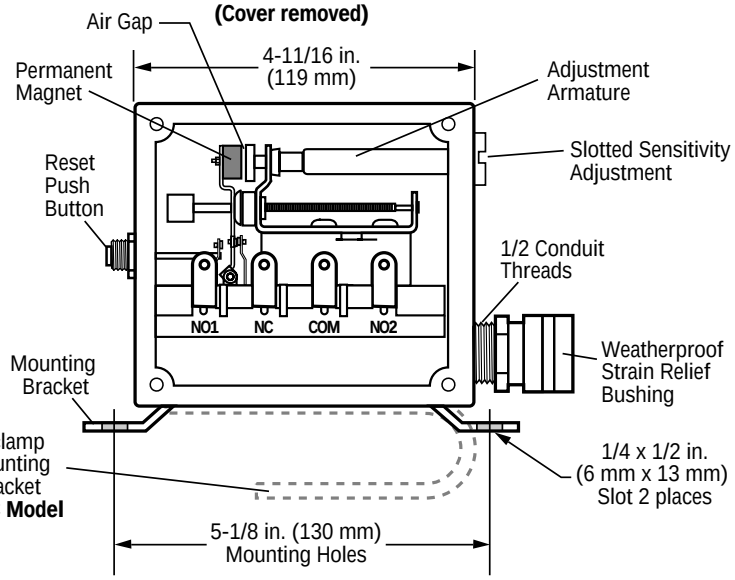
Contact Rating:
5 A @ 480 VAC



SIDE VIEW



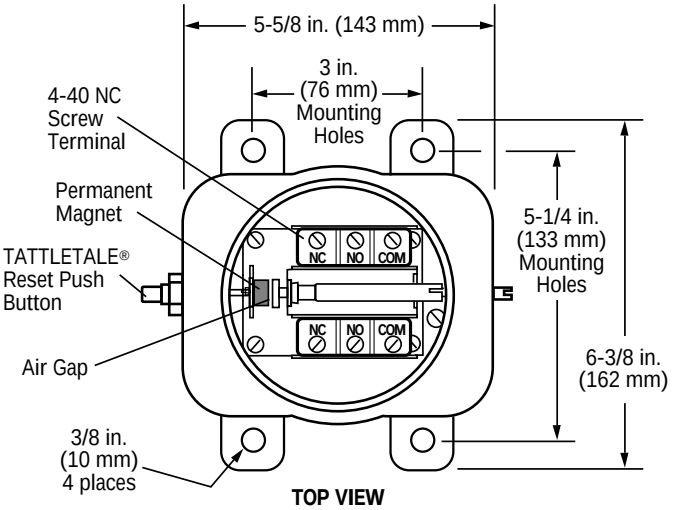
FRONT VIEW
(Cover removed)



VS2EX

- **NEMA 7 Specifications**
- **Snap-switch Contacts**
- **TATTLETALE® Reset Button**

Model VS2EX is housed in an explosion-proof enclosure with threaded cover. This enclosure is CSA and UL listed for Class I, Division 1, Groups C & D hazardous locations. In place of the leaf type contacts, 2-SPDT snap-switches are used in this model. Sensitivity is externally adjustable and, when tripped, the VS2EX gives a TATTLTALE® indication on the reset button. It is constructed to meet NEMA 7 specifications.

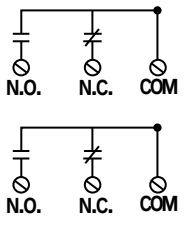


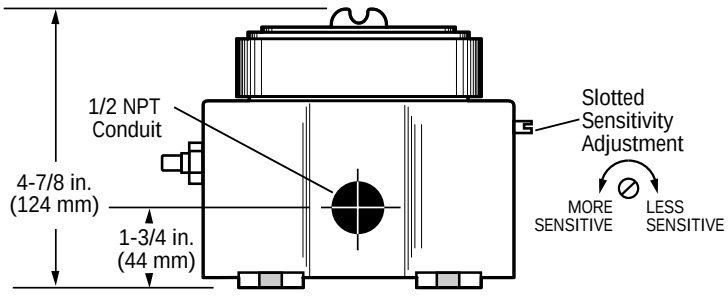
TOP VIEW
(Cover removed)

ELECTRICAL

Contact Rating:
5 A @ 125–480 VAC
1/2 A @ 125 VDC
1/4 A @ 250 VDC
2 A Resistive 30 VDC
1 A Inductive 30 VDC

2-SPDT Switches (DPDT)



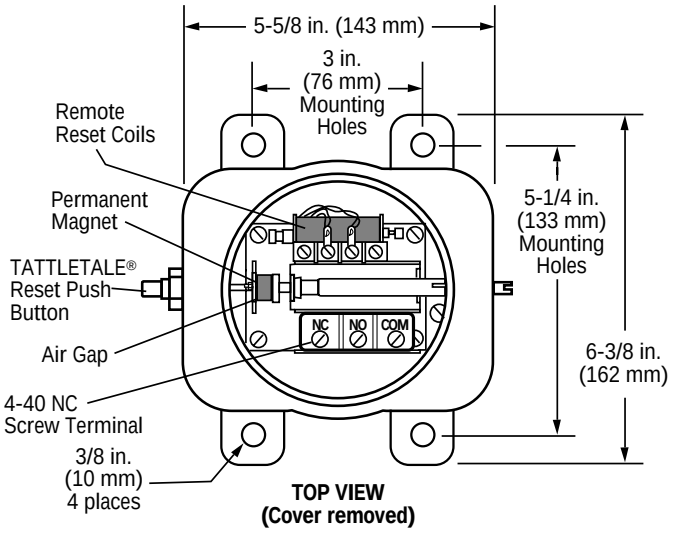


SIDE VIEW

VS2EXR

- **Remote Reset Feature**
- **NEMA 7 Specifications**
- **Snap-switch Contacts**
- **TATTLETALE® Reset Button**

Model VS2EXR features an electric remote reset feature in addition to the TATTLETALE® reset button. The VS2EXR uses only one SPDT snap-switch and is CSA and UL listed for Class I, Division 1, Groups C & D hazardous locations. It is constructed to meet NEMA 7 specifications.



TOP VIEW
(Cover removed)

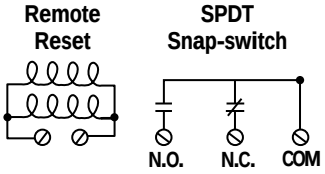
ELECTRICAL

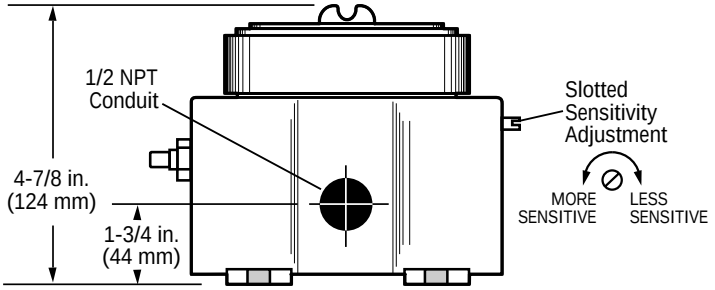
Contact Rating:

5 A @ 125–480 VAC
1/2 A @ 125 VDC
1/4 A @ 250 VDC
2 A Resistive 30 VDC
1 A Inductive 30 VDC

Remote Reset Rating:

115 VAC or 24 VDC (Specify)
350 mA AC/DC



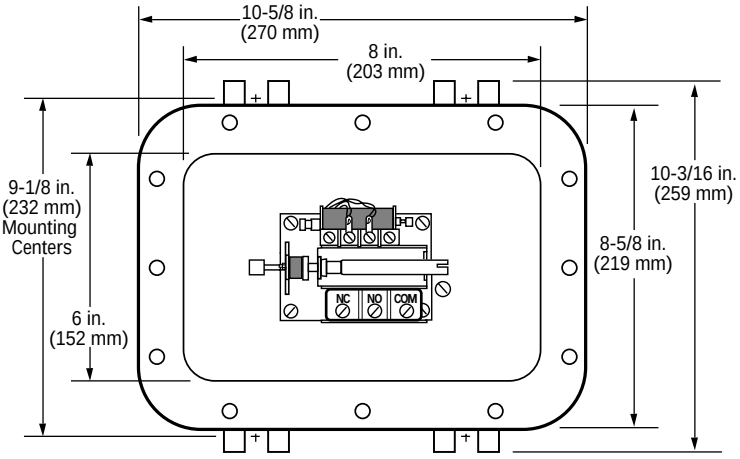


SIDE VIEW

VS2EXRB

- **For Group B Locations**
- **Snap-switch Contacts**
- **DPDT Feature Optional**
- **TATTLETALE® Reset Button**

Model VS2EXRB is constructed for use in Class I, Division 1, Group B, hazardous locations. It has, as standard, a SPDT snap-switch and an electric remote reset. Option is available for DPDT snap-switch.



TOP VIEW
(Cover removed)

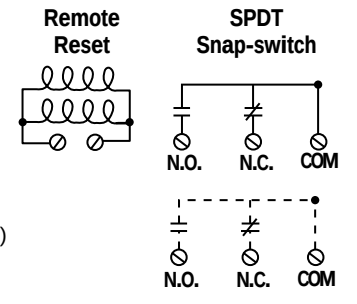
ELECTRICAL

Contact Rating:

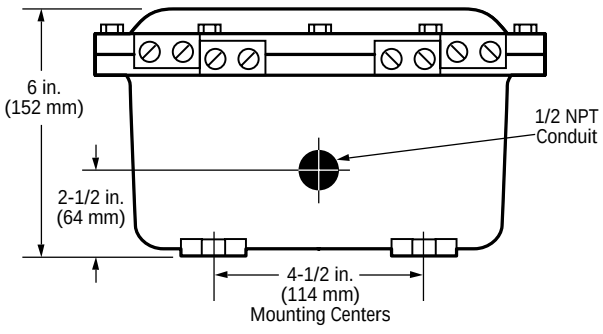
5 A @ 125–480 VAC
1/2 A @ 125 VDC
1/4 A @ 250 VDC
2 A Resistive 30 VDC
1 A Inductive 30 VDC

Remote Reset Rating:

115 VAC or 24 VDC (Specify)
350 mA AC/DC



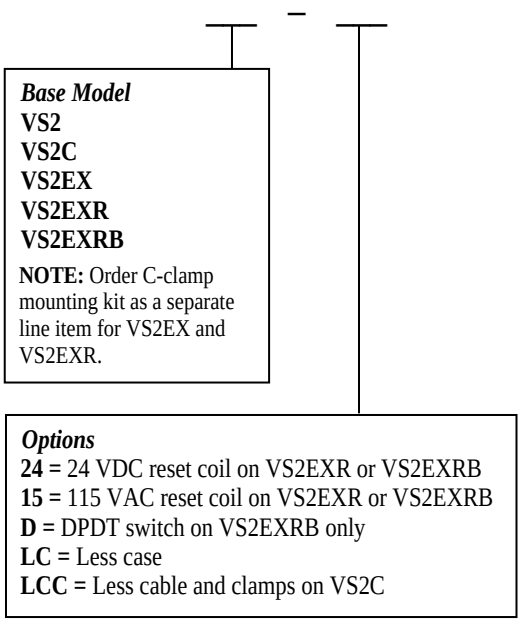
Option SPDT Snap-switch (DPDT)



SIDE VIEW

How to Order

To order your VS2 Series model use the diagram below.
Part number example: **VS2EXR-24**



Shipping Information

VS2 and VS2C

Shipping Weight:
VS2: *2 lb 8 oz. (1.1 kg)*
VS2C: *7 lb (3.2 kg)*

Shipping Dimensions:
VS2: *8-1/4 x 9-1/4 x 5 in. (210 x 235 x 127 mm)*
VS2C: *12 x 7 x 5-1/2 in. (305 x 178 x 140 mm)*

VS2EX

Shipping Weight: 4 lb 8 oz. (2 kg)

Shipping Dimensions: 8-1/4 x 9-1/4 x 5 in. (210 x 235 x 127 mm)

VS2EXR

Shipping Weight: 5 lb 8 oz. (2.2 kg)

Shipping Dimensions: 8-1/4 x 9-1/4 x 5 in. (210 x 235 x 127 mm)

VS2EXRB

Shipping Weight: 17 lb 8 oz. (7.9 kg)

Shipping Dimensions: 12 x 12 x 10 in. (305 x 305 x 254 mm)

Service Parts

When ordering service parts, specify both part number and description in listing below.

PART NO.	DESCRIPTION
VS2 and VS2C	
20-00-0030	Movement assembly
20-00-0031	Glass and gasket assembly
20-00-0032	Reset push button assembly
20-05-0021	Mounting clamp
20-00-0261	Cable clamp assembly (1 each)
20-05-0465	2-Conductor electrical cable, 45 feet (13.7 meters)
20-00-0137	5 clamps and 45 feet (13.7 meters) of cable
VS2EX	
20-01-0091	Movement assembly
20-05-0087	Cover
00-00-0309	Cover gasket
20-01-0090	Snap-switch and insulator kit (1 switch per kit) **prior to September 1, 1995.***
20-00-0288	**Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.***
20-00-0289	C-clamp conversion mounting kit
VS2EXR	
20-00-0262	Movement assembly
20-05-0087	Cover
00-00-0309	Cover gasket
20-01-0090	Snap-switch and insulator kit (1 switch per kit) **prior to September 1, 1995.***
20-00-0288	**Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.***
20-00-0049	Reset solenoid assembly (115 VAC)
20-00-0234	Reset solenoid assembly (24 VDC)
20-00-0289	C-clamp conversion mounting kit
VS2EXRB	
20-01-0090	Snap-switch and insulator kit (1 switch per kit) **prior to September 1, 1995.***
20-00-0288	**Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.***
20-00-0057	*Inside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D **prior to September 1, 1995.***
20-00-0058	*Outside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D **prior to September 1, 1995.***
20-00-0287	***Inside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D manufactured on September 1, 1995 or later.***
20-00-0290	***Outside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D manufactured on September 1, 1995 or later.***
20-05-0077	Adjustment shaft
20-00-0262	Movement assembly
20-00-0049	Reset solenoid assembly (115 VAC)
20-00-0234	Reset solenoid assembly (24 VDC)

* Models with date 0895 and before use old switch. Dated 0995 after, use straight snap-switch arm, no rollers.

In order to consistently bring you the highest quality, full featured products, we reserve the right to change our specifications and designs at any time.

FRANK W. MURPHY MANUFACTURER P.O. Box 470248; Tulsa, Oklahoma 74147; USA **tel.** (918) 627-3550 **fax** (918) 664-6146 **e-mail** sales@fwmurphy.com http://www.fwmurphy.com

FRANK W. murphy® MFR. Since 1939

USA–ISO 9001 FM 28221
UK–ISO 9002 FM 29422

Printed in U.S.A.

FRANK W. MURPHY MFR.
CONTROL SYSTEMS & SERVICES DIVISION
P.O. Box 1819; Rosenberg, Texas 77471; USA
tel. (281) 342-0297 **fax** (281) 341-6006
e-mail sales@fwmurphy.com

FRANK W. MURPHY, LTD.
Church Rd.; Laverstock, Salisbury SP1 1QZ; U.K.
tel. +44 1722 410055 **fax** +44 1722 410088
e-mail sales@fwmurphy.co.uk
http://www.fwmurphy.co.uk

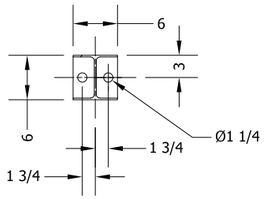
FRANK W. MURPHY FRANCE
tel. +33 1 30 762626 **fax** +33 1 30 763989

MURPHY DE MEXICO, S.A. DE C.V.
Blvd. Antonio Rocha Cordero 300, Fracción del Aguaje
San Luis Potosí, S.L.P.; México 78384
tel. +52-48-206264 **fax** +52-48-206336
e-mail ventas@murphymex.com.mx

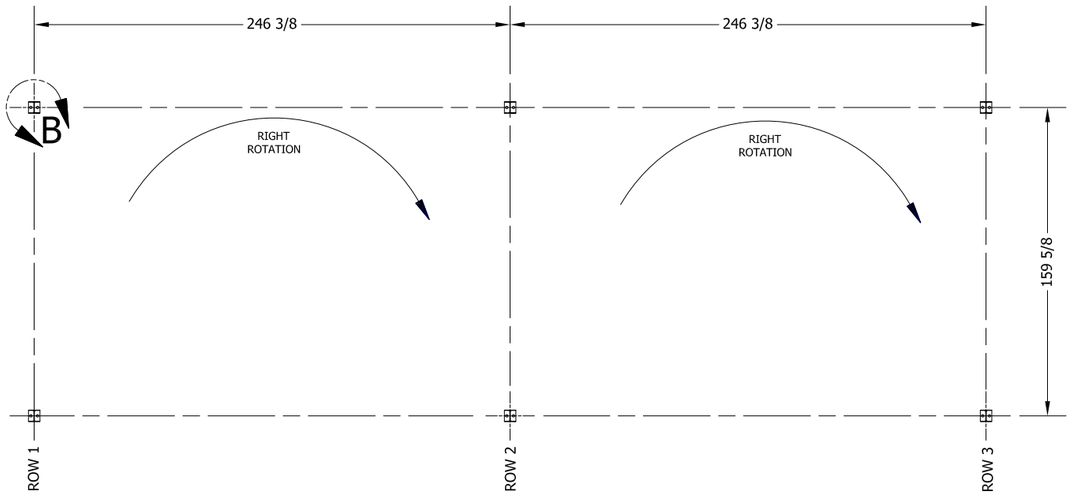
FRANK W. MURPHY PTE., LTD.
No. 2 Tuas South Street 2,
Sprintecs Bldg., #02-01/02
Singapore 638042
tel. +65 863-1398 **fax** +65 863-0208
e-mail fwmsales@fwmurphy.com.sg

MURPHY SWITCH OF CALIFORNIA
41343 12th Street West
Palmdale, California 93551-1442; USA
tel. (661) 272-4700 **fax** (661) 947-7570
e-mail sales@murphyswitch.com
http://www.murphyswitch.com

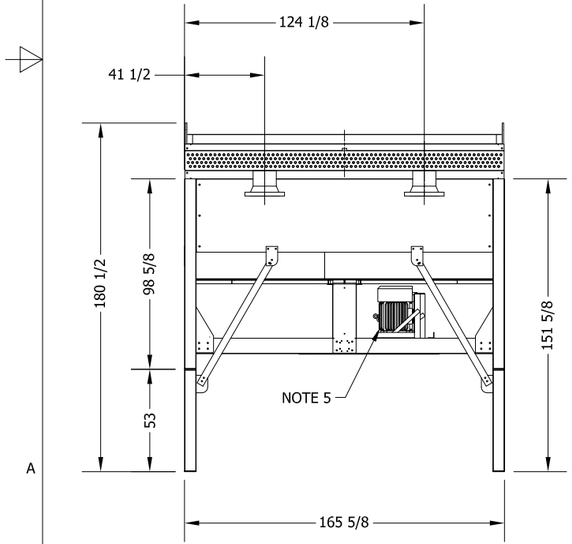
MACQUARRIE CORPORATION
1620 Hume Highway;
Campbellfield, Vic 3061; Australia
tel. +61 3 9358-5555 **fax** +61 3 9358-5558
e-mail murphy@macquarrie.com.au

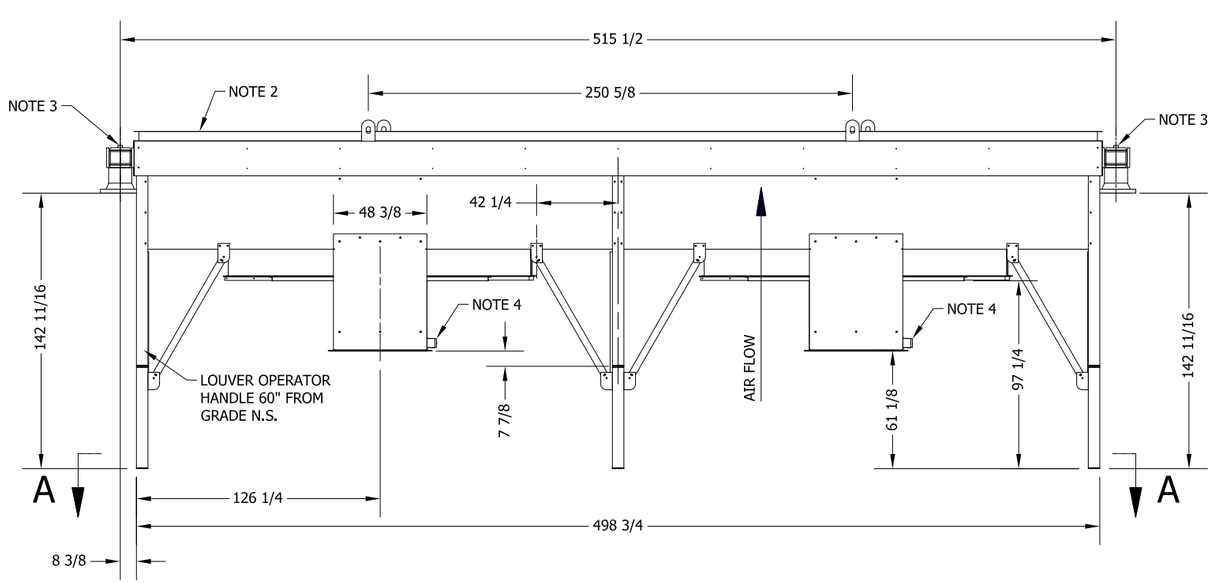


DETAIL B



SECTION A-A





NOTES:
1. COOLER IS OF BOLTED DESIGN
2. SERIES 500 MANUAL LOUVER W/ INTEGRAL HAIL SCREEN
3. 1"-6000" HALF CPLG. SA-105
4. MURPHY VS2-EX VIB. SWITCH
5. MOTORS ARE SIEMENS RGZEESD SUITABLE FOR VFD WITH SPACE HEATERS

Drive		Motor		Fan		
Fan Sheave	F14M-224S-20	HP	50	Make	Moore	
Motor Sheave	PB14MX-37S-90	RPM	1750	Dia. (ft)	13	
Belts	14MGT-3500-20	Frame	326T	Model	10000 - 42 SC	
Center Dist.	27.97	Enclosure	TEFC	Num Blades	7	
		Volts	460	RPM	294	
		Frequency	60	ACFM/Fan	244511	
		Phases	3	Elevation	@ 7500'	@ 3000'
				Pitch	23.29	18.7
				HP	38.9	34.02

COIL ORDER (Left to Right) w/ COIL VOLUMES
Expander Compressor Discharge Cooler (Coil 1) 546 gal.

FINAL CERTIFIED
Released For Fabrication

Wet/Operating Weight	44000	44000			100 mph		Snow Load	0	lbs/sq-ft				
Dry Weight	39400		Wind		38 psf		Seis Zone	2		Platform	100		lbs/sq-ft Live
Column Load (KIPS)	Dry Dead	Wet Dead	Wind Vert	Wind Horiz	Seis Vert	Seis Horiz	Snow	Plat		Noz Vert	Noz Horiz		Total
Row 1/Column	5.0	5.5	2.0	1.3	1.6	1.1	0.0	0.0		2.3	2.2		11.4
Row 2/Column	9.9	11.0	4.0	2.6	3.1	3.1	0.0	0.0		0.0	0.0		18.1
Row 3/Column	5.0	5.5	2.0	1.3	1.2	0.8	0.0	0.0		2.3	2.2		11.0

							Inlet Nozzle			Outlet Nozzle		
Coil No.	Service	Des P (psig)	Des Temp (°F)	CA (in)	ASME Code	NB Reg.	Qty	Size (in)	Rating (psi)	Qty	Size (in)	Rating (psi)
1	Expander Compressor Discharge Cooler A-321	550	225	0.0625	Yes	yes	2	12	300	2	12	300

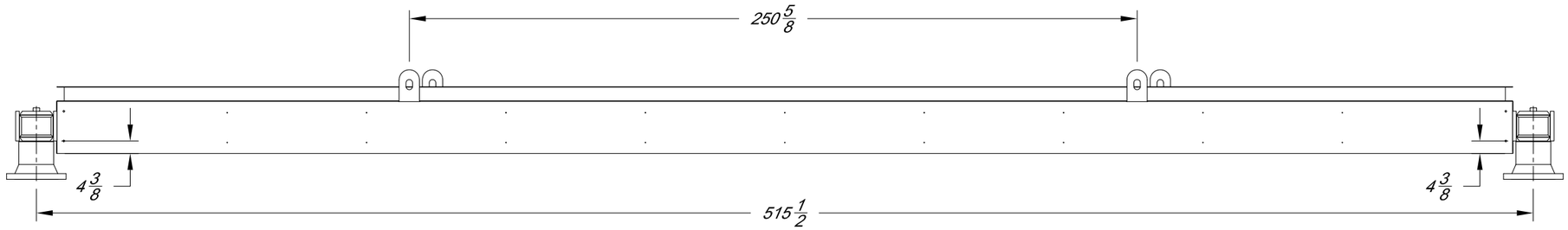
FINISH	
STRUCTURE: GALVANIZED	HEADERS: METALIZED
PO#: 4634152 Project: US-106521	UNITS: 1

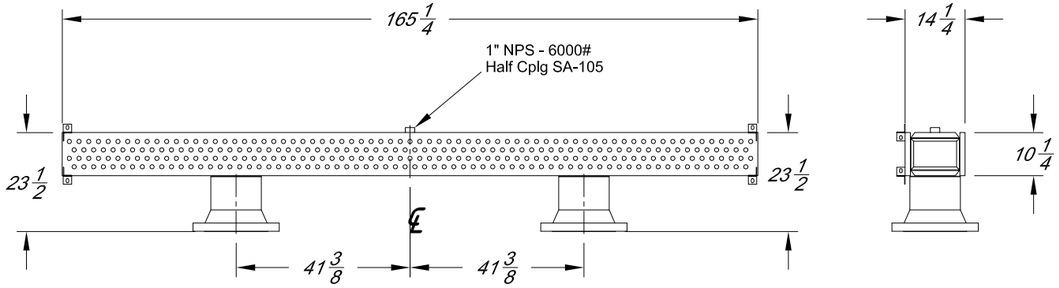
CHART COOLER SERVICE COMPANY, INC
TULSA, OK

DRAWN BY: ZBZ	APPROVED BY:
SCALE: NONE	DATE:6/24/2008

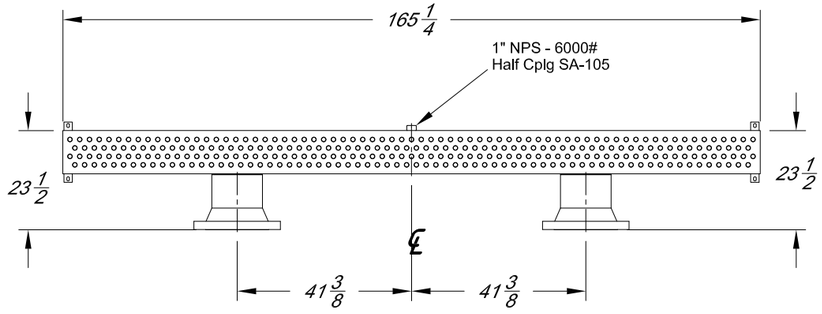
Exterran Energy Solution, L. P.
EQUIPMENT OUTLINE
A-321

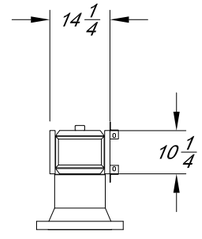
Model: H156-2-42	DWG: 33408-O



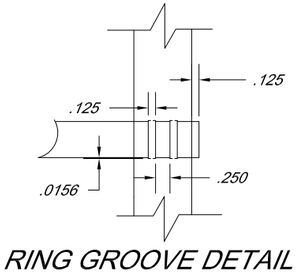


BACK Header Tubesheet View





FRONT Header Plugsheet View



RING GROOVE DETAIL

		SA-516 70			
SERVICE:		THICK	LENGTH	WIDTH	BEVELS
FRONT	TUBE/PLUG	1.25	165.25	10.25	NONE
FRONT	WRAPPER	1.25	165.25	11.5	LONG
FRONT	END	0.875	7.4375	11.5	ALL
FRONT	PASS				NONE

		SA-516 70			
BACK	TUBE/PLUG	1.25	165.25	10.25	NONE
BACK	WRAPPER	1.25	165.25	11.5	LONG
BACK	END	0.875	7.4375	11.5	ALL
BACK	PASS				NONE

SPECIAL REQUIREMENTS		DETAILS
API-661	No	*
POST WELD HEAT TREAT	No	*
X-RAY	No	*
BRINELL	No	*
MAG PARTICLE TEST	No	*
DYE PENETRANT TEST	No	*
IMPACT TEST	No	*

NOZZLE IN (2) 12"-300# RF-WN SA-105
OUT (2) 12"-300# RF-WN SA-105
PIPE IN w/ 0.5" Wall Thk(0)X 7.875" Lg.-SA-106 B
OUT w/ 0.5" Wall Thk(0)X 7.875" Lg.-SA-106 B
(2) - 1" NPS - 6000# Half Cplg SA-105

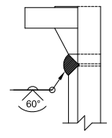
ASME Code Stamp Required.
National Board registration Req'd.

Corrosion Allowance: 0.0625"

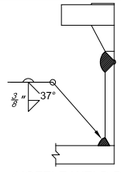
TUBES	282	FRAME THK	0.25
TF	71	LENGTH	501.25
ROWS	4	DEPTH/LEG	18 / 3
PASS	1	SUPPORT	S
LGTH	42' (or 504")	BINDER	3
TUBE ODxTHK	1 X 0.065	TOP CLOSURE	4.625" X 3.375"
MATL	SA-214	BTM CLOSURE	4.625" X 4.25"
FIN	L-TENSION	CLOSURE LEN.	165.25
PLUG QTY	564		
TYPE	SHOULDER	GASKET	A366
DESIGN PRES	550	DESIGN TEMP	225
MDMT	MDMT = -20	TEST PRES	715

+	+	+	+
+	+	+	+
+	+	+	+
+	+	+	+
REV	DATE	DESCRIPTION	BY

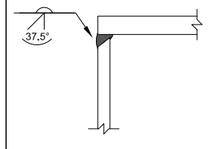
FINISH REQUIREMENTS	
HEADERS	Metallze
SIDEFRAMES	Galvanize



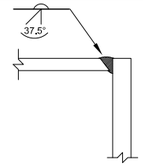
FLANGE-TO-PIPE WELD DETAIL
P1-104 (GMAW/SMAW)
P1-105 (GMAW/SAW)
P1-106 (GMAW/FCAW)



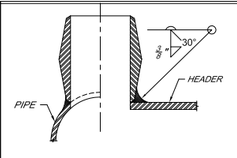
NOZZLE WELD DETAIL
P1-104 (GMAW/SMAW)
P1-106 (GMAW/FCAW)



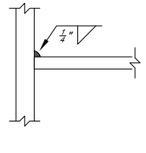
END PLATE WELD DETAIL
P1-104 (GMAW/SMAW)
P1-106 (GMAW/FCAW)



LONG SEAM WELD DETAIL
P1-104 (GMAW/SMAW)
P1-106 (GMAW/FCAW)
P1-114A (GMAW/FCAW/SAW)



CPLG/THREADOLET WELD DETAIL
P1-104 (GMAW/SMAW)
P1-106 (GMAW/FCAW)



PASS PLATE WELD DETAIL
P1-104 (GMAW/SMAW)
P1-106 (GMAW/FCAW)

DRAWING STATUS	
	ISSUED FOR APPROVAL
X	CERTIFIED - RELEASED FOR FAB

NOTES:
1. DESIGN PER 2007 ASME SECT, VIII, DIV. 1, w/ ADD 2006 & APPENDIX 13
2. IMPACT TESTING NOT REQUIRED PER UG-20(f)
3. MAGNETIC PARTICLE INSPECTION PER PROCEDURE NO. MT-100 OR LIQUID PENETRANT INSPECTION PER PROCEDURE NO. PT-100 PER UG 93 d-3.
4. ± 1/8" TOLLERANCE ON ALL DIMENSIONS EXCEPT NOZZLE 1/4"
5. WPS # P1-103,P1-104,P1-107 FOR REPAIR/OR ORIGIONAL WPS.
6. WPS P1-102 FOR LIFTING LUGS AND NAMEPLATE BRACKET.
7. SEE CSCI STD. DWG. LG-1 FOR LIFTING LUG DETAIL.
8. SEE DRAWING H6 FOR HEADER CLIP DETAILS.
9. SEE DRAWING 33408-1-1000 FOR HOLE LAYOUT.

CHART COOLER SERVICE COMPANY, INC
Tulsa, OK

DRAWN BY: *ZBZ*	APPROVED BY:
SCALE: NONE	DATE:6/24/2008

Exterran Energy Solutions, L. P.
Expander Compressor Discharge Cooler
A-321

H156	DWG: 33408-1