



## MAIN MENU – TABLE OF CONTENTS

Customer: Murphy Oil Canada

AXH Job: 118454

Ref: 1780-009 (Vista)-54115097-207 (Murphy)

Model: 42ZF-R

Tag: AC-5010

End User: Murphy Oil Company Ltd.

● Installation and Operation Manual

### Drawings

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- CRN Drawing

● Parts List

● Cooler Specification (Data) Sheet

### Q.A. Documentation

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- Stress Relieve Charts
- X-Ray Test Reports
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- Dye Penetrate/Magnetic Particle Test Reports
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## **AXH air-coolers**

401 East Lowry Road, Claremore, Oklahoma 74017  
(918) 283-9200 Fax (918) 283-9229  
[www.axh.com](http://www.axh.com)

## INTRODUCTION

This manual has been prepared for the purpose of providing general information and recommendations for the operation and maintenance of your air-cooled heat exchanger in order to insure that it will continue to provide you maximum performance in future years under a variety of operating conditions.

Normal maintenance items and light repairs as outlined can be achieved with basic mechanics tools. These include adjusting v-belt tension, checking and adjusting fan blade pitch angle, lubrication of bearings, setting of vibration switches and the periodic cleaning of fin tubes, both externally and internally. For more specific and detailed information please refer to the individual manufacturer's maintenance instructions for the specific item or component in questions (i.e. motors, fans, bearings, and controls). The Table of Contents indicates the appropriate section where this information is contained.

Naturally, prudent judgment should always be exercised when repairing, replacing or particularly modifying any original parts to make certain that they are equivalent to the original design. **AXH air-coolers** stocks most standard parts and components and are available within a 24 hour emergency basis if necessary.

## RECEIPT OF EQUIPMENT & SITING

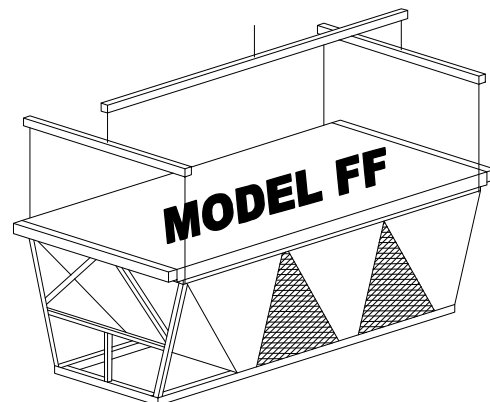
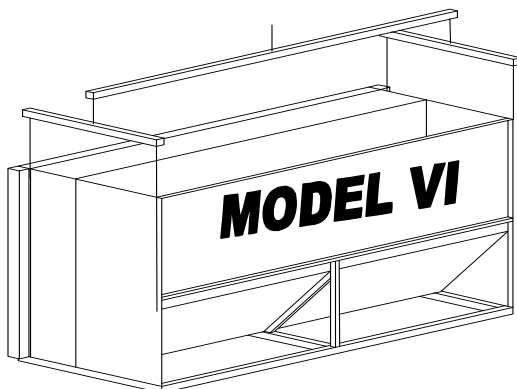
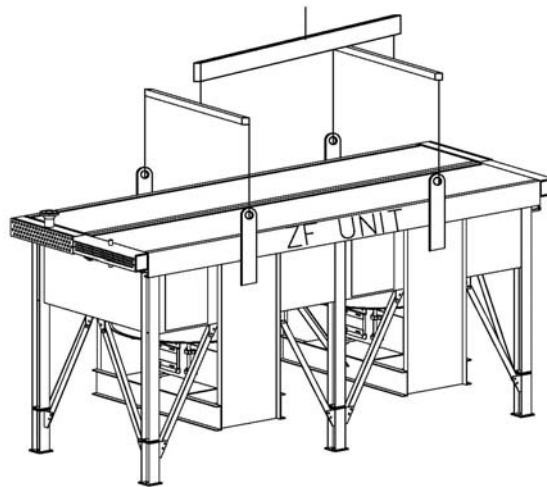
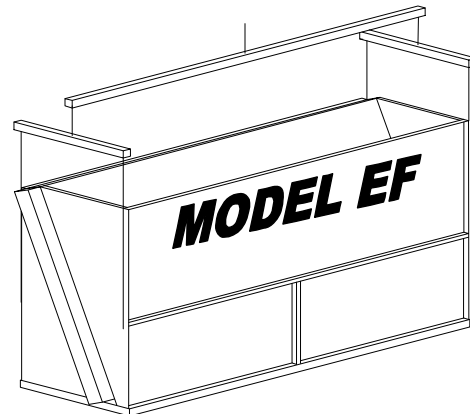
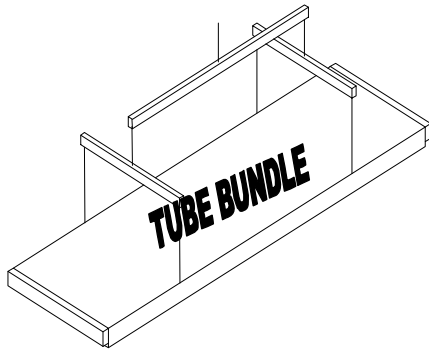
Upon arrival at site, the cooler should be inspected thoroughly by receiving personnel. Damage in transit could be the result of dropping or being struck by heavy objects or equipment. Observe the sub-skid, flanges, plenum side panels and coil sections for any apparent physical damage. Dents, bent flanges, crushed fins, damaged controls are among other items that should be described on the bill of lading document and presented by the carrier. Prompt reporting will expedite filing of claims and will expedite resolution and compensation from the responsible party.

Installation of the cooler(s) is the responsibility of the purchaser or contractor who must insure that the cooler intake areas are free from obstructions and provide adequate airflow. Spacing of air coolers should be adequate to avoid hot air re-circulation (and the affects of other coolers). The impact of grouping coolers closely together may be compensated for by either elevating and/or separating them.

The cooler is normally completely shop assembled and no field assembly at the job-site is required. However, occasionally optional or special accessories may require disassembly to meet transportation height or width limitations. In the event some assembly of the unit is required, the appropriate assembly instructions will accompany the shipment. The packing list should be checked carefully to see that all parts shipped with the cooler are on hand. These parts may be shipped separately, secured to the skid base (if so designed) or inside the plenum area.

## UNLOADING & HANDLING COOLERS

Spreader bars should be used for lifting when the cooler width is over eight (8) feet. The cooler is normally supplied with multiple lifting points to be used for off loading from carrier. Lifting by any other point may cause damage to the cooler. Following are some recommended ways of lifting. Please refer to the illustration below that resembles the type of **AXH air-coolers** cooler to be handled and use it as a guide on how to unload and handle the cooler properly. (See unit name plate for unit type i.e. EF, VI, FF, ZF, etc.)





## PRIOR TO RUN-IN & START UP

### HYDROSTATIC TEST

**AXH air-coolers** tube bundles (sections) are hydrostatically tested to 1.3 times the design pressure as required by ASME before being released for shipment. To ensure that no damage has been done during shipment and/or installation, it is good practice to hydro test the entire system, including piping, heat exchangers, pumps, etc., prior to start up.

### BEARINGS

Check bearings for lubrication. **Caution: DO NOT OVER GREASE.** The manufacturer has greased the bearings and no additional grease is necessary at start up. Remote lubrication lines, when provided, should be loosened at the bearing end, and checked to be sure they are filled with grease from the fitting end. This will ensure that the lube lines are full of grease and free of air and any debris. During high-speed operation too much grease will cause overheating. When dust and water are present bearings should contain as much grease as the operating speed will permit since a full bearing with very slight leakage is the best protection against the entrance of foreign material. Under normal conditions refer to the following table as a general guideline, although certain conditions may require a change of lubrication periods other than those described. Bearing mounting bolts and set screws should be checked for tightness. See bearing manufacturer recommended lubrication chart for recommended maintenance schedule and type of grease.

### FANS

Check fan blade bolts and hub bushing set screws for tightness. Rotate fan by hand to insure that shaft, speed reducer, and driver turn freely. The fan blades should be checked for adequate tip clearance and blade pitch angle. 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 the section on fans. If the fan is found not to be centered in the fan ring, slight adjustment of the tip clearance can be made by loosening the fan shaft bearing bolts and moving the complete fan and fan shaft assembly until it is centered in the fan ring. To check the fan blade angle, use a level bubble protractor (this can be obtained from **AXH air-coolers**). Loosen the nuts on the bolts and place the protractor on the angle setting mark or the clevis. Refer to fan manufactures information for proper location and air-x-hemphill parts list for design angle. Using a mallet, tap on the shank end of the blade to adjust the angle. Tighten fan blade bolts to the proper torque (refer to manufactures maintenance instructions) making sure to tighten evenly. Recheck blade angle. Occasionally coolers may be equipped with an auto-variable type fan. These fans have blade angles controlled by varying the air supply pressure. Air pressure should be applied to the fan before starting to check for proper operation. **Before starting, any electric motor should be “bumped” to check for proper direction of fan rotation and air flow. This will also insure that the motor is in proper working order.**

## **LOUVERS/SHUTTERS**

Check all mounting brackets and bolts for tightness. To insure that the linkage is adjusted properly on manually operated louvers, operate blades from a fully open to a fully closed position. On automatic louvers with air motors (optional) air should be applied to actuator to check for proper linkage adjustment, free operation, and sufficient air supply. For further information on air motors see attached manufacture maintenance instructions.

**CAUTION: DO NOT WALK ON LOUVERS OR USE THEM AS A LADDER**

## **V-BELT DRIVES**

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

## **GEAR BOX**

When supplied, 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.

## **VIBRATION SWITCH (OPTIONAL)**

For Murphy switches, after the switch has been installed, adjust it by turning the adjustment screw in a clockwise direction until the starting torque does not trip the vibration switch. For other brands see the specific manufacture's information.

## **PROCESS START-UP**

The process start-up should be conducted in a manner that will minimize thermal shock of the tube bundles. Over cooling of fluids during periods of low ambient temperature and/or low heat load duty should also be avoided, especially during start up.

## **HEADER ACCESS PLUGS**

Header plugs opposite each tube are installed at room temperature. To correct any minor leaking, it may be necessary to tighten the plugs when the bundle is at operating temperature. **WARNING: DO NOT tighten plugs while bundle is under pressure.** If any plugs are removed, the soft iron gasket (shoulder plugs only) should always be replaced. Replacement gaskets are in stock and may be ordered from **AXH air-coolers**. When installing the plugs, a thread lubricant and/or anti-galling compound should be used.

# LONG TERM MAINTENANCE

## FIN CLEANING

Fins should be kept free of dirt and lint. Bug and lint screens are an available option that will greatly assist in keeping tube bundles clean. Fin tubes can be cleaned by directing compressed air perpendicular to the tubes in a direction OPPOSITE to the normal airflow. Caution should be taken when using steam or chemicals to clean fins. DO NOT clean or spray water when the section/bundle is hot.

## TUBE CLEANING

The internal cleaning of tubes can be done in several different ways:

1. **Mechanical Cleaning** - This consists of using a drill, (or wire brushes), on long rods, and rotating them with air or electric motors. This is normally followed by a treated water or chemical wash or air purge.
2. **Chemical Cleaning** - This consists of circulating chemical solutions through the tubes. The solution should contain inhibitors to avoid corrosion of the tube walls.
3. **High Pressure Water Sprays** - This consists of placing a high-pressure water jet head at the end of hollow rods and pushing through the individual tubes.

**NOTE:** The last two processes will not work on tubes that have been “plugged” with sealing pins.

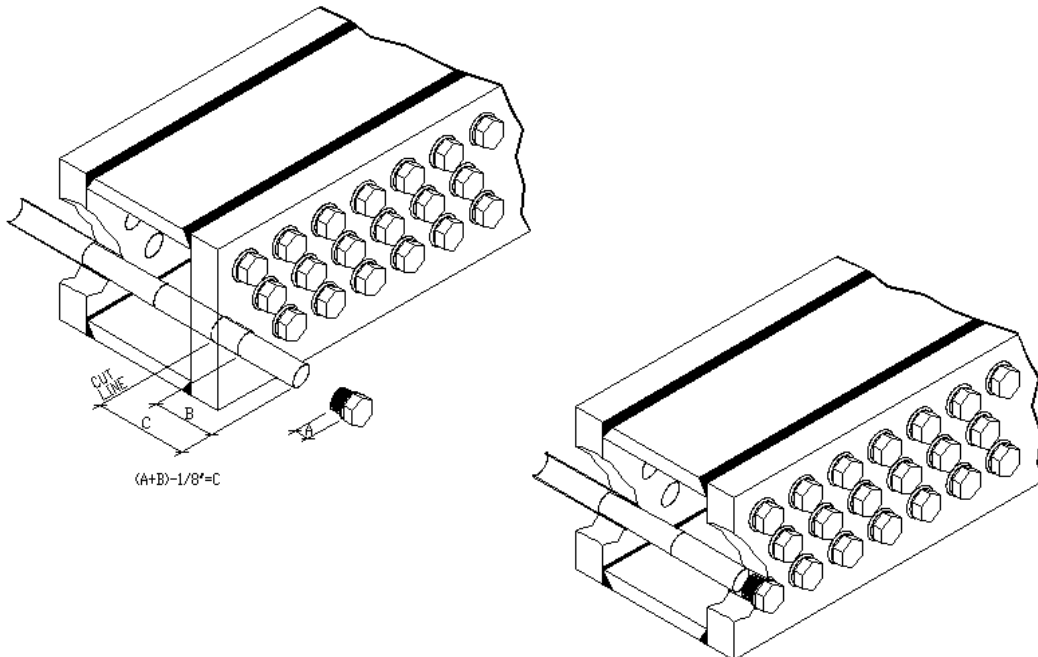
## LEAKING TUBES

Tube leaks are generally of two types: 1) leaks through the tube wall itself, and more commonly 2) leaks in the tube end attachment in the header (tube sheet). In the first case it is desirable to plug both ends of the tube. Only a limited number of tubes can be sealed off in this manner before performance is adversely affected and will vary with each specific application. When cooling performance falls below acceptable limits, the tube bundle may be re-tubed. If leaks develop in the tube end attachment at the tube sheet, re-rolling of the tube may be necessary. Care must be taken in selecting the proper tube expander for the tube size (diameter) and gauge of tube to be rolled. When rolling a tube, excess or “over-rolling” must be avoided. Consult the factory for further information on taper sealing pins to plug the tubes and tube roller sizes.

## INSTRUCTIONS FOR USING TAPER PINS FOR SEALING TUBES

- 1.) Remove header access plug from one end of leaking tube (do not switch plugs in holes) and replace with new gaskets whenever possible.
- 2.) Insert taper sealing pin through plug hole into tube and tap lightly with hammer until seated firmly, but not too tight to be removed.
- 3.) Measure plug to determine the depth it was originally screwed into header plug sheet. (Dimension A)
- 4.) Measure the distance that the taper pin protrudes from the header plug sheet in "seated" position. (Dimension B)
- 3.) Add the distance measured in Steps 3 and 4 and subtract 1/8". This will be the length which should be cut off the large end of the taper sealing pin. ( $A+B-1/8"$  = Dimension C)
- 4.) Remove the taper pin from the end of the tube.
- 5.) Cut the end off the large end of the taper pin to the length calculated in Step 5. CAUTION: Do not cut the pin too short.
- 6.) Re-insert the taper sealing pin in the tube and drive securely into place.
- 7.) Lubricate the access plug and replace it in plug sheet and run in tightly. The plug should now seat tightly and hold taper pin in place.
- 8.) Repeat operation on other end of tube.
- 9.) Hydro-test section to insure proper pressure seal without leaks.

**NOTE:** If the access plug that was removed does not seal properly, replace it along with the gasket if it is a shoulder type plug.



# INSPECTION

## TUBES

Tubes should be inspected for internal and external corrosion and/or erosion periodically. This depends on the severity and type of service and atmosphere that the tubes are operating in. Inspection of the tubes should be performed every six months to one year intervals. Tube wall thickness can be checked externally using an ultrasonic technique.

## FANS

Fans should be inspected for wear or loose bolts (cracks, pitting and corrosion) on all surfaces. These inspections should be performed every six months. In addition to surface inspections, all bolts and nuts must be checked for proper torque. (See the fan section of the manual).

## BEARINGS

In addition to checking bearings as recommended by the manufacture, the mounting bolts should be checked for proper torque and alignment. These checks should be done at least every six months.

## STRUCTURE

A general inspection of the structure should be performed every six months to a year. This inspection should include checks for corrosion, damaged members, sheeting guards and for loose bolts.

## HEADERS

Headers should be inspected for corrosion periodically. This corrosion should not be allowed to proceed past the stated corrosion allowance as stated on the individual job specification data sheet.

## RECOMMENDED SPARE PARTS

We suggest that one each of the parts that are identified as recommended spare parts on the Table of Contents page, be kept in stock or be readily available. The down time caused by waiting for delivery of a replacement part may cost far more in lost production or service than the cost of the item itself.

**Spare parts orders should be specified in accordance with the parts list description and always include the corresponding *AXH air-coolers'* model and job number.**

## **WARRANTY**

**AXH air-coolers** warrants that the equipment it *manufactures* is free of defects in material and workmanship, when operated in accordance with conditions stated, for a period of one (1) year after start-up not to exceed fifteen (15) months from shipment. Such warranty shall not apply to any equipment that has been altered or repaired by other than the Company's personnel. The Company's obligation under this warranty is limited, however, to repairing or, if in the Company's judgment it seems more appropriate, to furnishing without charge, F.O.B. the Company's factory, a similar part to replace any part which after examination shall, to its own satisfaction be determined to have been defective at the time it was shipped. This warranty applies only if the Company received an immediate written notice upon discovery of such defect. The Company makes no warranties covering deterioration or failure due to corrosion, erosion or fouling or due to improper installation or operation. EXCEPT AS SPECIFICALLY STATED ABOVE, AXH AIR-COOLERS HEREBY DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE.

## **LIMITATION OF LIABILITY**

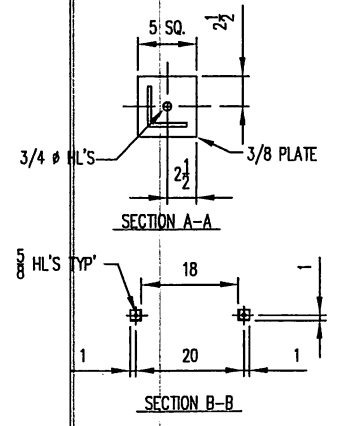
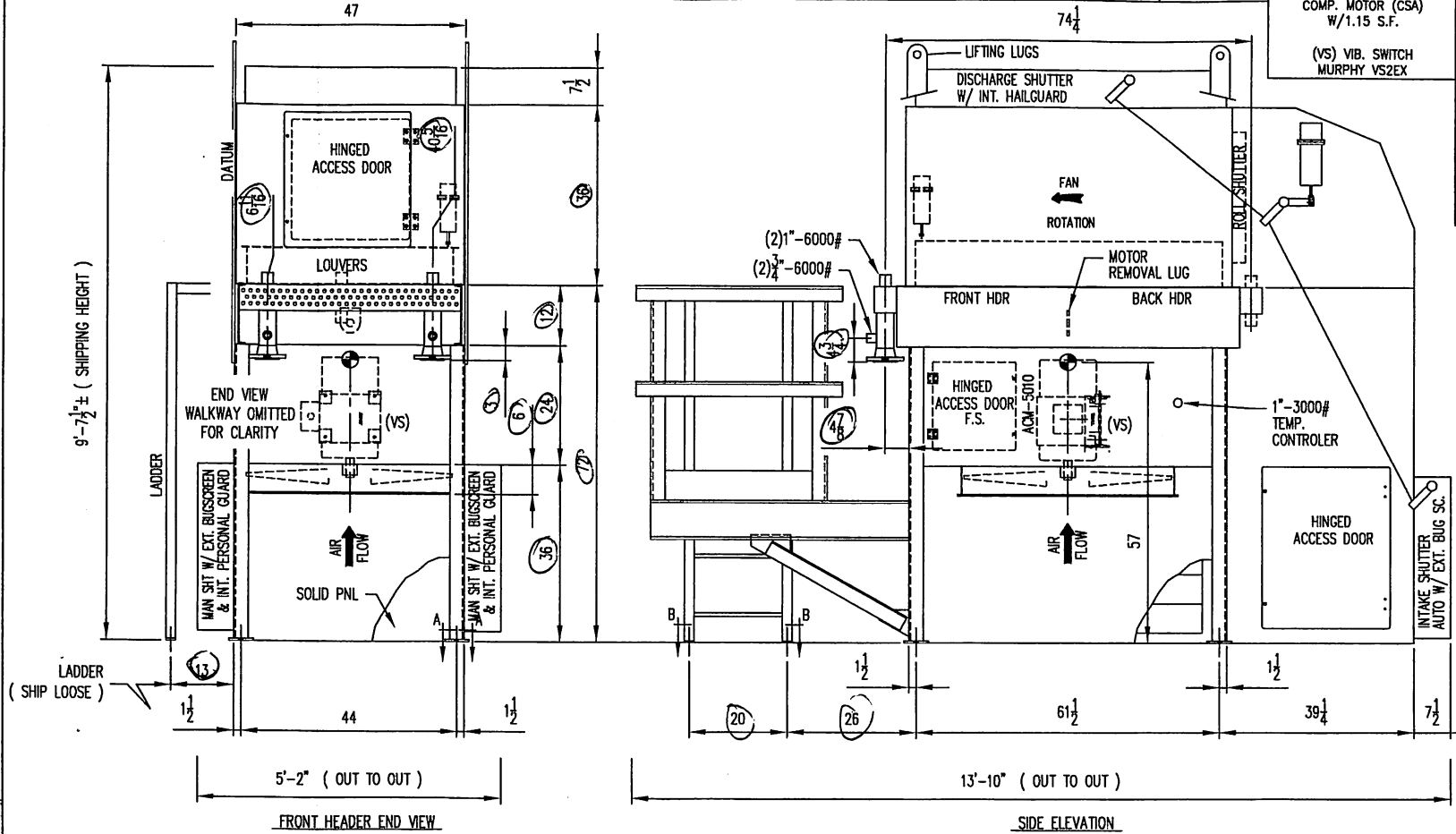
The remedies set forth herein are exclusive. AXH air-coolers shall not be liable, in excess of the purchase price of the equipment, for any damages, whether in contract, in tort or on any other basis, sustained by the customer or any other person arising from or related to the delivery, use or failure of the equipment or for any delay, special, incidental, consequential, indirect or commercial damages whether due to lost profits or otherwise resulting from the delivery, use or failure of the equipment. If it is ever necessary to contact our plant for service or replacement parts, it is essential that our job number and other identifying data be obtained from the metal nameplate attached to the cooler, or the nameplate attached to the tube bundle header box, which also contains the design pressure, temperature, and serial number.

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ITEM	SERVICE	MAWP	CODE	NOZZLES		PI/TI CONN.	PI/TI CONN.	VENT & DRAIN	LOUVERS	BUG SCREEN	DRIVE	FAN	FINISH
				INLET	OUTLET								
1	PRODUCED GAS 1.2 CUFT V7153.2/3	178 PSI @ 473/-49°F 1227 kPa @ 245/-45°C	ASME	3"-150# RFWN	3"-150# RFWN	(2)1-6000#	(2).75-6000#	(2)1-6000#	AUTO	YES-SOFT	DIRECT ELECTRIC MOTOR DRIVE, GUARDS BY AXH air-coolers 5HP, 900RPM, 460V, 3P, 60Hz, TEFC, VFD COMP. MOTOR (CSA) W/1.15 S.F.  (VS) VIB. SWITCH MURPHY VS2EX	42" Ø 8-BLADE 5ZR PAG-37.5" PA RIGHT HAND ROTATION 870 RPM @ 3.5 HP REQ'D  Ø1.625" BORE WITH .375" x .1875" K.WY.	STRUCTURE SIDEFRAMES GALVANIZED  HEADERS METALIZED

NOTES: 1) INTAKE & DISCHARGE SHUTTER TO OPEN AND ROLL SHUTTER TO CLOSE ON AIR FAILURE  
2) AIR COOLER IS DESIGNED FOR SOUR SERVICE (NACE)  
3) ALL DIMENSION ARE INCHES

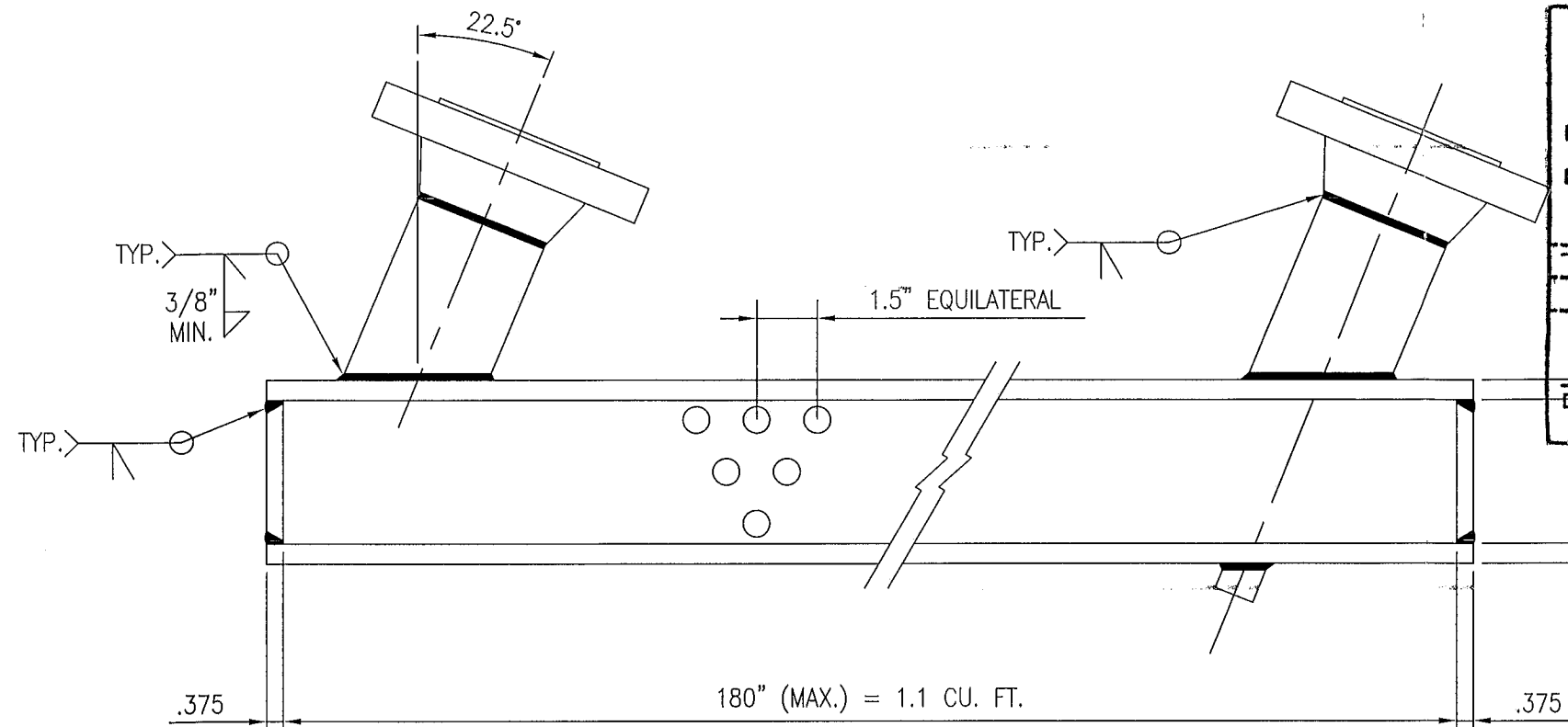


RELEASED  
FABRICATION OF THIS  
ORDER HAS BEGUN

				FOR: MURPHY OIL CANADA		ESTIMATED DRY WEIGHT 4,400#		
				CUST. TAG NUM: AC-501D				
				P.O. NO: 1780-009 (VISTA)				
				54115097-207 (MURPHY)				
4	ADDED MOTOR LUG, MOVED CPLG & ADDED METRIC INFO	MIKE	L.W.	01/23/12	USER: MURPHY OIL COMPANY Ltd.	MODEL	CERTIFIED 42 ZFR	DRAWING FOR: QUANTITY: 1
3	DESIGN PRESS/TEMP WAS 200 PSI @ 400/-49°F	BV	B	1/13/12	JOB SITE: CADOTTE PILOT CSS			
2	ADD VENT & DRAIN BACK HEADER	BV	B	1/12/12	JOB NO: 118454			
1	CHG'D PER CUSTOMER COMMENTS & RELEASED	MIKE	L.W.	01/09/12	DR: J.J.	DATE: 12/16/11		DWG. NO. 118454-CRT
REV	REVISION DESCRIPTION	BY	CK	DATE	CK: B.V.	DATE: 12/17/11	SCALE: FULL	DATE: 12/16/2011

KP 3-22-12

WISco  
W O R  
Initials: KP  
Date: 3-28-12  
117



**ALBERTA BOILERS SAFETY ASSOCIATION**  
**PROVINCE OF ALBERTA**  
**SAFETY CODES ACT**

REG. No. **V 7153.2**

DWG. No. **118454-CRN1 REV 0**

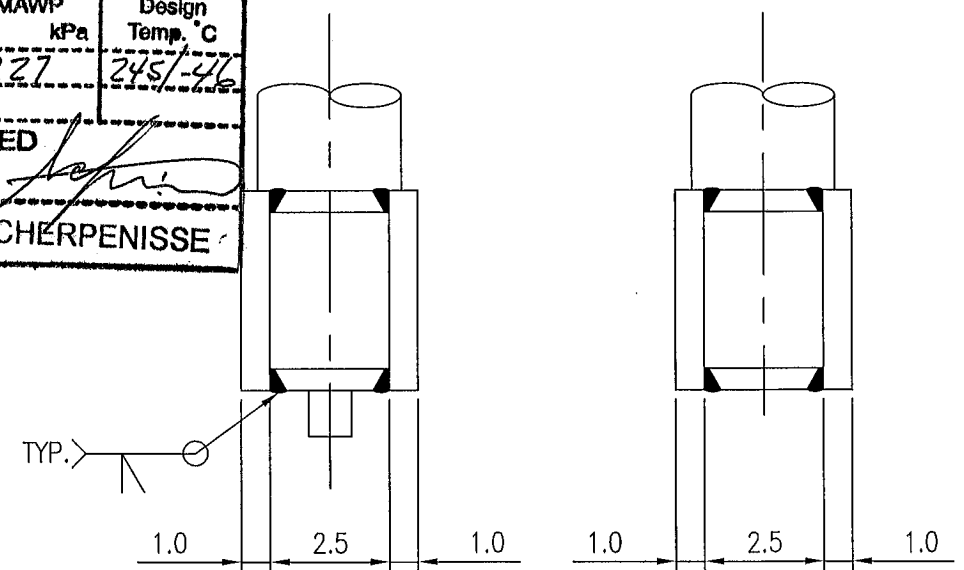
MAWP	Design Temp. °C
<b>T.S. INTERNAL 1227</b>	<b>245/46</b>

**ACCEPTED**

Date: **FEB 20 2012**

Signed: *[Signature]*

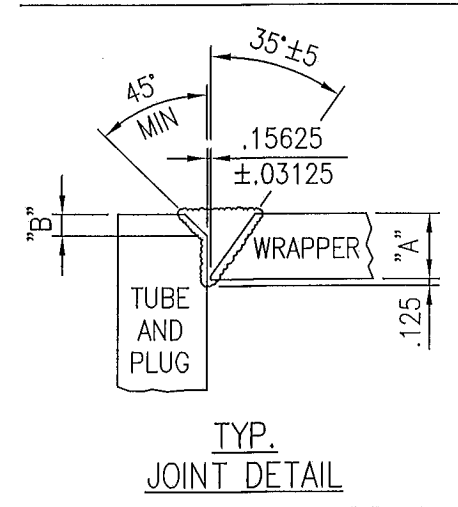
**F. SCHERPENISSE**



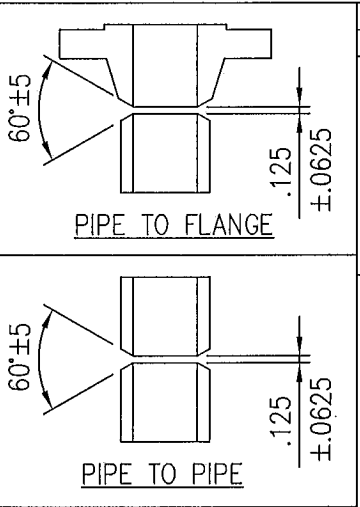
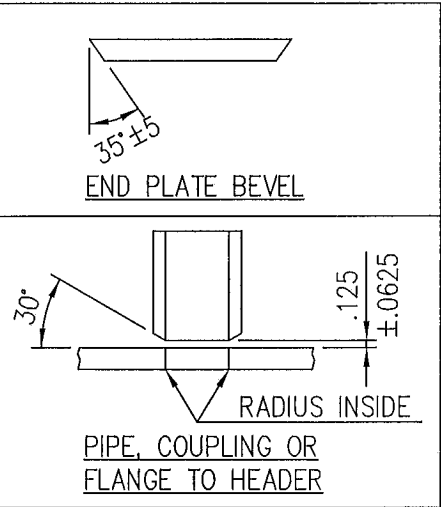
CROSS SECTION - SIDE VIEW

CROSS SECTION - END VIEW

NOTE: DIMENSION "B" IS ACTUAL WELD BEVEL PREPARATION FOR FABRICATION. DIMENSION "a<sub>2</sub>" REPRESENTS THE REQUIRED AMOUNT OF FUSION PER APPENDIX 28.



"A"	"B"
.375"	NONE
.5"	NONE
.625"	NONE
.75"	.125
.875"	.125
1.0"	.125
1.125"	.1875
1.25"	.1875
1.375"	.25"
1.5"	.25"
1.625"	.375"
1.75"	.375"
2.0"	.5"
2.25"	.5"
2.5"	.625"
2.75"	.625"
3.0"	.6875"



WELD PROCEDURES (LOW TEMP.)

≤ 1/2"	P1-P1-11	≤ 1/2"	P1-P1-11	≤ 1/2"	P1-P1-10	S.S.	P1-P8-03	≤ 1/2"	P1-P1-11	≤ 2"NPS	P1-P1-14
≥ 5/8"	P1-P1-08	≥ 5/8"	P1-P1-08	≥ 5/8"	P1-P1-07	C.S.	P1-P1-11	≥ 5/8"	P1-P1-08	≤ 1/2"	P1-P1-11
WR. PL.		END PL.		WR. PL.		1/8"		1/4"		1/8"	
30°		30°		35±5		1/8"		1/4"		1/8"	
END PL.		TS/PS		TS/PS		PASS PARTITION PLATES TO TUBE SHT. & WRAPPERS		RADIUS INSIDE			

MATERIALS

DESIGN INFORMATION

PLATE	SA 516-70N
FLANGES	3"-150# RFWN SCH 160 (SA-350-LF2 CLASS-1)
PIPE	3" SCH 160 (SA-333 GR.6)
TUBES	.625"ø x .060 MIN. WALL (SA214 STEEL)
PLUGS	.75" x 16 UNF3A x .75 LG. SHLDR (SA-350-LF2 CLASS-1)
COUPLING	1"-6000# (SA-350-LF2 CLASS-1)

DESIGN PRESSURE	178 P.S.I.
DESIGN TEMPERATURE	473/-50°F
HYDROSTATIC TEST	232 P.S.I.
CORROSION ALLOWANCE	0.0625
DESIGN CODE	2010 ASME SECTION VIII, DIV. 1, APPX. 13 & 28, NO AD.
IMPACT EXEMPT	UCS-66(a) CURVE D, UCS-66(g) & UCS-68(c)
P.W.H.T.	400°F HEATING, .5 HR HOLD @ 1150°F, 500°F COOLING
CHARPY IMPACT TEST	NA

CAN. REG. NO.	~
BOX TYPE	.625"-3 ROW

MACHINING

TUBE HOLES - DRILLED AND REAMED TO 0.633± .002
TUBE HOLES - GROOVED PER TEMA-C 7.44
PLUG HOLES - TAPPED FOR 0.75-16 UNF-1B.

NOTE: VESSELS CONSTRUCTED UNDER THIS REGISTRATION SHALL BE ASME CODE STAMPED "U" & REGISTERED WITH THE NATIONAL BOARD

NDT TEST	DYE PENETRANT PER UG-93d3
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REV	DESCRIPTION	BY	CK'D	DATE	QTY	DESCRIPTION	SHIPPING LIST



CUSTOMER: MURPHY OIL	DRAWN BY: J.J.	CHECKED BY: B.
P.O. NO.: ~	SCALE: NONE	
PROJECT: ~	DATE: 02/15/2012	
DESCRIPTION: CAN. REG. DRAWING FOR PRODUCED GAS	JOB NUMBER	SHEET
~	118454	CRN1
LOCATION: ~	REV.	0





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401 E. Lowry Road, Claremore, Oklahoma 74017  
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 www.axh.com

Job number: 118454A  
 Customer: MURPHY OIL CANADA  
 Quantity: 1.00  
 Model: 42-Z

**Parts List**

Note: Quantity Shown is for One Unit Only

Revision	Engineer	Date	Description
0	JB	01/17/2012	Initiated parts list
1	JB	01/25/2012	Added drain mod code to electric motor
2	JB	02/24/2012	Added nameplate mod for elec motor

**QUANTITY**

**DESCRIPTION OF PARTS**

\*\* 1.00 FAN EA FAN

Make: Multiwing  
 Model #: 42/8-8/37.5/PAG/5ZR/P1 1.625/BR  
 Diameter: 42"  
 No. Blades: 8  
 Rotation: Right Hand  
 Angle: 37.5  
 Bore: 1-5/8"  
 Keyway: 3/8"

1.00 LOUVERS EA LOUVERS

Auto louvers over section to include (1) Durastroke 1500 pivot mount  
 Manual side recirculation louvers, louvers to have integral personal guard & bugscreens  
 Auto end recirculation louvers to be linked to top recirculation & roll louvers  
 Auto roll louvers to include (1) Durastroke 1500 pivot mount  
 Auto top louvers to include integral hail guard

2.00 Air motor EA

Durastroke 1500

\*\* 1.00 Electric-Motor EA Item for Attached Notes

Make: TECO Westinghouse  
 Catalog #: E0058 - M13 drain mod M1A Nameplate mod  
 Horsepower: 5  
 RPM: 900  
 V/P/HZ: 460/3/60  
 Frame: 254T  
 Enclosure: TEFC  
 Shaft: Vertical  
 Mounting: W-6  
 Special Notes: Single winding, variable torque, VFD compatible, CSA.  
 Motor to be nameplated for: Class 1 Zone 2 Group IIA

1.00 VS-VS2EX EA Vib. Switch Murphy VS-2-EX Explosion Proof CSA Stamp

\*\* = RECOMMENDED SPARE PART



**AXH air-coolers**  
air-x-limited

401 E. Lowry Road Phone (918) 283-9200  
Claremore, OK 74017 Fax (918) 283-9229  
[info@axh.com](mailto:info@axh.com) [www.axh.com](http://www.axh.com)

**Proposal / Job No.** 118454A  
**Date** 1/19/2012  
**Page** 1 OF 1

1	<b>Purchaser</b>	VISTA PROJECTS / MURPHY OIL CORP.	<b>Ultimate User</b>	MURPHY OIL CORP.				
2	<b>Inquiry / PO#</b>	PO: 1780-009 (VISTA) / 54115097-207 (MURPHY)	<b>Destination</b>	CADOTTE PILOT CSS				
3	<b># Units</b>	1	<b>Model</b>	42ZF	<b>Reference</b>	PRODUCED GAS COOLER		
4	<b>Assembly</b>	PACKAGED	<b>Draft</b>	FORCED	<b>Overall Size, Ft</b>	4'W x 7'L	<b>Est Wt</b>	2,000 LBS

**THERMAL & MECHANICAL DESIGN**

5	<b>Service</b>	PRODUCED GAS
6	<b>Flow</b>	1495#/HR
7	<b>Fluid</b>	.7045SPGR
8	<b>Temp. In / Out, °F</b>	300.0 / 140.0
9	<b>Pressure, PSI</b>	25PSIG
10	<b>Pressure Drop, PSI</b>	2.8
11	<b>Heat Load, BTU/HR</b>	726450
12	<b>True LMTD</b>	79.8
13	<b>Overall Rate, U</b>	104.2
14	<b>Fouling Factor</b>	.0020
15	<b>Surface, Tube / Total, Sq Ft</b>	84 / 1331
16	<b>Sections, #</b>	(1)
17	<b>Design Temp, °F Max / Min</b>	473 / -49
18	<b>MWP / Test Press, PSIG</b>	173 / 232
19	<b>Pass Arrangement</b>	CROSSFLOW
20	<b># Tube Rows</b>	3
21	<b># Tube Passes</b>	4
22	<b>Tubes, OD x BWG</b>	5/8X16
23	<b>Material</b>	SA179 STEEL
24	<b># Per Section / Length, Ft</b>	89 / 6
25	<b>Turbulators</b>	
26	<b>Accelerators</b>	
27	<b>Fins, Type</b>	HI-EFF
28	<b>Material</b>	AL
29	<b>Nozzles, Rating / Type</b>	150RF
30	<b>Material</b>	SA350LF2
31	<b># Inlets / Size In</b>	(1) 3
32	<b># Outlets / Size In</b>	(1) 3
33	<b>Headers, Type</b>	BOX
34	<b>Material</b>	SA516-70
35	<b>Corrosion Allow, In</b>	.0625
36	<b>Grooved Tubesheet</b>	DBL
37	<b>Plugs, Type</b>	SHOULDER
38	<b>Plugs Material</b>	SA350LF2
39	<b>PWHT</b>	YES
40	<b>ASME Code &amp; Nat'l Board</b>	YES
41	<b>CRN</b>	AB / BC / SK
42	<b>Add'l Specs &amp; Options</b>	
43	<b>API</b>	661*
44	<b>Louvers / Hail Screen</b>	AUTO / INT
45	<b>Inspection / NDT</b>	BX / UT / H

**FX=** 100% X-Ray of all header seam, attachment & nozzle butt welds. **SX=** Spot X-Ray of 1 long seam & 1 end closure, per header  
**BX=** 100% X-Ray of all nozzle butt welds. **UT =** 100% UT of all header seam, attachment & nozzle butt welds. **H =** Hardness testing.

AIR-SIDE PERFORMANCE		FAN DATA		DRIVER DATA		STRUCTURAL	
46	<b>Ambient Air Temp, In °F</b>	86	<b>Fan(s)</b>	(1) MULTI-WING	<b>Type</b>	<b>Guards</b>	FAN / DRIVE
47	<b>Elevation, Ft</b>	2221	<b>Blade Material</b>	PAG	DIRECT DRIVE BY (1) 5HP,	SOFT BUGSCREENS	
48	<b>Air Flow, SCFM</b>	15,976	<b>HP / Fan</b>	3.5	900RPM, 460/60/3, TEFC, VFD	INTEGRAL HAIL GUARD	
49	<b>Outlet Air Temp, °F</b>	127.4	<b>Dia, In / # Blades</b>	42 / 8	COMP. MOTOR (CSA) WITH	WARM AIR RECIRC SYSTEM	
50	<b>Min Air Temp, °F</b>	-20	<b>RPM</b>	870	1.15 SERVICE FACTOR	LADDER & PLATFORM	
51			<b>Tipspeed, FPM</b>	9566	MURPHY VS2EX VIB. SWITCH		
52	<b>Est. Noise Data:</b>	84 dBA @ 1m, 59 dBA @ 15m	<b>Pitch, Deg</b>	37.5			

53 **Additional Info.**  
54 \* - API 661 WITH STANDARD EXCEPTIONS & CLARIFICATIONS  
55  
56  
57  
58

**AXH air-coolers**  
 401 EAST LOWRY ROAD, CLAREMORE, OK 74017  
 OF: 918-283-9200 / FX: 918-283-9229

**ASME PRESSURE VESSEL CODE SECTION VIII-DIVISION 1 ()**  
**STRESS CALCULATIONS FOR NON-REINFORCED RECTANGULAR CROSS SECTION HEADERS**  
**WRAPPER AS SHORT-SIDE PLATE / TUBE AND PLUG SHEET AS LONG-SIDE PLATE**

1	REFERENCE NAME   DATE   REF. NO.	VISTA PROJECTS / MURPHY OIL CORP.				02/15/12	118454
2	SERVICE NO.		1	2	3	4	5
3	SERVICE LABEL		PRODUCED GAS				
4	SERVICE TAG NO.		118454.1				
5	SECTION DESIGN PRESSURE, ACTUAL   MAX	PSIG	P	178	178		
6	SECTION HYDRO TEST, MULTIPLIER   PSIG @ 100°F			1.3	232		
7	DESIGN TEMP, MAX   MIN	°F		473	-50		
8	CORROSION ALLOWANCE	IN	CA		.0625		
9	TUBE O.D.	IN			0.625		
10	TUBE GAUGE	BWG			16		
11	TUBE MIN WALL THICKNESS	IN			0.06		
12	TUBE MATERIAL				SA214 STEEL		
13	TUBE PITCH	IN	pt		1.500		
14	TUBE VERTICAL SPACING	IN			1.299038		
15	SHLDR PLUG PITCH DIA.	IN	DE		0.7192		
16	TUBE ROWS				3		
17	FLANGE DIA	IN			3		
18	FLANGE CLASS	#			150RF		
20	NOZZLE TO HEADER CONNECTION TYPE				SET-ON PIPE		
19	NOZZLE CONNECTION SCH				SCH 160		
20	NOZZLE CONNECTION, OD   AVG ID	IN		3.5	2.624		
21	WRAPPER SPAN	IN	H		2.5		
22	TUBE/PLUG SPAN	IN	h		4.25		
23	WRAPPER THICKNESS	IN	t1		.5		
24	TUBE/PLUG THICKNESS	IN	t2		1.0000		
25	END PLATE THICK, ACTUAL   MINIMUM	IN	ts	0.3750	0.375		
28	DRILL DIMENSION MINIMUM, TOP   END	IN					
26	OUTSIDE DIMENSIONS, WRAPPER   TUBE/PLUG	IN		4.5	5.25		
27	HEADER MATERIAL				SA516-70N		
28	FLANGE MATERIAL				SA350-LF2		
29	NOZZLE CONN. MATERIAL				SA333GR6		
30	END PLATE FACTOR/JOINT EFFICIENCY		C/E		0.2		
31	STRESS ALLOWABLE, HEADER MATERIAL	PSI	(S)h		20000		
32	STRESS ALLOWABLE, NOZZLE CONN.	PSI	(S)n		17100		
33	STRESS ALLOWABLE, TUBES	PSI	(S)t		11400		
34	PRESSURE MAX, HEADER BOX	PSIG			723		
35	PRESSURE MAX, FLANGE	PSIG			200		
36	PRESSURE MAX, NOZZLE CONN.	PSIG			3382		
37	PRESSURE MAX, TUBE	PSIG			2370		
38	<b>ASME CALCULATIONS PER APPENDIX 13, FIG.13-2(a), SKETCH (1) AND CALCULATIONS PER APPENDIX 13 SECTION 13-7</b>						
39	$(t1-CA)^{3/12}$		I1		0.006978353		
40	$(t2-CA)^{3/12}$		I2		0.06866455		
41	$(I2/I1)^a$		K		5.90379		
42	$3.4-2.4*((H+CA^2)/(h+CA^2))$ OR 2.5 MAX.		Z		1.96		
43	$(H+CA^2)/(h+CA^2)$		a		0.6		
44	$(t1-CA)/2$		c1		0.21875		
45	$(t2-CA)/2$		c2		0.46875		
46	$(pt-DE)/pt$		em,eb		0.5205333		
47	<b>STRESS TYPE AT ASME SECTION</b>			<b>STRESS PSI / % OF MAXIMUM STRESS (NOTE B)</b>			
48	<b>MEMBRANE STRESS - SHORT-SIDE (WRAPPER) / LONG-SIDE (TUBE/PLUG)</b>			<b>SHORT</b>			
49	$(1) (P*(h+CA^2))/(2*(t1-CA))$		(Sm)N	1000	5%		
50	$(2) (P*(H+CA^2))/(2*em*(t2-CA))$		(Sm)M	538	3%		
51	<b>BENDING STRESS - SHORT-SIDE (WRAPPER)</b>						
52	$(3) ((P*c1)/(12*I1))*(-1.5*(H+CA^2)^2+(h+CA^2)^2*(1+a^2*K)/(1+K))$		(Sb)N	873	3%		
53	$(4) ((P*(h+CA^2)^2*c1)/(12*I1))*((1+a^2*K)/(1+K))$		(Sb)Q	4527	15%		
54	<b>BENDING STRESS - LONG-SIDE (TUBE/PLUG)</b>						
55	$(5) ((P*(h+CA^2)^2*c2)/(12*eb*I2))*(-1.5+(1+a^2*K)/(1+K))$		(Sb)M	4382	15%		
56	$(6) ((P*(h+CA^2)^2*c2)/(12*I2))*((1+a^2*K)/(1+K))$		(Sb)Q	986	3%		
57	<b>TOTAL STRESS - SHORT-SIDE (WRAPPER)</b>						
58	$(7) EQ(1)+EQ(3)$		(ST)N	1873	6%		
59	$(8) EQ(1)+EQ(4)$		(ST)Q	5527	18%		
60	<b>TOTAL STRESS - LONG-SIDE (TUBE/PLUG)</b>						
61	$(9) EQ(2)+EQ(5)$		(ST)M	4920	16%		
62	$(10) EQ(2)+EQ(6)$		(ST)Q	1524	5%		
63	<b>STRESS - END PLATES PER UG-34(3)</b>						
64	$P*Z*(C/E)*((H+CA^2)/(tS-CA))^2$		(S)EP	5532	28%		

(A) ALL DIMENSIONS ARE LISTED AS UNCORRODED. ALL STRESS CALCULATIONS ARE BASIS FULLY CORRODED DIMENSIONS.

(B) MAXIMUM STRESS IS ALLOWABLE HEADER STRESS (S)h FOR MEMBRANE AND END PLATES, 1.5 X (S)h FOR BENDING AND TOTAL STRESSES.



# PURCHASE ORDER

## 54115097-207

This number must appear on all correspondence.

<b>Buyer</b> MURPHY OIL CANADA 4000, S20 - 3 Avenue SW Calgary, AB, CA T2P 3Y3 Ryan Dick T: 403-294-8038 E: ryan_dick@murphyoilcorp.com	<b>PO Description</b> AERIAL COOLERS		<b>PO Date</b> 14-Nov-2011
	<b>Project Name</b> Seal CSS Pilot	<b>EPC Company</b> Vista Projects Limited	<b>Invoice Payment Terms</b> Net 45 Days
<b>Vendor Quote/Item Reference</b> Quote # 118454	<b>Location</b> 13-9-85-17W5M	<b>EPC Project Number</b> 1780	<b>Order Currency</b> USD\$
	<b>Delivery</b> 05-Mar-2012	<b>Murphy A/E Number</b> 54115097	<b>Shipping Terms</b> FCA, Claremore OK
<b>Vendor</b> AIR-X-LIMITED 2230 East 49 Street Tulsa, OK, USA 74105 David Freshwater T: 918-743-6111 F: 918-742-7039 E: dfreshwater@airxlimited.com	<b>Invoice To</b> MURPHY OIL CANADA 4000, S20 - 3 Avenue SW Calgary, AB, CA T2P 3Y3 Facilities Attn: Ryan Dick	<b>Ship To</b>	

54115097-207  
AIR-X-LIMITED

AIR-X-LIMITED		AERIAL COOLERS			
Item	Quantity	Description	Major/Minor	Unit Cost	Total
1	1.00 pkg	TAG #: AC-5010 - PRODUCED GAS AERIAL COOLER <i>Included: Murphy vibration switch, warm air circulation system with auto top &amp; roll shutters, manual intake - TIC by others, averaginh RTD &amp; temperature controller for warm air recirc system, registration for AB, BC &amp; SK, ladder &amp; platform, mechanical run test</i>	9024-447	\$40,110.00	\$40,110.00
2	1.00 pkg	TAG #: AC-5020 - BOILER FEED WATER COOLER <i>Included: Murphy vibration switch, warm air circulation system with auto top &amp; roll shutters, manual intake - TIC by others, averaginh RTD &amp; temperature controller for warm air recirc system, registration for AB, BC &amp; SK, ladder &amp; platform, mechanical run test</i>	9024-447	\$85,725.00	\$85,725.00
<b>Sub Total</b>					<b>\$125,835.00</b>
					(plus GST)

Direct Questions About This PO To:  
 Brant Lu @ Vista Projects Ltd.  
 T: 403-258-4768 E: brant.lu@vistaprojects.com

<b>Instructions to Vendor</b> - Show PO Number 54115097-207 on all invoices and correspondence pertaining to this order - Attach a copy of this Purchase Order to ALL INVOICES when submitting for payment - Attached as Exhibit 'A' are Terms and Conditions which are made a part hereof (for all purposes) - One (1) copy of this order is to be duly signed and returned upon receipt. Retention for more than ten (10) working days shall constitute acceptance of this order in its entirety - Work performed is not to deviate from the scope of this Purchase Order - No costs are to exceed the amount indicated on this Purchase Order	<b>Order Prepared By</b>  Sergio Terenta	<b>Total Value of Purchase Order</b> \$125,835.00 (plus GST)
	<b>Order Approved By</b>  Ryan Dick, Jeff Sand, Cal Buchanan	

\$125,835.00  
 (plus GST)

54115097-207  
 Page 1 of 1

**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**

1. Manufactured and certified by: AXH air-coolers, LLC - 401 EAST LOWRY ROAD - CLAREMORE, OKLAHOMA 74017  
(Name and address of manufacturer)

2. Manufactured for: MURPHY OIL CANADA, 4000, 520 - 3RD AVENUE SOUTHWEST, CALGARY, ALBERTA, CANADA T2P 3Y3

3. Location of installation: UNKNOWN  
(Name and address)

4. Type HORZ. H. EXCHANGER 118454.1 V7153.213 118454HDR-PROD GAS R1&118454-CRN1 R0 21006 2012  
(Horizontal, or vertical, tank) (Manufacturer's serial no.) (CRN) [Drawing number(s)] (National Board Number) (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. 2010 EDITION  
Year

to: NO ADDENDA - -  
Addenda, if applicable (date) (Code Case numbers) (Social Service per UG-120 (d))

6. Shell: TUBE/PLUG: SA-516-70N FR & BK 1" .0625 FR & BK 0' 5 1/4" 3' 9 5/8"  
(Material spec. number, grade) (Nominal thickness) (Corr. allow) (Inner diameter) (Length (overall))

7. Seams: CORNER JOINT SEE REMARKS 1.0 1150° 1 - - \*2  
[Long. (welded, dbl., sngl., Lap, Butt)] R.T. (Spot or Full) (Eff., %) (H.T. temp.) (Time, hr) [Girth (welded, dbl., sngl., lap, butt)] [R.T. (spot or full)] (Eff., %) (No. of courses)

8. Heads: (a) Material WRAPPERS: SA-516-70N (b) Material ENDS: SA-516-70N  
(Spec. no., grade) (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	WRAPPERS	1/2"	.0625	-	-	-	-	-	**	FLAT
b	ENDS	3/8"	.0625	-	-	-	-	-	***	FLAT

If removable, bolts used (describe other fastenings) \_\_\_\_\_  
(Material spec. number, grade, size, number)

9. MAWP 178 psi. N/A at max. temp. 473 °F N/A  
(Internal) (External) (Internal) (External)

Min. design metal temp. -49 °F at 178 psi. Hydro., pneu.-or-comb. test pressure 232 psi.

Proof Test NONE

10. Nozzles, inspection, and safety valve openings:

Purpose (Inlet, Outlet, Drain)	No.	Diameter or size	Type	Material		Nozzle Thickness		Reinforcement Material	Attachment Details		Location (Insp. Open.)
				Nozzle	Flange	Nom.	Corr.		Nozzle	Flange	
INLET/OUTLET	2	3"-150#	PIPE/RFWN	****	SA350-LF2	S/160	0.0625	NONE	UW-16(a)	UW-16(a)	HEADER
INSTRUMENT	4	1"	CPLG	SA350-LF2	-	6000#	0.0625	NONE	UW-16(a)	-	HEADER
PLUGS	178	3/4"-16	UNF	SA350-LF2	-	-	-	-	-	-	HEADER

11. Supports: Skirt NO Lugs N/A Legs N/A Other STRUCTURE Attached BOLTED  
(Yes or no) (Number) (Number) (Describe) (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: \_\_\_\_\_  
(Name of part, item number, Manufacturer's name and identifying stamp)

\*2 HEADERS, ONE AT EACH END. \*\*WRAPPERS FLAT DIA. 2 1/2" X 3' 9 5/8". \*\*\*ENDS FLAT DIA. 2 1/2" X 4 1/4". \*\*\*\*SA333-GR6 (SMLS)

89 TUBES SA-179 5/8" O.D. X .065 MW 6' 0" LG. RADIOGRAPH PER CUSTOMER SPECIFICATION'S.

IMPACTS EXEMPT PER UCS-66(a) CURVE D. PRESSURE RELIEF DEVICE BY OTHERS. CONSTRUCTED IN ACCORDANCE WITH APPENDIX 28.

**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 BOILER AND PRESSURE VESSEL CODE, Section VIII, Division 1. "U" Certificate of Authorization Number 34.950 expires 02/07/2014

Date 3-21-2012 Co. name AXH air-coolers, LLC. Signed Renee Weeks  
(Manufacturer) (Representative)

**CERTIFICATE OF SHOP / FIELD INSPECTION**

Vessel constructed by AXH air-coolers, LLC. at 401 E. LOWRY ROAD - CLAREMORE, OKLAHOMA 74017

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of OKLAHOMA and employed by SENECA INSURANCE COMPANY OF TEXAS

have inspected the component described in this Manufacturer's Data Report on 320-12 and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME BOILER AND PRESSURE VESSEL 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/her 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 3-21-12 Signed [Signature] Commissions NB12461A OK883  
(Authorized Inspector) (National Board (incl. endorsements,) State, Province, and number)

U  
W  
HT

21006

CERTIFIED BY **AXH air-coolers, LLC**

CLAREMORE, OKLAHOMA PROD GAS

MAX. ALLOWABLE WORKING PRESSURE 178 PSI @ 473 °F  
MIN. DESIGN METAL TEMP. -49 °F @ 178 PSI  
SER. NO. 118454.1 CRN. V7153.213  
YEAR 2012 HYDRO. 232 PSIG SERVICE



Rw 3.7.12

WISco  
W O R L D  
Initials: KR  
Date: 3-28-12  
117

**FINAL IN PROCESS  
INSPECTION CHECKLIST**



<b>CUSTOMER:</b>	MURPHY OIL CORPORATION
<b>JOB / MODEL NUMBER:</b>	118454 / 42ZF-R
<b>UNIT:</b>	

	PROD.	LEAD	Q.C.	CUST.
NOZZLE ARRANGEMENT AND FLANGE FACING	J.L. X 3-21-12	C.W. X 3-21-12	KP X 3-21-12	
RUST PREVENTION OF NOZZLE FACES	G.C. X 3-21-12			
RUST PREVENTION OF SHAFTS	Bc X 3-12-12			
DIMENSIONAL INSPECTION OF SUBCOLUMNS				
DIMENSIONAL INSPECTION OF BASE HOLES	Bc X 3-12-12		KP X 3-22-12	
TORQUING OF FAN HUB & BLADES	Bc X 3-12-12	C.W. X 3-12-12		
CHECK FAN BLADE CLEARANCE AND PITCH <i>Fixed Pitch 37.5°</i>	Bc X 3-12-12	C.W. X 3-12-12	RB X 3-12	
PARAFLEX CPLG, FAN BUSHING, AND BEARINGS SECURED	Bc X 3-12-12	C.W. X 3-12-12	RB X 5-12	
BEARINGS GREASED	<del>X</del>		<del>N/A</del>	
IDLER ALIGNMENT				
ELECTRIC MOTOR	AL X 3-12-12	C.W. X 3-12-12	KP X 3-21-12	
MANUAL AND/OR AIR MOTORS	J.L. X 3-21-12		KP X 3-22-12	
SHUTTERS OPERATE CORRECTLY, PICTURES TAKEN	J.L. X 3-21-12	C.W. X 3-21-12	KP X 3-22-12	
SIDE FLAP INSTALLATION (FRONT HEADER END) (BACK HEADER END)				
FINAL FINISH AVG. MIL.				
CLEANING OF GALVANIZED PARTS AS REQUIRED	G.C. X 3-21-12			
HAIL GUARD, FAN GUARD, AND/OR BUGSCREENS	J.L. X 3-21-12			
UNIT / MISC NAMEPLATE INSPECTION & ATTACHMENT	MP X 3-12-12	C.W. X 3-12-12	KP X 3-21-12	
TEST FIT OF LADDERS / PLATFORMS <u>PICTURES TAKEN</u>	G.C. X 3-21-12		KP X 3-21-12	
PARTS SHIPPING LOOSE	J.L. X 3-22-12	C.W. X 3-22-12	KP X 3-22-12	
VIBRATION SWITCH	Bc X 3-12-12		RB X 5-12	
ELECTRIC MOTOR VERIFICATION	Bc X 3-12-12	C.W. X 3-12-12	RB X 3-12	
RUN TEST AND VIBRATION CHECK		W.F.	KP X 3-21-12	up 3/22/12
VERIFY WEIGHT	J.L. X 3-22-12			



Q.C. RELEASE FOR SHIPMENT: KP 3-22-12

COMMENTS: 3RD PARTY INSPECTION REQUIRED. SEE J.I. INSPECTION TEST PLAN MUST BE SIGNED OFF! THIS COOLER HAS A WARM AIR RECIRC. SYSTEM.

W O R X
Initials: <i>[Signature]</i>
Date: 3-22-12
117

11/23/2011

P.O.# :2683

S.O.# :406163

AA BL#:2.25734603

Item :2 (4 PC) " X 2-1/4" DIAMETER X 137-1/2" LG

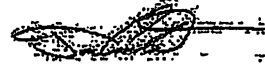
11-28-11



CMC IMPACT METALS PENNSYLVANIA  
1024 Kittanning Pike  
Chicoa PA 16025-2630  
888-692-7337  
www.cmcimpactmetals.com

# Material Test Report

Production Date  
06.27.2011



Tom Carter, Technical Director

Sold To:  
CMC Comets Steel  
6565 N MacArthur Blvd  
IRVING TX 75039-6283 US

Ship To:

Quality Management System certified to  
ISO 9001:2008  
and  
Pressure Equipment Directive (PED)  
97/23/EC T2, Annex I, Paragraph 4.3  
by BSI Quality System Register,  
Reg. # 2099-00

Customer PO No.	66269 SO 67379	BOL No.	Delivery No.	Sales Order No.
Customer Part No.		0000419228	0080538934	0000579721

### Product Description

ROUND:SBQ 2-1/4" 20R 1022M, 1022M/1518M A105/A350 LF2 Norm

Alternate Grades:  
ASTM/ASME A/SA 105-10, ASTM A696-90A GR C  
ASTM/ASME A/SA 350-07 GR. LF2 CLASS 1  
ASTM/ASME A/SA 675-03 GR 70, NACE MR0175-03  
EN 10204:04 3.1

Processing  
Normalize, RND - Straighten 1/8" in 5 ft

### CHEMICAL ANALYSIS

Heat No.	C (%)	Mn (%)	P (%)	S (%)	Si (%)	Cu (%)	Cr (%)	Ni (%)	Mo (%)	V (%)	Cb (Nb) (%)	Al (%)
7346038	0.22	1.15	0.010	0.005	0.23	0.02	0.14	0.02	0.010	0.003	0.001	0.030
Batch No.	Ti (%)	B (%)	As (%)	Pb (%)	Sb (%)	Zr (%)	N2 (ppm)	O2 (ppm)	H2 (ppm)	DI (in.)	CE (%)	
3460381765											0.44	

### THERMAL PROCESSING

Furnace No.	Austenitizing Temp. (°F)	Austenitizing Time (min)	Tempering Temp. (°F)	Tempering Time (min)	Normalizing Temp. (°F)	Normalizing Time (min)	Quench Media	Quench Temp. (°F)
11765					1740	12		

Notes: Certified a true copy of the original. retained in our file. *AL 11-14-11*

*AXIS AIR CORP*  
*1-16-12*

*2-1/4" D.I.C.*  
*SA-105*  
*SA-350 LF-2*  
*SA-675-70*  
*A-696-C*  
*Green*

Test	Tensile Test						Hardness Test					
	Yield (ksi)	Tensile (ksi)	Elongation (%)	Reduction of Area (%)	Yield at 0.6% Elongation Under Load (ksi)	Yield at 0.02% (ksi)	Test Orientation	Test Location	Brinell (BHN)	Test Location	Rockwell	Test Location
1	50.4	80.1	35	69			Longitudinal	Mid Radius	149	Surface		
2									156	Mid Radius		
3												
4												
5												
6												
7												
8												

*78A*

### JOMINY RESULTS (HRC)

Test	Distance (in.)											
	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J11	J12
1	J13	J14	J15	J16	J18	J20	J22	J24	J26	J28	J30	J32



1/23/2011 From:

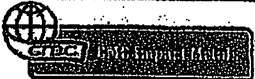
To:

P.O.# :2683

S.O.# :406163

AA #PL# 2-25734603

Item :2 (4 PC) " X 2-1/4" DIAMETER X 137-1/2" LG



CMC IMPACT METALS PENNSYLVANIA  
1024 Kittinging Pk  
Chicora PA 16025-2030  
888-682-7337  
www.cmcimpactmetals.com

# Material Test Report

Production Date 06-27-2011

Heat No. 784008

Furnace No. 11765



Tom Carter, Technical Director

## CHARPY IMPACT TESTS

Test	Average*	Specimen 1*	Shear	Lateral Expansion	Specimen 2*	Shear	Lateral Expansion	Specimen 3*	Shear	Lateral Expansion	Test Temp.	Size	Location	Orientation
	ft-lb <sub>v</sub>	ft-lb <sub>v</sub>	%	In.	ft-lb <sub>v</sub>	%	In.	ft-lb <sub>v</sub>	%	In.	°F			
1	49.3	50.5	27	0.036	42.5	27	0.033	55.0	33	0.033	-50	Full	Mid Radius	Longitudinal
2														
3														
4														
5														
6														
7														
8														

\*Absorbed energy values converted from sub-size results (ref. ASTM A370) when applicable.

## INCLUSION RATING

Method								
Test	Thin (T)	Heavy (H)	Thin (T)	Heavy (H)	Thin (T)	Heavy (H)	Thin (T)	Heavy (H)
	1							
2								
3								

## BEND TESTS

Test	Pin Radius (in.)	Orientation	Result	Final Bend Angle
1				
2				

Certified a true copy of the original, retained in our file.

AG 7-14-11

## OTHER TESTS

Type of Test	Method		
Grain Size	ASTM E112	Grain Size:	5
Ballistic Test 1		Req'd Velocity:	Observed Velocity: Result:
Ballistic Test 2		Req'd Velocity:	Observed Velocity: Result:
Ultrasonic Test		Criteria:	Result:
Decarburization			
Macro Test	ASTM E381	SR	
Reduction Ratio		9:1	

Additional Comments

AXH

Order # 38770  
 Qty 100  
 Price # 53039

Country of Origin : United States

PRODUCTION MFG, TULSA, OKLA.

CUSTOMER MARSCO

P.O.# 53039-9

ITEM 1" 6000 # x 2 3/8" TOE COUPLING

LICAT CODE 78A

06/22/2011 From: U.S. ALLOYS, INC. To: PRODUCTION MFG.  
 Item : LF-2 RND A350/A105 HR NORMALIZED, 2-1/4" X 20'3", 20'2" P.O.#: 2596  
 S.O.#: 123698 Item #: 1 P/N #:

6-27-11



2 1/4" LF2  
 A9U

8000 N. County Road 235 East  
 Pittsboro, IN 44167  
 Phone: (317) 883-7000  
 Fax: (317) 883-7238

### Certified Material Test Report

Cert #: 112044 Mill Order: 1105644 Heat #: A112409 Issued: 01/02/2011 11:07:20  
 Work Order: 111988 Sales Order: 85987-1 Customer: US Alloys PO #: 18476-3  
 Load #: 132585 Reference #: Reference Desc: End Use:  
 Size: 2-1/4" Shape: Round Grade: A350LF2 Chem Length: 20'00"  
 Grain Practice: A1 Fine Grain (6-8) per ASTM A29 Reduction Ratio: 36.0 to 1 Disposition: 1

**Ladle Chemistry Analysis (ASTM A29)**

C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Co	B	Ca	W	Ti	Mi
0.16	1.02	0.010	0.023	0.21	0.029	0.24	0.10	0.15	0.03	0.012	0.0077	0.002	0.001	0.0000	0.0010	0.000	0.001	0.81
Pb	Co	As	Sb	Zr	Bi	H	O	Coq	J-Factor									
0.000	0.007	0.006	0.002	0.001	0.000	1.4		0.41										

**Product Check Analysis (ASTM A29)**

C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Co	Ti	B	Ca	O
Front																	
Back																	

**Jominy (ASTM A269)**

J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J12	J14	J18	J16	J20	J24	J28	J32
Calc'd																	
Front																	
Back																	

**Microcleanliness (ASTM E40)**

Method A								Method C		Method E		Microcleanliness (DIN 50607)			
AT	AH	BT	BH	CT	CH	DT	DH	S	O	SAM "B"	SAM "D"	S	O	Tot	Tot

**Repsch**

Repsch		Grainize		Macrostructure (ASTM E351)			Magnetic Particle Inspection	
Depth	% of Diameter	Austenitic	Ferritic	S	R	C	Frequency	Severity

**Mechanical Properties (ASTM A370)**

Tensile Properties					Hardness	
Tensile Strength	0.2% Yield Strength	% Elong (2")	% ROA	0.35% EUL Yield Strength	(HR)	(Surf)

Steel Dynamics - Engineered Bar Products has a quality system in place which has been certified ISO 9001:2008 compliant, including PED certification.

**Comments/Specs**

ASTM A578-90b (reinst rev.) — ASTM A105-05 — ASME SA105-04 — Electric Arc Furnace Melted - Vacuum Tank Degassed — Electric Arc Furnace Melted - Vacuum Tank Degassed — NACE MR-01-76 / ISO 15156 — Normalize — DIN EN 10204:2004 Issue 3.1 — U.S. Alloys Spec USA4H old 12/04/06 — ASTM A350-04a LF2 Class 1 — ASTM A998-90a Grade C — ASTM A875-03 Grade 70 — ASME SA350-04 LF-2 Class 1 — ASME SA898-04 Gr C — ASME SA875-04 Gr 70 — DIN 3.1.B — Cameron MR-006 Rev. C1 — NACE MR0100-2003

Condition: Normalize, Straighten

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.  
 Dylan Kats - Rolling Mill Metallurgist

Any alteration to this report voids Steel Dynamics' warranting of results. No work repair has been performed on this material. This material is not radioactive and has not been exposed to radioactivity while under the control of Steel Dynamics. This material has not been exposed to mercury while under the control of Steel Dynamics. Unless otherwise noted, this material was melted, continuously cast, and rolled in the USA; w/ all testing performed by Steel Dynamics.

18-17-11  
 AIR COOLERS  
 QC CERTIFIED

From: U.S. ALLOYS, INC. To: PRODUCTION MFG.  
 LF-2 RND A350/A105 HR NORMALIZED, 2-1/4" X 20'3", 20'2" P.O.#: 2596  
 Item #: 1 P/N #:



2 1/4" LF2  
 A9U

6-27-11

8000 N. County Road 228 East  
 Pittsburg, MO 64567  
 Phone: (417) 882-7000  
 Fax: (417) 882-7255

### Certified Material Test Report Heat Treatment Addendum

Cart #: 112044	NIJ Order: 1105844	Heat #: A112409	Issued: 8/10/2011 11:07:20
Work Order: 111966	Sales Order: 85997-1	Customer: US Alloys	PO #: 18470-3
Load #: 135385	Reference #:	Reference Desc:	End Use:
Size: 2-1/4"	Shape: Round	Grade: A350LF2 Chem	Length: 20'00"

Normalize		Austenitize		Quench Media		Temper		Stress Relieve		
Time	Temp	Time	Temp	Type	Time	Temp	Time	Temp	Time	Temp
3.5 hrs	1670 F	hrs	°F	Water	min	°F	hrs	°F	hrs	F

\* Furnaces are calibrated to API 6A Annex P, and use atmospheric thermocouples.  
 \*\* QTC is 12" prolongation from longitudinal orientation, machined to a 0.505" buttonhead for tensile.

Charpy Impact (ASTM E23) (V-notch 1.0mm x 10mm)				Impact Energy (ft-lbs)				Lateral Expansion (0.001")				% Shear				
Sample ID	Orientation	Location	Temp(F)	1	2	3	Avg	1	1	3	Avg	1	2	3	Avg	
96700	Longitudinal	Mid-Radius	Q1	-50	35	48	83	89	30	42	75	49	20	30	90	47

Hardness (ASTM A378)			HB
Sample ID	Location		
96700	Mid-Radius	Q1	147

Tensile (ASTM A378)				Tensile	0.2% Yield	ME (2")	%ROA
Sample ID	Orientation	Location					
96700	Longitudinal	Mid-Radius	Q1	74,500 psi	48,400 psi	25	80

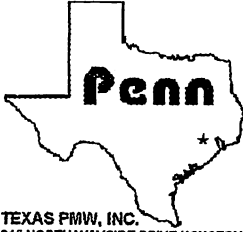
TEST REPORT FURNISHED  
 BY U. S. ALLOYS, INC.  
 ITEM LF2 2'14"  
 HT. CODE W/TG CLR CODE Amor  
 DATE 6-13-11 APP. BY UA

PRODUCTION MFG, TULSA, OKLA.  
 CUSTOMER LEE SUPPLY  
 P.O. # 11-3329 KB  
 ITEM 1" 6000# x 2 3/4" TOE COUPLING  
 HEAT CODE A9U

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

*Smith Book*  
 Gerald Boyce - Bar Finishing Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results.



TEXAS PMW, INC.  
315 NORTH WAYSIDE DRIVE HOUSTON, TX 77020  
(713) 679-7900 - FAX (713) 679-7920

**Penn**  
**MACHINE**  
Since 1931

PENNSYLVANIA MACHINEWORKS, INC.  
201 BETHEL AVENUE ASTON, PA 19014  
(610) 487-3300 - FAX (610) 497-3325



US DROP FORGE CO.  
P.O. BOX 131 - ROUTE 551  
1588 AUBURN ROAD SYDDESBORO, NJ 08085  
(856) 467-0500 - FAX (856) 467-4598

**CERTIFIED MATERIAL TEST REPORT**

MATTSCO SUPPLY COMPANY  
P.O. BOX 2925  
TULSA, OK 74101

P.O. 544259  
ORDER # 03 206788  
3/06/12

36-1 1/4X3/4 6M TOL LF2 QTY: 4

HEAT CODE: 6U1S-A MATERIAL: LF2  
SPECIFICATION: A350 SPEC. YEAR: 02 SPEC. REV: A  
HEAT TREATMENT: QUENCHED & TEMPERED  
UNS NUMBER: K03011

CHEMICAL ANALYSIS											
C	MN	P	S	SI	NI	CR	MO	CU	V	CB	
.200	1.040	.011	.025	.230	.080	.070	.026	.170	.003	.002	
AL	CB	SN									
.028	.002	.009									

PHYSICAL ANALYSIS								
YS (PSI)	TS (PSI)	%EL 4D	%RA	HARDNESS (HB)	CHARPY1 FT/LBS	CHARPY2 FT/LBS	CHARPY3 FT/LBS	CHARPY AVG
51500	77500	34.00	79.00	152	236.000	221.000	238.000	231.666

TESTED@ TEMP (F)	QUENCHED (F)	TEMP (F)	C.E=
-50	1625	1200	.41

MATERIAL I/A/W ASME-SEC. II SA SPECIFICATION-CERTIFICATE I/A/W EN10204 TYPE 3.1  
THE ABOVE MATERIAL IS A350-LF2 CLASS 1 AND MATERIAL MEETS NACE-MRO175 (2003 EDITION) AND NACE-MRO-2003  
MATERIAL MEETS NACE-MRO103-2007  
CHARPY IMPACT SPECIMEN SIZE : 10 BY 10 (MM) AND IMPACT TEST TEMPERATURE STATED IN NEGATIVE DEGREES F.  
DURING THE MANUFACTURE AND PROCESSING OF THIS PRODUCT, IT DID NOT COME IN DIRECT CONTACT WITH MERCURY  
OR ANY OF ITS COMPOUNDS NOR WITH ANY MERCURY CONTAINING DEVICE THAT EMPLOYED A SINGLE BOUNDARY OF CONTAINMENT.  
NO WELD REPAIRED MATERIAL - MADE IN THE U.S.A

*JBF*  
3-13-12  
Customer # 39862  
Item #  
MattSCO File# 54425



WE HEREBY CERTIFY THAT THE REPORTED FIGURES ARE CORRECT AS CONTAINED IN THE RECORDS OF THE CORPORATION.

*James B. Friant*  
JAMES B. FRIANT  
QUALITY MANAGER



MANUFACTURERS OF Penn FORGED PIPE FITTINGS  
QUALITY • SERVICE • PARTNERSHIP  
www.pennusa.com



PO # 39862



NATIONAL FLANGE & FITTING CO.

4420 CREEKMONT ST.
P. O. BOX 924149
HOUSTON, TEXAS 77292 - 4149
(713) 688 - 2515
FAX (713) 688 - 0205

SOLD TO MATTSCO SUPPLY CO
5740 E. ADMIRAL PLACE
TULSA, OK 74115

MILL TEST REPORT

CUSTOMER'S ORDER NO: 867-S-12

INVOICE NUMBER DATE
02119500 10/19/11

Table with columns: ITEM, QTY, DESCRIPTION, MATERIAL, H CODE. Contains 9 rows of item specifications including sizes like 2", 3", 4" and materials like SA-350-LF2 N.

Table with columns: ITM, H CODE, CAR, MAN, PHOS, SUL, NIC, CHR, MOL, SIL, CU, VA, NB. Contains mechanical test data for items 1 through 9.

COMMENT: ITEM 1: NORMALIZED @ 1724F FOR 1 HR/INCH/THICKNESS, AIR COOL. ITEMS 2&3: NORMALIZED @ 1650F FOR 1 HR/INCH/THICKNESS, AIR COOL. ITEM 4: NORMALIZED @ 1650F FOR 4 HRS, AIR COOL. ITEMS 5&7: NORMALIZED @ 1650F FOR 2 HRS, AIR COOL. ITEM 6: NORMALIZED @ 1670F FOR 1 MIN/MILLIMETER/THICKNESS, AIR COOL. ITEM 8: NORMALIZED @ 1670F FOR 2.3 HRS, AIR COOL. TEMPERED @ 1220F FOR 4 HRS, AIR COOL. ITEM 9: NORMALIZED @ 1670F FOR 1 HR/INCH/THICKNESS, AIR COOL.

THIS IS TO CERTIFY THAT THE MATERIAL FURNISHED ON THIS ORDER COMPLIES IN ALL RESPECT WITH THE SPECIFICATIONS INDICATED IN DESCRIPTION. WE FURTHER CERTIFY THIS PRODUCT WAS MANUFACTURED IN THE UNITED STATES.

NATIONAL FLANGE & FITTING COMPANY

BY: [Signature]

Handwritten signature and date 2-20-12, and AXH AIR COOLERS QC CERTIFIED logo.

PO# 38797



air-coolers

# MATERIAL TRACEABILITY RECORD

JOB NO. 118454

PIPES  PLATES  TUBES  BY JW DATE 2-27-11 CUSTOMER \_\_\_\_\_

MTL. P.O. NO. SECTION NO.	MATERIAL DESCRIPTION	HEAT OR CERTIFICATION NO.
PRODUCED GAS	1. 3" SCH 160, SA-333-GR. 6 (SMLS) (2 pipes)	09405913
	2.	
	3.	
	1.	
	2.	
	3.	
	1.	
	2.	
	3.	
	1.	
	2.	
	3.	

NOTE: ALL MATERIAL OF SAME DESCRIPTION IN A SECTION MUST BE OF SAME HEAT NO.

**AXH air-coolers • 401 E Lowery Road • Claremore, OK 74017 • (918) 283-9200**

*JW*  
2-27-11  
  
AXH AIR COOLERS  
QC CERTIFIED

Alpinstrasse 17  
 8662 Kitzbühel-Aumühl  
 T. +43(0)304723-0  
 F. +43(0)304783-532  
 www.voestalpine.com

Legal Structure: Limited Partnership  
 Location: Kitzbühel/Austria  
 Company Registry Number 188400K  
 Commercial Court of Leoben  
 DPR 0592884, VAT Nr. ATU 43890408

General Partner: voestalpine Tubulars GmbH  
 Legal Structure: Limited Liability Company  
 Location: Linz, Company Registry Number 108833 f  
 Commercial Court of Linz

**Abnahmeprüfzeugnis 3.1 / Nr./No. Z58984**  
 (gem. EN 10204)

**Inspection - Certificate 3.1**  
 (according to EN 10204)

Besteller:  
 Purchaser: VOEST-ALPINE TUBULAR CORPORATION  
 USA-77042 HOUSTON TEXAS  
 INDUSTRIAL PIPING SPEC., TULSA OK 74188-1270

Hersteller:  
 Manufacturer: voestalpine Tubulars GmbH & Co KG

Prüfgegenstand  
 Object of tests: SEAMLESS STEEL TUBES

Anforderungen:  
 Requirements: ASTM A 106-08/ ASME SA 106 - Gr.B+C,  
ASTM/ASME A/SA 333-08 - Gr. 1+6  
 (ASME Section VIII Part A - 1, July 2007 + Addenda 2009b)  
 NACE MR 0175 / ISO 15168-2:2004

Werkstoff:  
 Material: GRADE B / GRADE C / GRADE 6 / GRADE 1

\*) Grade C/Grade 1 without marking on tubes

Kennzeichnung:  
 Marking: PAINT STENCILLING: V8 A/SA 106 Grade B A/SA 333 GRADE 6 3,600" O, 438"  
 SCHED160 2800 PSI HOT FINISHED SEAMLESS LT -50°F length ft. Heat No. PO# HR023040  
 MADE IN AUSTRIA

Ausführung:  
 Condition: BOTH ENDS BEVELLED ACC. TO API/ASTM (30°)

Wärmebehandlung:  
 Heat treatment: hot finished (845-945°C) followed by controlled cooling  
 in air from 845°C to room temperature

Umfang der Lieferung / Volume of delivery:

Pos.-Nr. Item No. Parte n°	Stückzahl Number Of Numbers	kg	ft	Abmessung Dimension Dimension	Schmelz-Nr. Heat No. N° Coûlé	Probe-Nr. Test No. N° d'éprouvette
4	48	12695,00	1948,665	3,600 in x 0,438 in / 14,33 lbs/ft	see attachment	see attachment

**F5VAT31606R6**

Bestell-Nr.: VATC PO# 808514  
 Your order No.: PO# HR023040

Auftrags-Nr.: 4432  
 Our work order No.:

Versandanzahl:  
 Dispatch order No.:

Ermittlungsart:  
 Mailing process: Y

Zeichen des Lieferwerkes:  
 Marking of producer: V8

  
 AX AIR COILERS  
 QC CERTIFIED  
 2-3-12  
 Z

Kitzbühel, 21.01.2010

Page 1 of 4

voestalpine Tubulars GmbH & Co KG  
 Qualitätsstelle / Quality Department

**GFREIER**

Der Werkstoffverständige  
 Works Inspector / L'Expert d'usine

**voestalpine**

ONE STEP AHEAD.

voestalpine Tubulars GmbH & Co KG

Volumes of delivery

Bundle No.	Heat	Lot
1-4	09405913	132118 -- 01
	09405913	132118 AD 01

Test Results

- 1 Visuelle Inspektion/ Visual Inspection: o.B./satisfactory
- 2 Dimensionskontrolle/ Dimensional Inspection: o.B./satisfactory
- 3 Wasserinnendruckversuch/Hydrostatic test: 2500 PSI  
o.B./satisfactory
- 4 Ringfaltversuch/Flattening test: o.B./satisfactory
- 5 Streuflussprüfung gem. ASTM E 570 / Flux leakage testing acc.  
ASTM E 570: o.B./satisfactory

No 58984

Kndberg, 21.01.2010

Page 2 of 4

voestalpine Tubulars GmbH & Co KG  
Qualitätsabteilung / Quality Department

**GFREIER**

Der Werksverantwortliche  
Works Inspector / L'Expert d'usine

**voestalpine**

ONE STEP AHEAD.



**voestalpine Tubulars GmbH & Co KG**

**Mechanical testing**

Lot No	Specimen	Yield Strength	Tensile Strength	Elongation %
	mm	Rp0.20 PSI	PSI	Lo= 2°
from:	Gr.B/Gr.8	35500	60200	30,00
	Gr.C	40000	70000	
	Gr.1	30000	55000	
to:				
132118 -- 01 N 1	strip/longitudinal	19,12 10,74 53081	74981	35,00
132118 -- 01 N 2	strip/longitudinal	19,00 11,34 51776	73386	36,80
132118 -- 01 N 3	strip/longitudinal	19,00 10,93 52646	74111	39,00

**Hardness testing HRB (max. 22 HRC Δ 99 HRB)**

Lot No	Hardness number	Mean hardness number	Verfallon
from:			
to:			
132118 -- 01 N 1	77,50	77,20	,17

**Impact test results Charpy-V -45°C specimen 88x10x10 mm longitudinal**

Lot No	Single	Value
132118 -- 01 N 1	140 112 93	115

**№ 5 8 9 8.4**

Kindberg, 21.01.2010

Page 3 of 4

voestalpine Tubulars GmbH & Co KG  
Qualitätsstelle / Quality Department

**GFREIFER**

Der Werkstoffverständige  
Works Inspector / Expert of usma.

**voestalpine**

ONE STEP AHEAD.

voestalpine Tubulars GmbH & Co KG

Chemical test results

Heat analysis Weight %

Heat

	C	Si	Mn	P	S	Cr	Ni	Mo	V	Cu	Ti	Al	Sn	Nb	B	C.E
09405913	0.1728	0.2572	0.9461	0.0148	0.0043	0.0400	0.0270	0.0028	0.0014	0.0123	0.0021	0.0272	0.0015	0.0342	0.0003	0.34 %

Product analysis Weight %

				C	Si	Mn	P	S	Cr	Ni	Mo	V	Cu	Ti	Al	Sn	Nb	B
132118	-	01	N 1	0.1820	0.2430	0.9190	0.0150	0.0051	0.0350	0.0160	0.0117	0.0049	0.0090	.0017	0.0272	0.0012	0.0339	0.0000
132118	-	01	N 2	0.1760	0.2390	0.9100	0.0160	0.0050	0.0340	0.0160	0.0117	0.0048	0.0090	.0016	0.0269	0.0010	0.0322	0.0000

№ 5 8 9 8:4

Kindberg, 21.01.2010

Page 4 of 4

voestalpine Tubulars GmbH & Co KG

Qualitätsstelle / Quality Department

**GREIFER**

Der Werkssachverständige  
Works Inspector / L'Expert d'usine

**voestalpine**

ONE STEP AHEAD.

09405913 | 132118-1 | 132118-2 | 132118-3 | 132118-4 | 132118-5 | 132118-6 | 132118-7 | 132118-8 | 132118-9 | 132118-10 | 132118-11 | 132118-12 | 132118-13 | 132118-14 | 132118-15 | 132118-16 | 132118-17 | 132118-18 | 132118-19 | 132118-20 | 132118-21 | 132118-22 | 132118-23 | 132118-24 | 132118-25 | 132118-26 | 132118-27 | 132118-28 | 132118-29 | 132118-30 | 132118-31 | 132118-32 | 132118-33 | 132118-34 | 132118-35 | 132118-36 | 132118-37 | 132118-38 | 132118-39 | 132118-40 | 132118-41 | 132118-42 | 132118-43 | 132118-44 | 132118-45 | 132118-46 | 132118-47 | 132118-48 | 132118-49 | 132118-50 | 132118-51 | 132118-52 | 132118-53 | 132118-54 | 132118-55 | 132118-56 | 132118-57 | 132118-58 | 132118-59 | 132118-60 | 132118-61 | 132118-62 | 132118-63 | 132118-64 | 132118-65 | 132118-66 | 132118-67 | 132118-68 | 132118-69 | 132118-70 | 132118-71 | 132118-72 | 132118-73 | 132118-74 | 132118-75 | 132118-76 | 132118-77 | 132118-78 | 132118-79 | 132118-80 | 132118-81 | 132118-82 | 132118-83 | 132118-84 | 132118-85 | 132118-86 | 132118-87 | 132118-88 | 132118-89 | 132118-90 | 132118-91 | 132118-92 | 132118-93 | 132118-94 | 132118-95 | 132118-96 | 132118-97 | 132118-98 | 132118-99 | 132118-100

171895

<b>USIMINAS U</b> USINAS SIDERÚRGICAS DE MINAS GERAIS S.A. USINA JOSÉ BONIFÁCIO DE ANDRADA E SILVA - CUBATÃO-SP/BRASIL SEDE: BELO HORIZONTE - MG - BRASIL R. PROF. JOSÉ VIEIRA DE MENDONÇA, 3011 BAIRRO ENFERMEIRO NOGUEIRA - CP 806 - CEP: 31310-260 CNPJ: 08.884.730/0001-08 INSCRIÇÃO ESTADUAL: 0283121905115	<b>INSPECTION CERTIFICATE/PACKING LIST</b> <b>CERTIFICADO DE INSPEÇÃO</b> <b>STEEL PLATE</b> <b>CHAPA GROSSA DO LCG</b>	Customer-Cliente: <b>THIRD COAST INTERNATIONAL TRADING I</b>	Lot Lote <b>926636</b>	Date of Issue Data de Emissão <b>24/05/2011</b>
	Tolerances - Tolerâncias Thickness-Espessura <b>-0.25/+1.78 mm</b> Width-Largura <b>-6.00/+25.00mm</b> <b>-6.00/+47.00mm</b>		Sale Order Ordem de Venda Nº <b>00213897</b> Item <b>03</b>	Certificate Nº Nº Certificado <b>706648</b>

As mutual protection to clients and ourselves, all reports are submitted as a confidential property authorization for publication of statements, conclusion extracts from or regarding our reports is reserved pending our written approval. Any and all the documents issued by the client will be valid if its content respect the terms of the original files of USIMINAS. We hereby certify that material herein described has been made by the basic oxygen process (LD), tested and analysed by our technological laboratories according to the technical standard. Para mútua proteção de fornecedores e demais esse certificado tem caráter confidencial e sua transcrição total ou parcial, assim como, cópias fotográficas ou eletrônicas são proibidas, exceto quando autorizadas por escrito pela USIMINAS. Todo o qualquer documento emitido pelo cliente será válido se o seu conteúdo respeitar os termos dos arquivos originais da USIMINAS. Qualquer cópia ou reprodução (discreta ou não) de qualquer parte dos dados aqui apresentados sem a autorização por escrito da USIMINAS é proibida. Este documento é propriedade exclusiva da USIMINAS e deve ser tratado como tal.

Quality - Qualidade **ASTM-A516-10-70-MT. ASME-SA516-10-70-MT**

Nominal Dimensions - Dimensões Nominais **1x96x480 inch**

Packages Volumes	Pieces per Packages	Net Weight	Gross Weight	Heat	Sample	Packages Volumes	Pieces per Packages	Net Weight	Gross Weight	Heat	Sample
Volume	Pecas por Volume	Peso Líquido	Peso Bruto		Amostra	Volume	Pecas por Volume	Peso Líquido	Peso Bruto		Amostra
1490908	1	5,927	5,927	247718	247718	1490908	1	5,927	5,927	247718	247718
1490909	1	5,927	5,927	247718	247718	1490909	1	5,927	5,927	247718	247718
1490910	1	5,927	5,927	247718	247718	1490910	1	5,927	5,927	247718	247718

Total Gross Weight - Peso Bruto Total = 35.562 MT - Total Net Weight - Peso Líquido Total = 35.562 MT - Packages - Volumes = 6 - Pieces - Pecas = 6

Tensile Test - Ensaio de Tração					Charpy Test - Ensaio de Charpy				
Sample	POS	Dir	YS	TS	Sample	Dir	Temp	KE1	KE2
247718	T	LR	341	524.1	247718	1	-40	36	24
247718	T	LR	341	524.1	247718	1	-40	36	24
247718	T	LR	341	524.1	247718	1	-40	36	24

SM = 100 mm Tensile Unit - Unidade de Tensão - MPa  
 C = PLASTICITY  
 Specimen Location-Pos, Keir. CP = SUPERFICIE

Chemical Composition (% Weight) - Composição Química (% Peso)

Element	C	Mn	P	S	Si	Al	Cu	Mo	Cr	Ni	Nb	V	Ti
Analysis	0,26	1,03	0,015	0,004	0,39	0,021	0,005	0,003	0,243	0,018	0,012	0,002	0,016

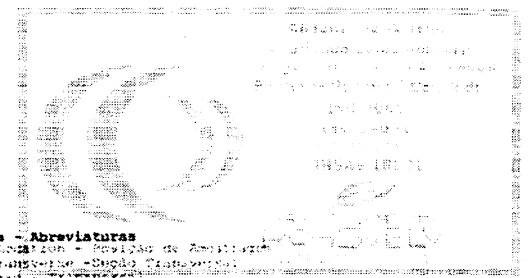
Supply Condition - Condição de Fornecimento

TEMPERATURE - TEMPERATURA

Temp	Dir	Charpy	RT	ST	PT
910	+/ - 10°C	AIR-AR	41	20	61

Abbreviations - Abreviaturas

(\*) Rocker Plate - Volume Anunciado  
 P = Lateral/Fabela  
 Dir = Orientation - Direção  
 Temp = Temperature-Temperatura  
 RT = Heating Time - TA = Tempo Aquecimento  
 Soaking Time-Tempo de Encharque = Minutos-minutos  
 Heat Treatment Temperature-Temperatura Trat. Térmico = °C



P# 35915

Handwritten signature and stamp: 18.09.11, AIR COOLERS QC CERTIFIED

Remarks - Observações

MSDS - Material Safety Data Sheet N° 03 available at Usiminas Extranet  
 FDS - Ficha de Dados de Segurança do Produto número 03, disponível na Extranet da Usiminas

Paulo Loyola de Souza  
 SUPERINTENDÊNCIA DE GARANTIA DA QUALIDADE  
 QUALITY ASSURANCE MANAGEMENT

# SSAB

## Test Certificate

Form TCI: Revision 1: Date 31 Oct 2000

12400 Highway 43 North, Axis, Alabama 36505

<b>Customer:</b> DELTA STEEL L.P. 5599 SAN FELIPE-STE 600 P.O BOX 2289 HOUSTON TX 77252	<b>Customer P.O. No.:</b> DTL-510960	<b>Mill Order No.:</b> 41-272997-02	<b>Shipping Manifest :</b> AR096925
	<b>Product Description:</b> ASME SA516-70/SA516-65/SA516-60(09A) ASTM A516-70/A516-65/A516-60(06) LCVN 15/12 FT.LBS @ -60F/A673-P NORMALIZED		<b>Ship Date:</b> 25 Jul 10 <b>Cert Date:</b> 25 Jul 10
	<b>Size:</b> 0.500 X 96.00 X 480.0 (IN)		<b>Cert No:</b> 081233782 (Page 1 of 1)

Tested Pieces			Tensiles					Charpy Impact Tests												
Heat Id	Piece Id	Piece Dimensions	Tst Loc	YS (PSI)	UTS (PSI)	%RA	Elong % 2in 8in	Tst Dir	Average Hardness	Abs. Energy(FTLB)			% Shear			Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr	
E0F031	A27	0.501 X 96.00 (DISCRT)	L	49000	71000		26	T		80	134	103	105.7							

Heat Id	Chemical Analysis														ORGN	
	C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti		CEV
E0F031	.18	.95	.010	.002	.24	.026	.025	.21	.11	.08	.05	.002	.005	.021	.38	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 23 MINUTES.

E0F031 A27 6180036 PCES: 1, WGT: 6618

E0F031 A27 6180031 PCES: 1, WGT: 6618

E0F031 A27 6180030 PCES: 1, WGT: 6618

*JT*  
2-24-11



AX AIR COOLERS  
QC CERTIFIED

(P) Cust Part # :	WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION	Jason Thomas SENIOR METALLURGIST
-------------------	--	-------------------------------------

3/8 516 10/10

E1B176

# SSAB

## Test Certificate

Form TC1: Revision 1: Date 31 Oct 2000

12400 Highway 43 North, Axis, Alabama 36505

Customer: STEEL SERVICE COMPANY 24412 AMAH PARKWAY  CLAREMORE OK 74019	Customer P.O. No.: 33430	Mill Order No.: 41-295826-01	Shipping Manifest : AR113857
	Product Description: ASTM A516-70(06)/ASME SA516-70(09A) LCVN 15/12 FT.LBS.@-40F/A673-P		Ship Date: 23 Mar 11 Cert Date: 23 Mar 11
	NORMALIZED		Cert No: 081271221 (Page 1 of 1)
Size: 0.375 X 96.00 X 480.0 (IN)			

Tested Pieces			Tensiles					Charpy Impact Tests					BDWTT								
Heat Id	Piece Id	Piece Dimensions	Tst Loc	YS (PSI)	UTS (PSI)	%RA	Elong 2in 8in	Tst Dir	Average Hardness	Abs. Energy(FTLB)			% Shear			Tst Temp	Tst Dir	Tst Siz (mm)	Temp	%Str	
E1B176	D37	0.376 X 96.00 (DISCRT)	C	54000	75000		37	T		92	124	129	115.0					-60F	L	7.5	

Heat Id	Chemical Analysis														ORGN	
	C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Ch	V	Ti		CEV
E1B176	.19	1.12	.011	.005	.19	.027	.025	.25	.14	.10	.04	.001	.006	.016	.43	USA

MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED DURING THE MANUFACTURE OF THIS PRODUCT  
 KILLED STEEL, PRODUCED TO A FINE GRAIN PRACTICE  
 CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15  
 MTR DIN EN10204:2004 TYPE 3.1 COMPLIANT  
 100% MELTED AND MANUFACTURED IN THE USA.  
 CHARPY FULL SIZE EQUIVALENT = ABSORBED ENERGY AVG X 10 / TEST SIZE IN MM  
 NORMALIZED PLATES. HEATED AT 1650F FOR 19 MINUTES.

PRODUCTS SHIPPED:  
 E1B176 D37 6220664 PCS: 1, WGT: 4969      E1B176 D37 6220662 PCS: 1, WGT: 4956  
 E1B176 D37 6220661 PCS: 1, WGT: 4956      E1B176 D37 6220660 PCS: 1, WGT: 4959

(*) Cust Part # :	WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH, AND MEETS THE REQUIREMENTS OF, THE APPROPRIATE SPECIFICATION	Jason Thomas SENIOR METALLURGIST
-------------------	--	-------------------------------------


*[Signature]*  
 10-EX  
 AIR AIR COOLERS  
 QC CERTIFIED

*D# 316678*

SO# 388493 SO LINE# 1  
 Customer PO # 36575 Pc. Count 1  
 Tag # Job #

1/4  
 522170  
 SA 240 304

ACCL 20019

Herstellerwerk / Manufacture's works / Usine productrice  <b>ThyssenKrupp Nirosta</b>	Art der Prüfbescheinigung / Type of inspection document / Type de document <b>ABNAHMEPRUEFZEUGNIS</b> <b>INSPECTION CERTIFICATE</b> <b>CERTIFICAT DE RECEPTION</b> nach / according to / suivant <b>EN 10204-3.1</b>	Bescheinigungs-Nr. / Document Number / Numéro de document <b>1000300469 / 1</b> Seite / Page / Page: <b>1 / 2</b>
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Oberbeschriebenstrasse 16, 47007 Krefeld  <p style="font-size: 2em; font-family: cursive;">1/4" Plate T-304/L</p> <p style="font-size: 2em; font-family: cursive;">HT# 522170</p>	Besteller/Empfänger / Customer/Consignee / Acheteur/Désistataire <b>THYSSENKRUPP NIROSTA, BANNOCKBURN,</b> Kundenbestell-Nr. / Customer's order number / Numéro de la commande du client <b>51002715 - PO L31739</b> Werkstoffbezeichnung / Manufacture's work's order no. / N° de la commande de l'usine productrice <b>900408592 / 004</b> Lieferansatz-Nr. / Delivery Note No. / Avis d'expédition N°. <b>07316104 / 040</b> Erzeugnis / Product / Produit <b>BLECH/SHEET/TOLE</b>
---	--

Lieferbedingungen / Terms of delivery / Conditions de livraison <b>ASTM A 240/A 240M</b> <b>ASME SA 240/SA 240M Sec. II Part A Ed 2010</b> <b>SAE AMS 5511 H</b> <b>ASTM A 888-03</b> <b>SAE AMS 5513 J</b> <b>ASTM A 480/A 480M</b> <b>ASME SA 480/SA 480M Sec. II Part A Ed 2010</b> <b>acc. to PED 97/23/EC</b> <b>NACE STANDARD MR0175 (ONLY ANALYSIS)</b>	Spezifikation und Gütegruppen / Spec. grade and quality / Niveau de fabric <b>TYPE 304 L / 304</b>
---	---


Kundenbestell-Nr. Customer's order number N° de l'ordre du client	Maße des Erzeugnisses ( Dicke / Breite / Länge ) Dimensions ( Thickness / Width / Length ) Mesures du produit ( Epaisseur / Largeur / Longueur ) <b>0.2520 inch x 60.0000 inch x 120.0000 inch</b>	Hersteller Die/making proc. Mode d'élabor.	Ausführung Form Fini
---	---	--	----------------------------

Pos.-Nr. Packung ein- N° Positiv	Anzahl Mo of plates N° de pièces	Wt. Gewicht Actual weight Masse effective	Ident.-Nr. Erzeugnis Ident.-no. of product Ident.-N° du produit	Schmelzenerz. Cast number N° de la coulée	Proben-Nr. Sample No. Echantillon n°	Proben-Nr. Sample No. Echantillon n°
8263971	7	3.532 lbs	228523	522170	1002460150	1002460151
8263972	7	3.532 lbs	228523	522170	1002460150	1002460151
8263975	7	3.554 lbs	228523	522170	1002460150	1002460151
8263979	7	3.527 lbs	228523	522170	1002460150	1002460151
8263985	7	3.532 lbs	228523	522170	1002460150	1002460151
8263990	7	3.527 lbs	228523	522170	1002460150	1002460151
8263997	7	3.527 lbs	228523	522170	1002460150	1002460151
8263999	7	3.532 lbs	228523	522170	1002460150	1002460151
8264001	6	3.025 lbs	228523	522170	1002460150	1002460151
8264005	6	3.029 lbs	228523	522170	1002460150	1002460151
		<b>38</b>	<b>34.317 lbs</b>			

Chemische Zusammensetzung / Chemical composition / Composition chimique	% C	% Si	% Mn	% P	% S	% Cr	% Ni	% N	% Cu	% Mo
522170	0.022	0.31	1.25	0.028	0.0030	18.19	8.09	0.063	0.32	0.30

Probenbezeichnung bei Lot oder Certificate Probennr. / Sample Bezeichnung / Designation Ident.-Anzahl der Eigenschaften	YB0, 2%	YB1, 0	TS	R1, A2	NRB					
1002460150	50906	56833	90645	55.8	87.0					
1002460151	50761	56998	91370	55.3	89.0					

Bestandig gegen intermit. Korrosion / Résistant à l'intermit. cor. / Résistant à la cor. / Intermittent  
 Maße-Obertoleranz / Dimensiones-Surface / Dimensiones-Surface: I.O.  
 Unverschleißprüfung (Bestandigkeit) / Test of identity (durability) / Contrôle d'identité (analyse spectre): I.O.  
**WAERMEBEHANDLUNG 1050 GRAD C / LUFT**

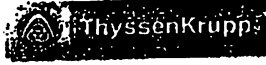

Aussteller der Bescheinigung / Originator of the document / Auteur du document <b>ThyssenKrupp Nirosta GmbH</b> Dieses Zeugnis wurde maschinell erstellt Werk Krefeld  Abnahme	Butzen Abnahmebeauftragter Inspector / Expun Tel. 02151-832447 Fax: 02151-834108	Stempel des (der) Abnahmebeauftragten Resealing agent's stamp Tampon de l'agent désigné   Datum der Ausstellung und Bestätigung Date of issue and validation date d'émission et validation <b>20.05.2011</b>
--	--	--

Handwritten signature and stamp  
 ANLAIR COILERS  
 QC CERTIFIED

P# 20.5.11

SO# 388493 SO LINE# 1  
 Customer PO # 36575 Pc. Count 1  
 Tag # Job #

ACCL 001.50

<p>Herstellerwerk / Manufacture's works / Usine productrice</p>  <p><b>ThyssenKrupp Nirosta</b></p>	<p>Art der Prüfbescheinigung / Type of inspection document / Type de document</p> <p><b>ABNAHMEPRUEFZEUGNIS</b>  <b>INSPECTION CERTIFICATE</b>  <b>CERTIFICAT DE RECEPTION</b>      nach / according to / suivant  <b>EN 10204-3.1</b></p>	<p>Bescheinigungs- / Document number / Numéro de document  <b>20.05.2011</b>  <b>1000300469 / 1</b></p> <p>Seite / Page / Page:  <b>2 / 2</b></p>
<p>TRAITEMENT THERMIQUE : 1050 GRAD C / AIR          HEAT - TREATMENT : 1050 DEGREE / AIR          NO WELD REPAIR          Frei von Quecksilber / free of mercury          ASTM A 262 PRACTICE E 10.          No Ni of Cuban Origin, RoHS - Compliant          "DFARS compliant"</p>		
<p>Aussteller der Bescheinigung / Originator of the document / Auteur du document</p> <p><b>ThyssenKrupp Nirosta GmbH</b>          Dieses Zeugnis wurde          maschinell erstellt          Werk Krefeld          Abnahme</p>	<p>Butzen</p> <p>Abnahmebeauftragter          Inspector / Expert          Tel: 02161-832447          Fax: 02161-834188</p>	<p>Stempel des (der) Abnahmebeauftragten          Receiving agent's stamp          Poliveau de l'agent réceptionnaire</p>  <p>Datum der Ausstellung und Bestätigung          Date of issue and validation          Date d'émission et validation</p> <p><b>20.05.2011</b></p>



air-coolers

# MATERIAL TRACEABILITY RECORD

JOB NO. 118454

PIPES  PLATES  TUBES  BY KS/FP/JM DATE 3/6/12 CUSTOMER

MIL. P.O. NO. SECTION NO.	MATERIAL DESCRIPTION	HEAT OR CERTIFICATION NO.
PRODUCED GAS SECT. P.O.# 30142 89 TUBES	1. 5/8 x .065 X 6' L9	202574
	2. SA-179	
	3.	
	1.	
	2.	
	3.	
	1.	
	2.	
	3.	
	1.	
	2.	
	3.	
	1.	
	2.	
	3.	

NOTE: ALL MATERIAL OF SAME DESCRIPTION IN A SECTION MUST BE OF SAME HEAT NO.

**AXH air-coolers • 401 E Lowery Road • Claremore, OK 74017 • (918) 283-9200**



RW 3-7-12




Benteler Steel/Tube GmbH  
 Postfach 13 40  
 33043 Paderborn  
 Deutschland  
 Tel.: +49.5254.81-0 Fax: +49.5254.13666

**BENTELER**   
 Steel/Tube

**ABNAHMEPRÜFZEUGNIS EN 10204-3.1**  
**INSPECTION CERTIFICATE EN 10204-3.1**  
**CERTIFICAT DE RECEPTION EN 10204-3.1**  
 EN 10204:2005-01

Dokument-Nr.: 41-628522/001/P  
 Document No.:  
 No. du document:  
 Kunden-Bestell-Nr.: BST 10-9955 / Tubes Inc. T-43144-20  
 Purchase Order No.:  
 No. de commande du client:  
 Benteler Auftrags-Nr.: 1560219  
 Benteler Order No.:  
 No. de commande Benteler:  
 Versandanzeigen-Nr.: 4150819  
 Dispatch Note No.:  
 No. d'avis d'expédition:  
 Produkt: NAHTLOSE STAHLROHRE  
 Product: SEAMLESS STEEL TUBES  
 Produit: TUBES D'ACIER SANS SOUDURE

Prüf-Nr.:  
 Inspection No.:  
 No. du certificat:  
 Hersteller: Warmrohrwerk/Zieherei  
 Manufacturer: ISO/TS 16949 (ISO 9001) TÜV CERT 44111090381-002  
 Producteur: PED 97/23/EC TÜV CERT 07-202-6635 WZ-0606/0H  
 Herstellerzeichen:   
 Manufacturer's brand:  
 Marque du producteur:  
 Stempel des Abnahmebeauftragten: WA  
 Stamp of the inspection representative:  
 Poinçon du contrôleur:  
 Stahlschmelzungsverfahren: ELEKTROSTAHL  
 Steelmaking process: ELECTRIC FURNACE  
 Procédé d'élaboration de l'acier: FOUR ELECTRIQUE

Blatt: 1 / 4  
 Page:  
 Page:

Benteler Steel/Tube GmbH - Postfach 1340 - 33043 Paderborn - Deutschland

Tubes Inc.  
 900 E. Pecan  
 SAND SPRINGS OK 74063  
 USA



Rw 5.10.11

Lieferbedingungen: ASTM-A 179-1990a, ASME SA-179, ASME Section II Part A Edition 2010

Terms of delivery:

Conditions de livraison:

Maße - Toleranzen: ASME SA-450-CFS, ASME Section II Part A Edition 2010, ASTM-A 450-2007-CD

Dimensions-tolerances:

Dimensions-tolérances:

Stahlsorte: A 179, SA 179

Steel grade:

Nuance d'acier:

Lieferzustand: Normalized

Delivery condition:

État de livraison:

Produktkennzeichnung: FSD: BENTELER A179-SA179 HEAT-NO. DIMENSIONS MADE IN GERMANY WEEK/YEAR WA A 179/SA 179

Product marking:

BST 10-9955 / Tubes Inc. T-43144-20

Marquage du produit:

AEZ = Ätztintenbeschriftung, Etching ink marking, Gravure à l'encre | FK = Farbkennzeichnung, colour marking, marquage par couleur | FS = Farbschablonierung, paint stencilling, marquage par peinture | FSD = Farbschablonierung, Colour jet printer, Imprimante à jet d'encre de c |  
 |LK = Laserkennzeichnung, Laser marking, Marquage laser | PKE = Etikettenkennzeichnung, tag marking, marquage sur étiquette | PS = Prägestempel, die stamp, marquage par poinçonnage | TS = Tintenstahlkennzeichnung, Ink jet spray marking, imprimante à jet d'encre

Pos.	Stück	Maße	Länge	Gewicht	Schmelzen-Nr.	Prüfdruck	Rohr-Nr.-Gruppe	Vielfachlängen
Item	Number	Dimensions	Length	Weight	Heat No.	Test pressure	Tube number group	Multiple lengths
Poste	Nombre	Dimensions	Longueur	Poids	No. de coulée	Pression d'épreuve	Série de no. des tubes	Longueurs multiples
			feet	lbs				
0001	1675	0.625" O.D. * 0.065" MW	48 FT 1 "	80539,57	33292	202574		
0002	1918	0.750" O.D. * 0.065" MW	36 FT 1 "	69207,91	35095	202922		

TUBES, INC.  
 1-888-537-8880  
 THESE MILL TEST REPORTS APPLY TO:  
 YOUR P.O. NO. 30142  
 JOB NUMBER 30142-STOCK

**ABNAHMEPRÜFZEUGNIS EN 10204-3.1**  
**INSPECTION CERTIFICATE EN 10204-3.1**  
**CERTIFICAT DE RECEPTION EN 10204-3.1**

Dokument-Nr.: 41-628522/001/P  
 Document No.:  
 No. du document:

Prüf-Nr.:  
 Inspection No.:  
 No. du certificat:

Blatt: 2 / 4  
 Page:  
 Page:

Schmelzenanalyse [%] / Heat analysis [%] / Analyse sur coulée [%]

Pos. Item	Schmelzen-Nr. Heat No.	C	SI	MN	P	S
Poste	No. de coulée					
0001	202574	0,100	0,158	0,47	0,008	0,003
0002	202922	0,100	0,195	0,47	0,012	0,004

Prüfergebnisse / Test results / Résultats des essais

Die Rohre sind auf Dichtheit geprüft durch: The tubes have been submitted to a leak tightness test by: Les tubes ont passé un contrôle d'étanchéité par:	Hydrostatic test: eddy current testing instead of hydrostatic test	PASSED
Die Rohre wurden zerstörungsfrei geprüft: The tubes are non destructive tested: Les tubes ont passé un essai non destructif:	ET-test: acc. to ASME SA-450, ASTM-A 450; acc. to ASTM-E 309; for imperfections	PASSED
Augensichtkontrolle: Visual inspection: Examen visuel:	PASSED	PASSED
Aufweitversuch: Drift expanding/flare test: Essai d'évasement:	PASSED	PASSED
Maßkontrolle: Dimensions examination: Vérification des dimensions:	PASSED	PASSED
Ringfaltversuch: Flattening test: Essai d'aplatissement:	PASSED	

Ergebnisse der mechanischen Prüfung / Results of mechanical testing / Résultats des essais mécaniques

Die Probennahme erfolgte an Vielfachlängen.  
 The sampling was carried out on multiple lengths.  
 L'échantillonnage était réalisé aux longueurs multiples.

**ABNAHMEPRÜFZEUGNIS EN 10204-3.1**  
 INSPECTION CERTIFICATE EN 10204-3.1  
 CERTIFICAT DE RECEPTION EN 10204-3.1

Dokument-Nr.: 41-628522/001/P  
 Document No.:  
 No. du document:

Prüf-Nr.:  
 Inspection No.:  
 No. du certificat:

Blatt: 3 / 4  
 Page:  
 Page:

Härteprüfung / Hardness test / Essai de dureté

Pos. Item Poste	Proben-Nr. Specimen No. No. de l'éprouv.	Schmelzen-Nr. Heat No. No. de coulée	Härte Hardness Dureté	HRC	HB	HV	HRB	HBW
Anforderungen Requirements Exigences							MAX 72	
0001	000001	202574					067 /	
0001	000002	202574					067 /	
0001	000003	202574					067 /	
0001	000004	202574					067 /	
0001	000005	202574					067 /	
0001	000006	202574					067 /	
0001	000007	202574					067 /	
0001	000008	202574					067 /	
0001	000009	202574					067 /	
0001	000010	202574					067 /	
0001	000011	202574					067 /	
0001	000012	202574					067 /	
0001	000013	202574					067 /	
0001	000014	202574					067 /	
0002	000001	202922					067 /	
0002	000002	202922					066 /	
0002	000003	202922					067 /	
0002	000004	202922					066 /	
0002	000005	202922					067 /	
0002	000006	202922					066 /	
0002	000007	202922					068 /	
0002	000008	202922					067 /	
0002	000009	202922					067 /	

Benteler Steel/Tube GmbH  
 Postfach 13 40  
 33043 Paderborn  
 Deutschland  
 Tel.: +49.5254.81-0 Fax: +49.5254.13666

**BENTELER**   
 Steel/Tube

**ABNAHMEPRÜFZEUGNIS EN 10204-3.1**  
**INSPECTION CERTIFICATE EN 10204-3.1**  
**CERTIFICAT DE RECEPTION EN 10204-3.1**

Dokument-Nr.: 41-628522/001/P  
 Document No.:  
 No. du document:

Prüf-Nr.:  
 Inspection No.:  
 No. du certificat:

Blatt: 4 / 4  
 Page:  
 Page:

Härteprüfung / Hardness test / Essai de dureté

Pos. Item Poste	Proben-Nr. Specimen No. No. de l'éprouv.	Schmelzen-Nr. Heat No. No. de coulée	Härte Hardness Dureté	HRC	HB	HV	HRB	HBW
Anforderungen Requirements Exigences							MAX 72	
0002	000010	202922					068 /	
0002	000011	202922					067 /	
0002	000012	202922					066 /	
0002	000013	202922					068 /	
0002	000014	202922					067 /	
0002	000015	202922					067 /	
0002	000016	202922					068 /	
0002	000017	202922					067 /	
0002	000018	202922					067 /	

Vermerk / Remark / Remarque

Certificate remarks: fully killed fine grained steel, Country of origin of the material and heat: Germany

Verkäufer(in) / Salesman/ woman in charge / Personne chargée : Mr Höke, Tel.: 05254/81-4263, Fax: 4269

Paderborn Schloß Neuhaus, 21.02.2011, TEL.: 05254.81-1767 FAX: 05254.81-1752

Abnahmebeauftragter  
 Inspection representative  
 Contrôleur  
**THOMAS GOLLAN / TEM**

Es wird bestätigt, daß die gelieferten Erzeugnisse den techn. Lieferbedingungen des Auftrages entsprechen. Dieses Dokument wurde mittels EDV erstellt und ist ohne Unterschrift rechtsgültig.  
 We certify that the supplied products comply with the order specification. This document was prepared by means of electronic data processing and is valid without signature.  
 Nous attestons que les produits livrés sont conformes aux stipulations de la commande. Ce document a été établi par traitement électronique de l'information et est valide sans signature.

**Customer Information**

Your PO#: 500594

Part #: 118454.1

Description :PROD GAS FR HEADER

# Thermal Specialties Heat Treating Certification

**Thermal Specialties. Information**

Date Processed: 03/04/2012

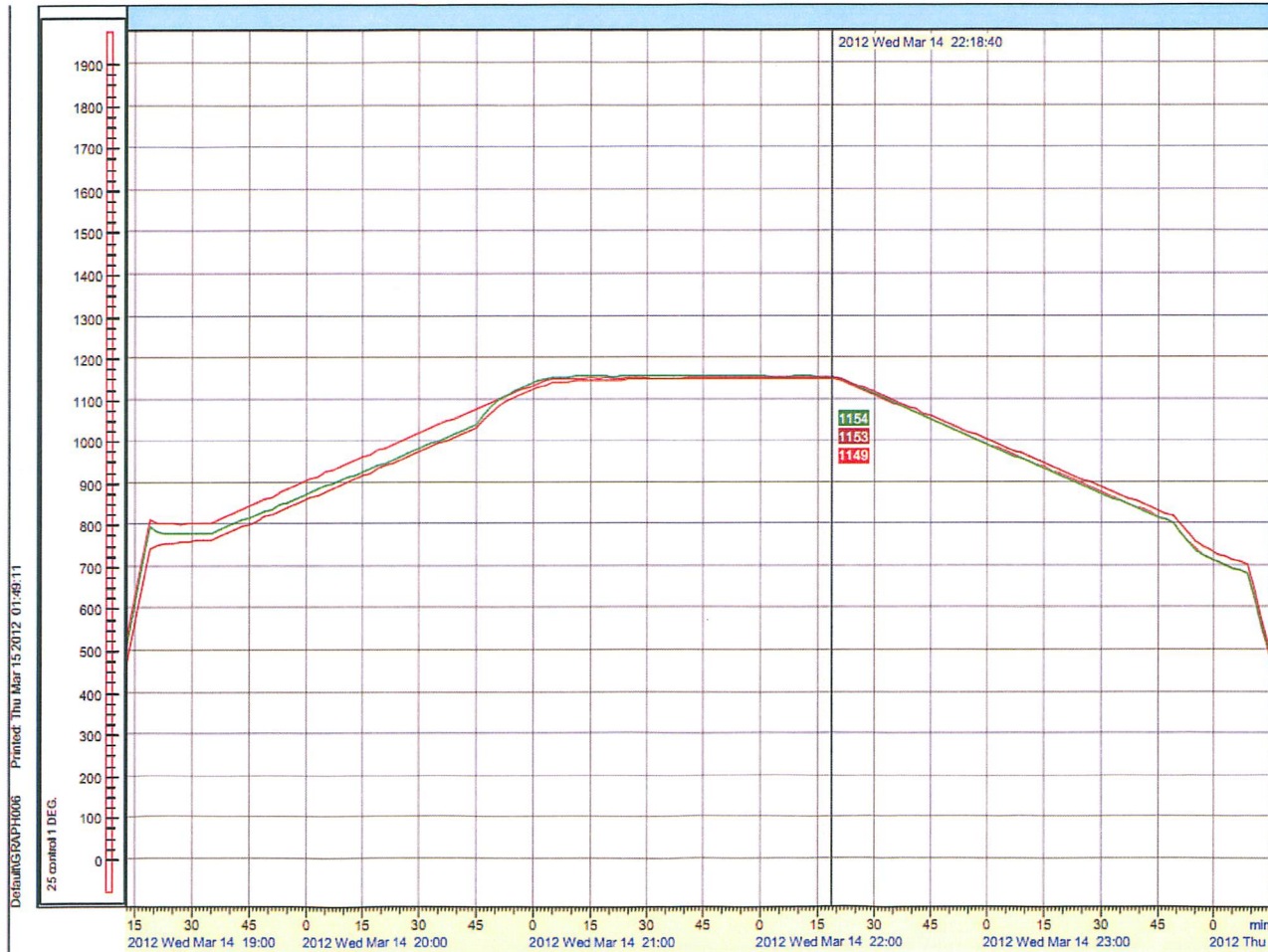
TSHTSO#: 174669

Furnace#: 25

Calibration Date: 02/22/2012

Thermocouple Type K

Approved by:     JL    



*Handwritten:* VJ  
3-15-12



Thermal Specialties certifies that the item has been processed in accordance with customer's requirements. Processes were obtained through standard approved methods and in accordance with Thermal Specialties quality assurance manual



1030 N. Iriquois Ave.  
Tulsa, OK 74106  
918-585-8200

# Bill of Lading

(PWHT Chart On Reverse Page)

Sold To:		Ship To:	
Customer Name	AXH AIR-COOLERS	Customer Name	AXH AIR-COOLERS
Bill to Address	401 E. LOWRY RD.	Ship to Address	401 E. LOWRY RD.
City, ST, Zip	CLAREMORE,OK 74017	City, ST, Zip	CLAREMORE,OK 74017
Telephone	918-283-9200	Telephone	918-283-9200
Contact:	JEFF STEELE	Contact:	JEFF STEELE
E-Mail		E-Mail	

Customer PO No.	N/A	Ship Date	03/13/2012
Customer Job No.	MULTI	Ship Time	08:00
Bill of Lading No.	N/A	Ship Method	ZENTECH

Part Quantity		Part Name	Weight
1	118454.1 PROD GAS BK	HEADER	N/A

Part Description
PWHT OF (1) HEADER

*JD*  
*3-13-12*

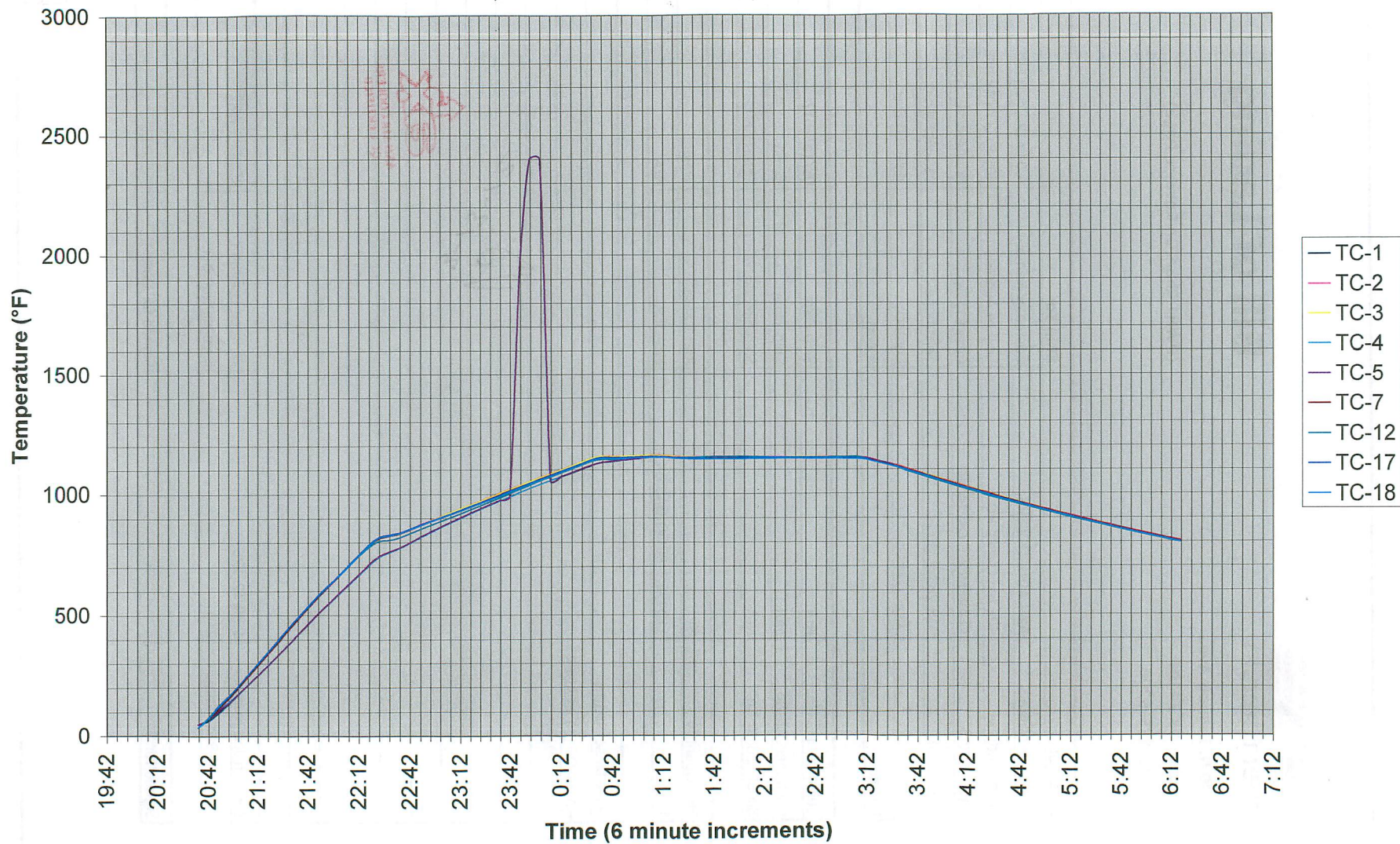
Zentech Job Number	1-30-12-126	Zentech Operator	ROBERT AGEE
Experian Seq. Num.	210	Furnace Number	4

Signed for By		Signed for Date	
---------------	--	-----------------	--

WISco  
W O R  
Initials: *JP*  
Date: *3-14-12*  
117



### Zentech Thermal Processing Furnace No. 4



Calibration Date: 7/1/2011  
Calibration Due: 7/1/2012

Signed By: ROBERT AGEE

WISco  
WR  
Initials: RP  
Date: 3-14-12  
117

CUSTOMER: AXH IRISNDT#: 135618 DATE: 2-29-12  
 LOCATION: Claremore JOB#: 118454.1 P.O.#: \_\_\_\_\_ PART#: \_\_\_\_\_  
 MATERIAL: 95 CODE: ASme ORIG. FILM  REPAIR FILM \_\_\_\_\_

**TESTING VARIABLES**

Ir<sub>192</sub>  Co<sub>60</sub>  X-Ray : Ci 43 kv \_\_\_\_\_ mA \_\_\_\_\_ EFSS: .149  
 PROCESSING: MANUAL  AUTOMATIC  SINGLE FILM  COMPOSITE FILM   
 EXPOSURE: DWE/SWV  DWE/DWV  SWE/SWV   
 FILM: TYPE F-80 CLASS 1 SENSITIVITY 2-2+  
 FILM USAGE: 3½ x 8½  3½ x 10 \_\_\_\_\_ 3½ x 17 \_\_\_\_\_ 4½ x 10 \_\_\_\_\_ 4½ x 17 \_\_\_\_\_ 14 x 17 \_\_\_\_\_  
 7 x 8½ \_\_\_\_\_ 7 x 17 \_\_\_\_\_ 8 x 10 \_\_\_\_\_ 70mm \_\_\_\_\_ Other \_\_\_\_\_

FILM I.D.	INTERVAL	I.Q.I.	SHIM	MAT'L THK	SOD Inches	O.F.D. Inches	DENSITY	IRISNDT Proc.	DIA.	DISCONTINUITIES	ACCEPT	REJECT
1	N1 T-2	17F	1/8	.438	3/8	.438	2.1	RE3	3"		✓	
2	2-3										✓	
3	3-4										✓	
4	4-5										✓	
5	N2 T-2										✓	
6	2-3										✓	
7	3-4										✓	
8	4-5										✓	
9												
10												
11												
12												
13												
14												
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16												
17												
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19												
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21												
22												
23												
24												
25												
26												
27												
28												
29												
30												

*Revised OK  
Jul 3-8-12*

**IRISNDT Procedure:**

RT 1, 2, 2A, 6, 7 - Single Wall Exposure  
 RT 3, 3A, 4, 5, 8, - Double Wall Exposure  
 S.O.D. = Source-to-object distance  
 O.F.D. = Object-to-film distance  
 S.O.D. + O.F.D. = S.F.D

**TERMS AND ABBREVIATIONS**

AB - Arc Burns      EUC - External Undercut      IC - Internal Concavity      P - Porosity  
 BT - Burn Through      IUC - Internal Undercut      LF - Lack of Fusion      S - Slag  
 CK - Crack      HB - Hollow Bead      LC - Low Cover      RS - Round Seam  
 EP - Excessive Penetration      IP - Incomplete Penetration      MA - Misalignment      LS - Long Seam  
 IQI - Image Quality Indicator (Penetrameter)

Unit # \_\_\_\_\_ Miles: \_\_\_\_\_  
 In \_\_\_\_\_ Out \_\_\_\_\_ Hrs. \_\_\_\_\_  
 In \_\_\_\_\_ Out \_\_\_\_\_ Hrs. \_\_\_\_\_  
 Personnel: J. W. [Signature]      Interpretation by: \_\_\_\_\_  
 \_\_\_\_\_      \_\_\_\_\_      ASNT      \_\_\_\_\_  
 \_\_\_\_\_      \_\_\_\_\_      SNT-TC-1A      \_\_\_\_\_  
 \_\_\_\_\_      \_\_\_\_\_      (Print)      \_\_\_\_\_  
 \_\_\_\_\_      \_\_\_\_\_      (Signature)      \_\_\_\_\_      CERT. # \_\_\_\_\_  
 Client Representative: \_\_\_\_\_      \_\_\_\_\_      (Stamp)





# Ultrasonic Inspection Report

JOB # 118454.1 FR Page 1 of 1  
 PO # \_\_\_\_\_ Date 03/14/12

Client: AXH Air Coolers Item Inspected: Box Header Seams IRISNDT# 135945  
 Location: Claremore, OK Nozzle Attachments  
 Code: ASME Sec. V ART. 4  
ASME VIII DIV I APP. 12 Heat Treatment: B.P.W.H.T.

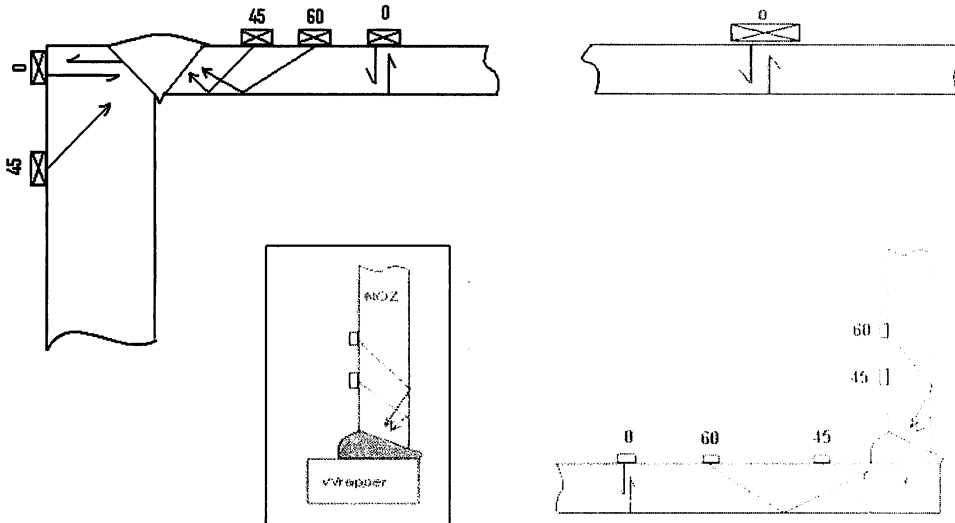
Procedure: 4.0 U.T. Surface Condition: As Welded Material: c/s  
 UT Equipment: EPOCH XT IRISNDT# 101371412 Cal Date: 2/1/2012

Calibration Block: <u>IIW</u>	Probes:	Angle:(degrees)	<u>0</u>	<u>60</u>	<u>45</u>	<u>60</u>		
Test Piece: <u>ASME 3/4" Basic</u>		Frequency:(mhz)	<u>5</u>	<u>2.25</u>	<u>5</u>	<u>5</u>		
Distance/Amp Cal: <u>2/4 to 6/4T</u>		Crystal Size:(inches)	<u>1/2"</u>	<u>1/2"</u>	<u>1/4"</u>	<u>1/4"</u>		

Transfer Loss Cal: Direct Comparison Scan Gain: +6dB Couplant: UT-X Batch # IRIS  
 Ref. Flaw Size: 3/32" SDH Primary Reference Level: 80% FSH  
 Scan Method: Contact TOF Lamination: X Thickness: X Shear Wave: X

**Scope: UT Inspection Performed On All Accessible Areas Of Box Header Weldments**  
 Long Seams, End Blocks, And Nozzle Attachment Welds

**Results: 118454.1 FR - Accept**



UT Revealed No Rejectable Indications  
 All Welds Are Acceptable Per Code

*REVIEW ONLY*

WISco
W <input type="checkbox"/> R <input checked="" type="checkbox"/>
Initials: <u>MR</u>
Date: <u>3-28-12</u>
117

Unit: <u>455</u>	Miles:	Hrs.:	Consumables:	Technician: <u>Mark Rake</u> (print)
In:	Out:			Technician: <u>Mark Rake</u> (sign)
In:	Out:			SNT-TC -1A Level: <u>II</u> cert# <u>522</u>
				I am in full agreement with report contents:
				Client Representative: <u>103-14-12</u>

Tulsa, Oklahoma  
 1115 West 41st Street  
 Phone: 918-446-8773 Fax: 918-446-8777



Report # 118454.1 Page 1 of 1  
 Day Wed Date 03/07/12

Client: AXH Coolers Code: ASME Sec. V ART. 5 Cable: BCB-74-6' / BCM-74-6'  
 Location: Claremore Ok. ASME Sec.VIII DIV. I APP. 12 Search/Unit: K/B-012X70  
 AFE:# 118454.1 Search/Unit: K/B-008XRV  
 IRIS NDT # \_\_\_\_\_ Heat Treatment: AS WELDED Search/Unit: K/B-010N51

Procedure: 4.0 U.T. Surface Condition: Good Material: C/S  
 UT Equipment: USM GO IRISNDT#: #09120535 Cal Date: 1/1/2012  
 Calibration Block: V-2, IIW Probes: Angle:(degrees) 

0	45	60
---	----	----

  
 Test Piece: 3/4"ASME Frequency:(mhz) 

5	5	5
---	---	---

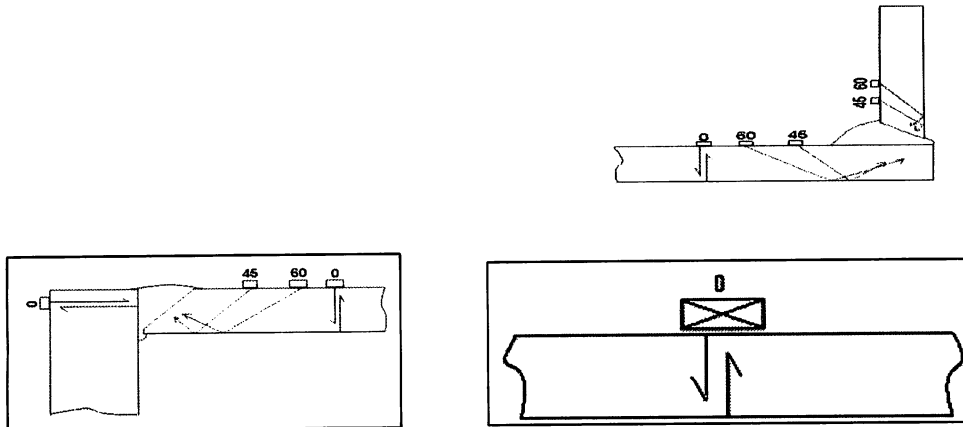
  
 Distance/Amp Cal: 2/4 to 4/4T Crystal Size:(inches) 

0.500"	0.250"	0.250"
--------	--------	--------

  
 Transfer Loss Cal: Direct Comparison Scan Gain: +6db Couplant: UT-X Batch #: IRIS  
 Ref. Flaw Size: 3/32", SDH Primary Reference Level: 80% FSH  
 Scan Method: Contact TOF Lamination: X Thickness: X Shear Wave: X

**Scope: U.T. inspection of all Seam and Attachment weldment.**

118454.1 BK ACCEPT



*REVIEW ONLY*  
 WISCO  
 WORK  
 Initials: *PC*  
 Date: *3-14-12*  
 117

U.T. inspection of accessible weldment revealed no relevant indications.  
 U.T. inspection is acceptable per above reference code.

Unit	Miles:	Hrs.	Consumables	Technician:	<i>Mike Carman</i> (print)
In.	Out:			Technician:	(sign)
In:	Out:			SNT-TC -1A Level:	II
Mike Carman				I am in full agreement with report contents: Client Representative: <i>3-7-12</i>	

Tulsa, Oklahoma  
 1115 West 41st Street  
 Phone: 918-446-8773 Fax: 918-446-8777





REPORT OF NONDESTRUCTIVE TESTING  
MAGNETIC PARTICLE EXAMINATION RECORD

REFERENCE STANDARD: ASME SECT.V, ASME SECT. VIII DIV.1, APPENDIX 6  
AXH AIR-COOLERS STANDARD MS-20.0 REVISION: 0

EXAMINATION EQUIPMENT & METHOD

MAGNETIZING EQUIPMENT: Parker Research Contour Probe SERIAL #: 3563

CURRENT TYPE:  AC  DC

MT TYPE:  WET  DRY  FLOURESCENT  VISIBLE

LIGHTING EQUIPMENT:  FLOURESCENT LIGHT  
 WHITE LIGHT USING PARKER RESEARCH Y300 OR Y400 PROBE LIGHTING  
 FLASHLIGHT  # OF BATTERIES \_\_\_\_\_ TYPE: \_\_\_\_\_ CELL \_\_\_\_\_  
 MAXIMUM DISTANCE FROM OBJECT: \_\_\_\_\_ FEET \_\_\_\_\_  
 OTHER \_\_\_\_\_

MINIMUM LIGHT INTENSITY ON SURFACE TO BE EXAMINED: 100 FOOT CANDLES

EXAMINATION RESULTS

IDENTIFICATION:

CUSTOMER: MURPHY OIL CORP. DATE: 3-13-12

JOB #: 118454 ITEM #: 01FR/BK (EXAMPLE: .1, .2, .3)

MATERIAL TYPE: SA516-70N MATERIAL THICKNESS: \_\_\_\_\_

EXAMINATION PERFORMED:

- PLATE EDGES - BEFORE WELDING (ALL TUBE AND PLUG SHEETS WHICH HAVE BEEN BEVELED / MACHINED FOR WELD JOINT PREPARATION), AND AFTER WELDING (PERIPHERAL EDGE OF TUBE AND PLUG SHEETS) PER ASME SECTION VIII, DIV. 1, UG-93 BEFORE 2-29-12 AFTER 3-13-12
- ALL WELDED SEAMS WHERE ACCESSIBLE
- ALL FINAL WELD SEAMS, NOZZLES, & COUPLINGS WHERE ACCESSIBLE
- ALL NOZZLE & COUPLING ROOT PASSES WHERE ACCESSIBLE
- OTHER \_\_\_\_\_

EXAMINATION RESULTS:

ACCEPT  REJECT

DESCRIPTION AND/OR MAP OF INDICATIONS FOUND

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Smith  
EXAMINER

II  
QUALIFICATION LEVEL



*Review only*

WISCO
W <input type="checkbox"/> R <input checked="" type="checkbox"/>
Initials: <u>LP</u>
Date: <u>3-28-12</u>
117



REPORT OF NONDESTRUCTIVE TESTING  
LIQUID PENETRANT EXAMINATION RECORD

REFERENCE STANDARD: ASME SECT.V, ASME SECT. VIII DIV.1, APPENDIX 8  
AXH AIR-COOLERS STANDARD MS-21.0 REVISION: 0

EXAMINATION EQUIPMENT & METHOD

LIQUID PENETRANT TYPE: DUBL CHECK DP-50 OTHER: Chemetall Oakite/Ardrox 906

CLEANER / REMOVER: DUBL CHECK DR-60 OTHER: Chemetall Oakite/Ardrox 9PR50

DEVELOPER: DUBL CHECK D-100 OTHER: Chemetall Oakite/Ardrox 9D1B

LIGHTING EQUIPMENT:  FLOURESCENT LIGHT  
 FLASHLIGHT  # OF BATTERIES TYPE: CELL  
MAXIMUM DISTANCE FROM OBJECT: FEET  
 OTHER

MINIMUM LIGHT INTENSITY ON SURFACE TO BE EXAMINED: 100 FOOT CANDLES

EXAMINATION RESULTS

IDENTIFICATION:

CUSTOMER: MURPHY OIL CORP DATE: 3-7-12

JOB #: 118454 ITEM #: .1 FR/BK (EXAMPLE: .1, .2, .3)

MATERIAL TYPE: SAS16-70N MATERIAL THICKNESS:           

EXAMINATION PERFORMED:

- PLATE EDGES - BEFORE WELDING (ALL TUBE AND PLUG SHEETS WHICH HAVE BEEN BEVELED / MACHINED FOR WELD JOINT PREPARATION), AND AFTER WELDING (PERIPHERAL EDGE OF TUBE AND PLUG SHEETS) PER ASME SECTION VIII, DIV. 1, UG-93 BEFORE 3-7-12 AFTER
- ALL WELDED SEAMS WHERE ACCESSIBLE
- ALL FINAL WELD SEAMS, NOZZLES, & COUPLINGS WHERE ACCESSIBLE
- ALL NOZZLE & COUPLING ROOT PASSES WHERE ACCESSIBLE
- ALL NOZZLE AND COUPLING HOLE OPENINGS FOR LAMINATION
- OTHER

EXAMINATION RESULTS:

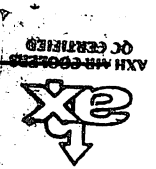
ACCEPT  REJECT

DESCRIPTION AND/OR MAP OF INDICATIONS FOUND  
            
          

*V Smith*  
EXAMINER

*II*  
QUALIFICATION LEVEL

*Review only*  
WISco  
WORK  
Initials: *PP*  
Date: *3-28-12*  
117





AXH air-coolers

### CERTIFICATE OF CALIBRATION

DATE OF CALIBRATION: 12/9/2011 IN VERTICAL POSITION, TEMPERATURE: 78 DEG.F

THE GAUGES AND/OR INSTRUMENTS LISTED HAVE BEEN TESTED AGAINST  
PRESSURE STANDARDS: AMETEX MODEL T-3  
SERIAL NO. 99260 COMPARATOR PRESSURE TESTER

GAUGE NO: # 26	RANGE: 0-600
PRESSURE	
APPLIED	INDICATED
150 LB	150 LB
300 LB	300 LB
450 LB	450 LB
600 LB	600 LB

GAUGE NO: # 24	RANGE: 0-600
PRESSURE	
APPLIED	INDICATED
150 LB	150 LB
300 LB	300 LB
450 LB	450 LB
600 LB	600 LB

GAUGE NO:	RANGE:
PRESSURE	
APPLIED	INDICATED

GAUGE NO:	RANGE:
PRESSURE	
APPLIED	INDICATED

GAUGE NO:	RANGE:
PRESSURE	
APPLIED	INDICATED

GAUGE NO:	RANGE:
PRESSURE	
APPLIED	INDICATED

NUMBER OF GAUGES LISTED ABOVE WITH SERIAL NO. AND RANGE: 2

TECHNICIAN: RW

DATE: 12/9/2011

RECALIBRATION DUE DATE: 12/9/2012



**HYDROSTATIC TEST REPORT**

MANUFACTURED FOR MURPHY OIL CORPORATION

AXH JOB NUMBER 118454

VESSEL TESTED 118454.1 PROD GAS

TEST PRESSURE 232 PSI

HYDRO TEST HELD FOR 1 HR.

**THIS REPORT IS TO CERTIFY THAT THE AFOREMENTIONED  
VESSEL (OR) VESSELS WERE HYDROSTATIC TESTED IN  
ACCORDANCE WITH ASME SECTION VIII DIV 1.**

CUSTOMER WITNESS \_\_\_\_\_

DATE 3.20.2012 BY Renee Weeks  
QUALITY CONTROL DEPARTMENT

*Review ONLY*

WISCO
W <input type="checkbox"/> R <input checked="" type="checkbox"/>
Initials: <u>JCP</u>
Date: <u>3-28-12</u>
117



401 E. LOWRY ROAD  
CLAREMORE, OKLAHOMA 74017

# HARDNESS TESTING INSPECTION REPORT

PROCEDURE: AXH MS-29.0  
 CODE SPECIFICATION: \_\_\_\_\_  
 ACCEPT. CRITERIA: \_\_\_\_\_  
 JOB NO.: 118454.1 PROD GAS HEADERS  
 DATE: 3-13-12

MATERIAL TYPE: SA516-70N SURFACE CONDITION: GROUND  
 HEAT TREATMENT: \_\_\_\_\_

EQUIPMENT: KRAUTKRAMER MIC-10 CALIBRATION DATE: 3-13-12

CALIBRATION BLOCKS: \_\_\_\_\_

HARDNESS SCALE READING: ROCKWELL B \_\_\_\_\_ VICKERS \_\_\_\_\_  
 ROCKWELL C \_\_\_\_\_ BRINELL

ITEM	COMPONENT IDENTIFICATION AND LOCATION OF READING	BRINELL IMPRESSION		BRINELL BAR HARDNESS	HARDNESS VALUE	ACCEPT	REJECT
		BAR	MATERIAL				
FRT	LS1	WELD			188		
		HAZ			179		
	ES1	W			187		
		H			175		
	N1	W			187		
		H			176		
	N2	W			186		
		H			177		
BK	LS1	W			189		
		H			180		
	ES1	W			188		
		H			177		

TECHNICIAN: V Smith 3-15-12  
 (PRINT) (DATE)

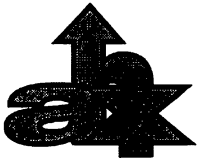
V Smith  
 (SIGNATURE)



REUSE ONLY  
 WISCO  
 W O R T  
 Initials: VP  
 Date: 3-28-12  
 117

I am in full agreement with report contents.  
 CLIENT REPRESENTATIVE: \_\_\_\_\_

(SIGNATURE)



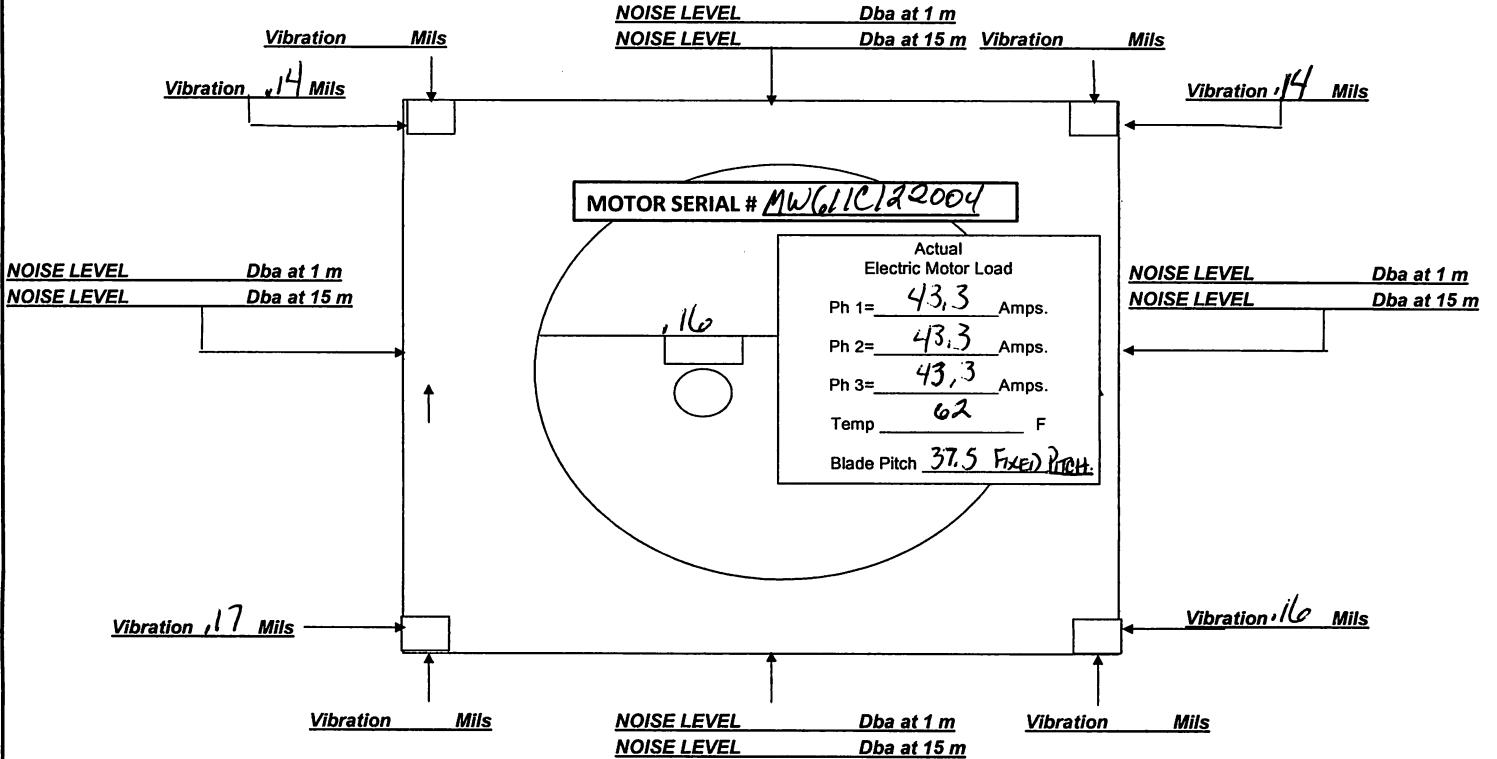
# AXH air-coolers

401 East Lowery Rd. - Claremore, Ok. 74017  
918-283-9200 - fax: 918-283-9229  
www.axh.com

JOB NUMBER(S): 118454  
CUSTOMER: MURPHY OIL CORPORATION  
QUANTITY: 1 MOTOR  
MODEL: 42ZF-R  
Date: 3-21-12

## RUN-IN & NOISE TESTING

### BACK HEADER END



### FRONT HEADER END

*UP  
Insert/moody  
3/22/12  
10:20 A.M*

#### TESTING PERFORMED

1. Vibration Displacement in Mils. Peak to peak
2. Vibration Meter: Balmac Model 205
3. Noise Meter: Extech Model 407764  
ANSI S1.4-1983 Type 2, IEC 651



#### AXH air-coolers

Tested By: KEVIN PRISER  
Date Tested: 3-21-12  
Time Tested: 3:15 am/pm

*REVIEW ONLY*

WiSco
W O R
Initials: <i>UP</i>
Date: <u>3-28-12</u>
117





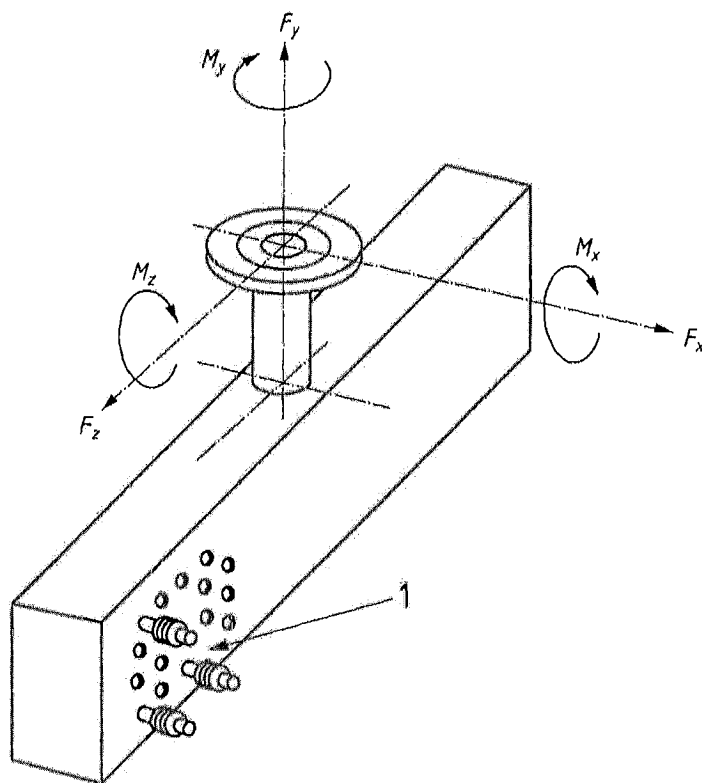
## Table of Contents

<u>Section</u>	<u>Description</u>
A	API-661 Nozzle Loads
B	Finite Element Analysis 42ZF
C	Finite Element Analysis 96BZF

## **Section A - API-661 Nozzle Loads**

## Finite Element Analysis Summary

Nozzles for both coolers were checked for 3x API-661 nozzle loads. The resulting von mises stresses were compared to the yield stress for the material at the design temperature, and found to be within the acceptable limits. Both headers (42ZF and 96BZF) can withstand 3xAPI-661 Nozzle loads without modification.



**Key**  
 1 fin tubes

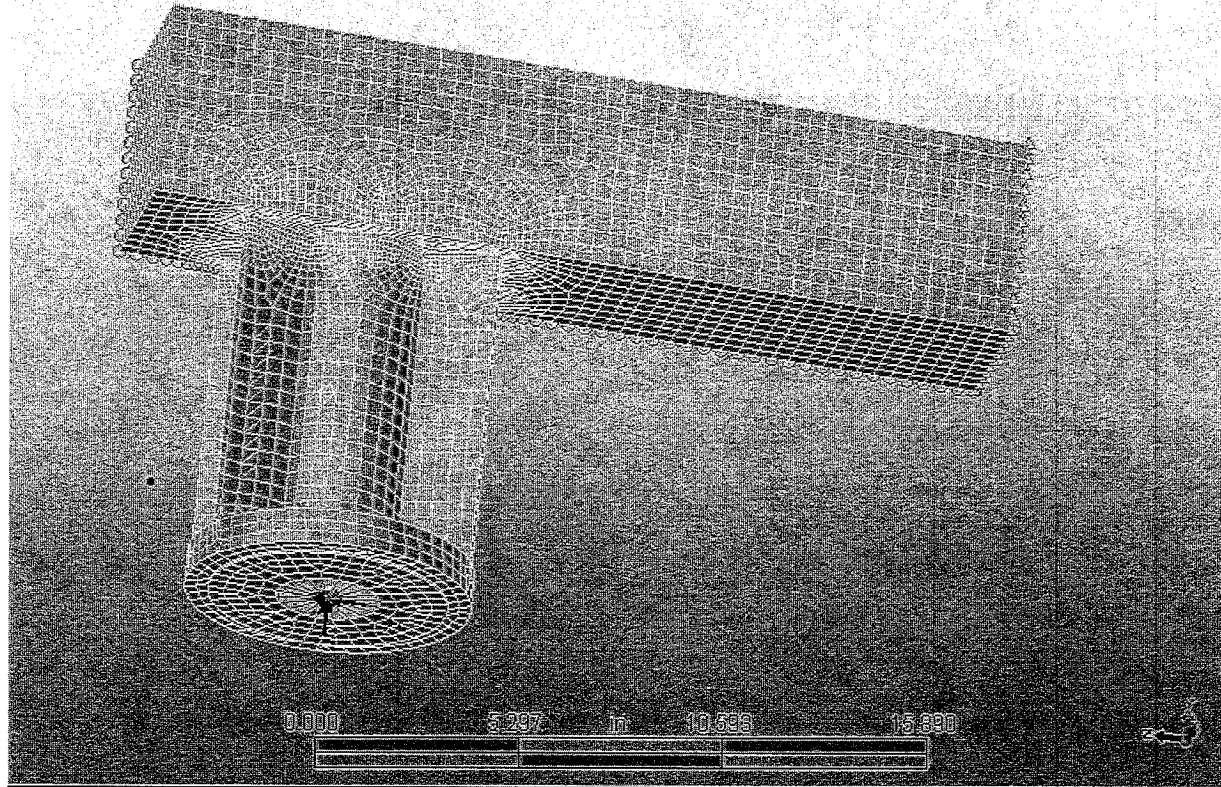
**Figure 6 — Nozzle loads**

**Table 4 — Maximum allowable nozzle loads**

Nozzle size DN (NPS)	Moments N·m (ft·lbf)			Forces N (lbf)		
	$M_x$	$M_y$	$M_z$	$F_x$	$F_y$	$F_z$
40 (1 1/2)	110 (80)	150 (110)	110 (80)	670 (150)	1 020 (230)	670 (150)
50 (2)	150 (110)	240 (180)	150 (110)	1 020 (230)	1 330 (300)	1 020 (230)
80 (3)	410 (300)	610 (450)	410 (300)	2 000 (450)	1 690 (380)	2 000 (450)
100 (4)	810 (600)	1 220 (900)	810 (600)	3 340 (750)	2 670 (600)	3 340 (750)
150 (6)	2 140 (1 580)	3 050 (2 250)	1 630 (1 200)	4 000 (900)	5 030 (1 130)	5 030 (1 130)
200 (8)	3 050 (2 250)	6 100 (4 500)	2 240 (1 650)	5 690 (1 280)	13 340 (3 000)	8 010 (1 800)
250 (10)	4 070 (3 000)	6 100 (4 500)	2 550 (1 880)	6 670 (1 500)	13 340 (3 000)	10 010 (2 250)
300 (12)	5 080 (3 750)	6 100 (4 500)	3 050 (2 250)	8 360 (1 880)	13 340 (3 000)	13 340 (3 000)
350 (14)	6 100 (4 500)	7 120 (5 250)	3 570 (2 630)	10 010 (2 250)	16 680 (3 750)	16 680 (3 750)

**Section B - Finite Element Analysis 42ZF**

**118454**



**Nozzle Loading Analysis  
AXH Job # 118454 42ZF Cooler**

## Executive Summary

The nozzles need to be verified to be suitable for 3x API-661 Nozzle loads. The finite model was constructed using 8 node Brick elements. Due to symmetry, only 1/2 of the header was modeled and the middle of the header was treated as being restrained from translations in all 3 directions. The nozzle was modeled with gussets. The loads applied are as follows:

Internal Pressure = 178 psig

3x API-661 Nozzle Loads applied to end of nozzle.

Fx = 1,350 lbs

Fy = 1,140 lbs

Fz = 1,350 lbs

Mx = 10,800 lb-in

My = 16,200 lb-in

Mz = 10,800 lb-in

The resulting von-mises stresses were calculated and compared to the yield stress for the material at the design temperature. Since the von mises are less than the yield stresses, the model is considered to be acceptable.

Allowable Tensile Stresses at 473 Deg. F:

A-333-Gr. 6 Nozzle - Fy = 28,878 psi

A-516-70N Plate = 31,405 psi

## Summary

### Model Information

Analysis Type - Static Stress with Linear Material Models

Units - English (in) - (lbf, in, s, °F, °R, V, ohm, A, in·lbf)

Model location - C:\Paulin\AXHAXH118454\Box Header 42ZF.fem

Design scenario description - Design Scenario # 1

## Analysis Parameters Information

### Load Case Multipliers

Static Stress with Linear Material Models may have multiple load cases. This allows a model to be analyzed with multiple loads while solving the equations a single time. The following is a list of load case multipliers that were analyzed with this model.

Load Case	Pressure/Surface Forces	Acceleration/Gravity	Rotation	Angular Acceleration	Displaced Boundary	Thermal	Voltage
-----------	-------------------------	----------------------	----------	----------------------	--------------------	---------	---------



1	1	0	0	0	0	0	0
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**Multiphysics Information**

Default Nodal Temperature	0 °F
Source of Initial Nodal Temperatures	Model file
Time step from Heat Transfer Analysis	Last
Default nodal voltage	0 V
Source of nodal voltages	Model file

**Processor Information**

Type of Solver	Automatic
Disable Calculation and Output of Strains	No
Calculate Reaction Forces	Yes
Invoke Banded Solver	Yes
Avoid Bandwidth Minimization	No
Stop After Stiffness Calculations	No
Displacement Data in Output File	No
Stress Data in Output File	No
Equation Numbers Data in Output File	No
Element Input Data in Output File	No
Nodal Input Data in Output File	No
Centrifugal Load Data in Output File	No

**Part Information**

Part ID	Part Name	Element Type	Material Name
1	Box Header 42ZF	Brick	Steel (ASTM - A36)
2	Part 2	Rigid	Rigid elements have no material properties or the material properties have not been defined.

## Element Information

Element Properties used for:

- Box Header 42ZF

Element Type	Brick
Compatibility	Not Enforced
Integration Order	2nd Order
Stress Free Reference Temperature	0 °F

Element Properties used for:

- Part 2

Element Type	Rigid
Stiffness	10000000000
Component DOF - Tx	Yes
Component DOF - Ty	Yes
Component DOF - Tz	Yes
Component DOF - Rx	Yes
Component DOF - Ry	Yes

Component DOF - Rz	Yes
--------------------	-----

118406 Rev 0

## Material Information

### Steel (ASTM - A36) -Brick

Material Model	Standard
Material Source	Autodesk Simulation Material Library
Material Source File	C:\Program Files\Autodesk\Algor Simulation 2012\matlibs\algor.mat.mlb
Date Last Updated	2004/09/30-16:00:00
Material Description	Structural Steel
Mass Density	0.000735 lbf·s <sup>2</sup> /in/in <sup>3</sup>
Modulus of Elasticity	29000000 lbf/in <sup>2</sup>
Poisson's Ratio	0.29
Shear Modulus of Elasticity	11200000 lbf/in <sup>2</sup>
Thermal Coefficient of Expansion	6.5e-006 1/°F

## Loads

### FEA Object Group 8: Surface Pressure/Tractions

#### Surface Pressure/Traction

ID	Description	Part ID	Surface ID	Magnitude (lbf/in <sup>2</sup> )	X Magnitude (lbf/in <sup>2</sup> )	Y Magnitude (lbf/in <sup>2</sup> )	Z Magnitude (lbf/in <sup>2</sup> )	Multiplier Table Id	Multiplier	Type	Follows Displacement	Apply Modified Pressure	Pressure Type	Loss Coefficient (lbf/in <sup>2</sup> )
1	Unnamed	1	66	178.000000	0.000000	0.000000	0.000000	1	1.000000	Pressure	No	No	Static pressure	0.000000

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5	Unnamed	1	51	178.000000	0.000000	0.000000	0.000000	1	1.000000	Pressure	No	No	Static pressure	0.000000
6	Unnamed	1	50	178.000000	0.000000	0.000000	0.000000	1	1.000000	Pressure	No	No	Static pressure	0.000000

**FEA Object Group 11: Nodal Forces**

Nodal Force

ID	Description	Vertex ID	Node Number	Magnitude (lbf)	Vx	Vy	Vz	Multiplier Table ID
4	Unnamed	44176	21735	1350.000000	1.000000	0.000000	0.000000	1

**FEA Object Group 12: Nodal Forces**

Nodal Force

ID	Description	Vertex ID	Node Number	Magnitude (lbf)	Vx	Vy	Vz	Multiplier Table ID
5	Unnamed	44176	21735	1140.000000	0.000000	1.000000	0.000000	1

**FEA Object Group 13: Nodal Forces**

Nodal Force

ID	Description	Vertex ID	Node Number	Magnitude (lbf)	Vx	Vy	Vz	Multiplier Table ID
6	Unnamed	44176	21735	1350.000000	0.000000	0.000000	1.000000	1

**FEA Object Group 14: Nodal Moments**

Nodal Moment

ID	Description	Vertex ID	Node Number	Magnitude (lbf-in)	Vx	Vy	Vz	LC_Placeholder	Coordinate System ID
4	Unnamed	44176	21735	10800.000000	1.000000	0.000000	0.000000	1	0

**FEA Object Group 15: Nodal Moments**

Nodal Moment

ID	Description	Vertex ID	Node Number	Magnitude (lbf-in)	Vx	Vy	Vz	LC_Placeholder	Coordinate System ID

5	Unnamed	44176	21735	16200.000000	0.000000	1.000000	0.000000	1	0
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FEA Object Group 16: Nodal Moments

Nodal Moment

ID	Description	Vertex ID	Node Number	Magnitude (lbf-in)	Vx	Vy	Vz	LC_Placeholder	Coordinate System ID
6	Unnamed	44176	21735	10800.000000	0.000000	0.000000	1.000000	1	0

### Constraints

FEA Object Group 7: Surface Boundary Conditions

Surface Boundary Condition

ID	Description	Part ID	Surface ID	Tx	Ty	Tz	Rx	Ry	Rz
1	Unnamed	1	58	Yes	Yes	Yes	Yes	Yes	Yes

FEA Object Group 9: Surface Boundary Conditions

Surface Boundary Condition

ID	Description	Part ID	Surface ID	Tx	Ty	Tz	Rx	Ry	Rz
2	Unnamed	1	55	Yes	Yes	Yes	No	No	No

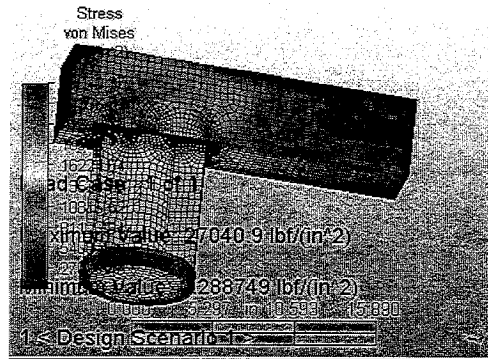
FEA Object Group 10: Edge Boundary Conditions

Edge Boundary Condition

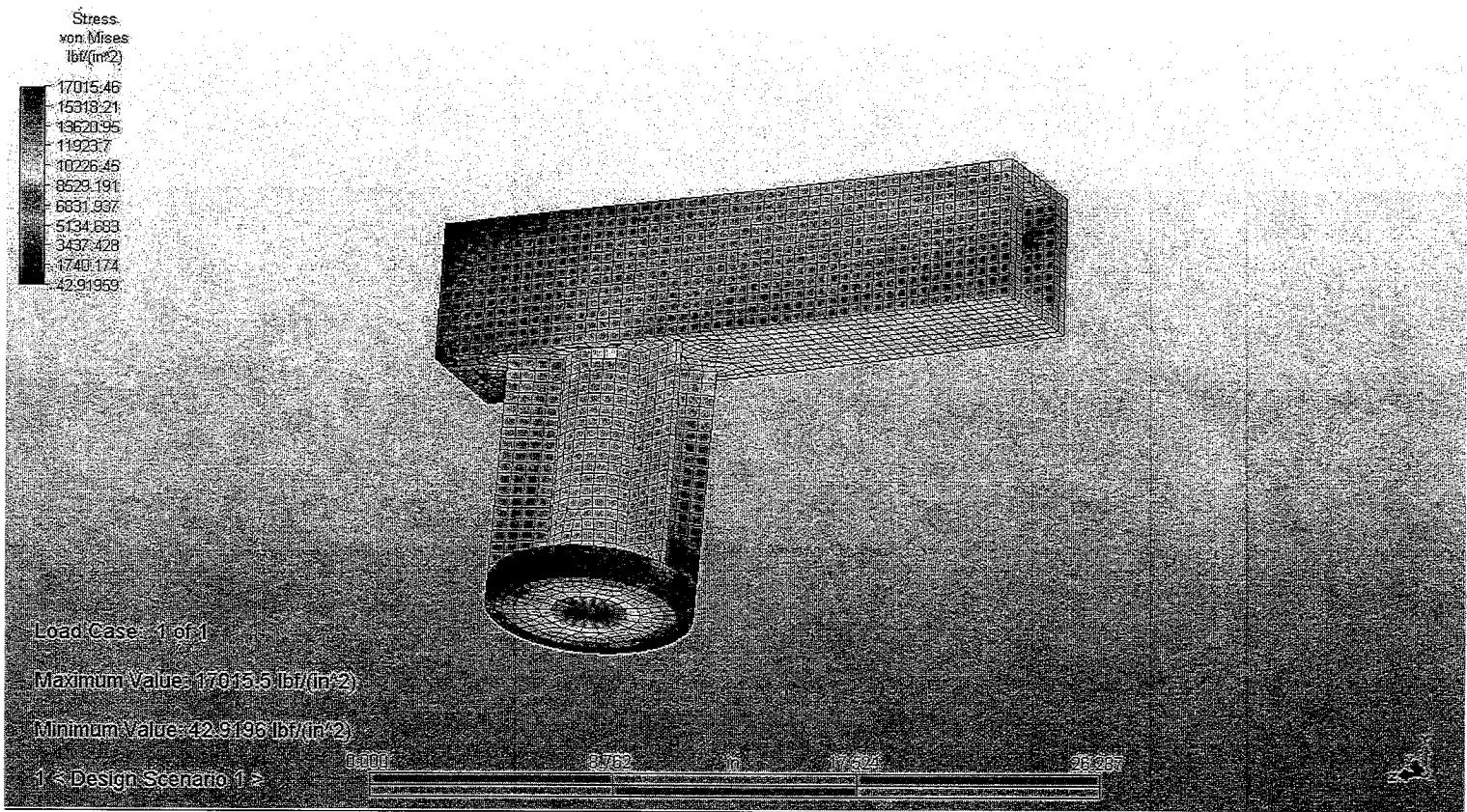
ID	Description	Part ID	Edge ID	Tx	Ty	Tz	Rx	Ry	Rz
1	Unnamed	1	266	Yes	Yes	Yes	Yes	Yes	Yes

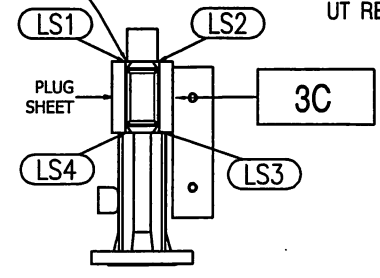
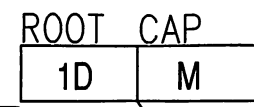
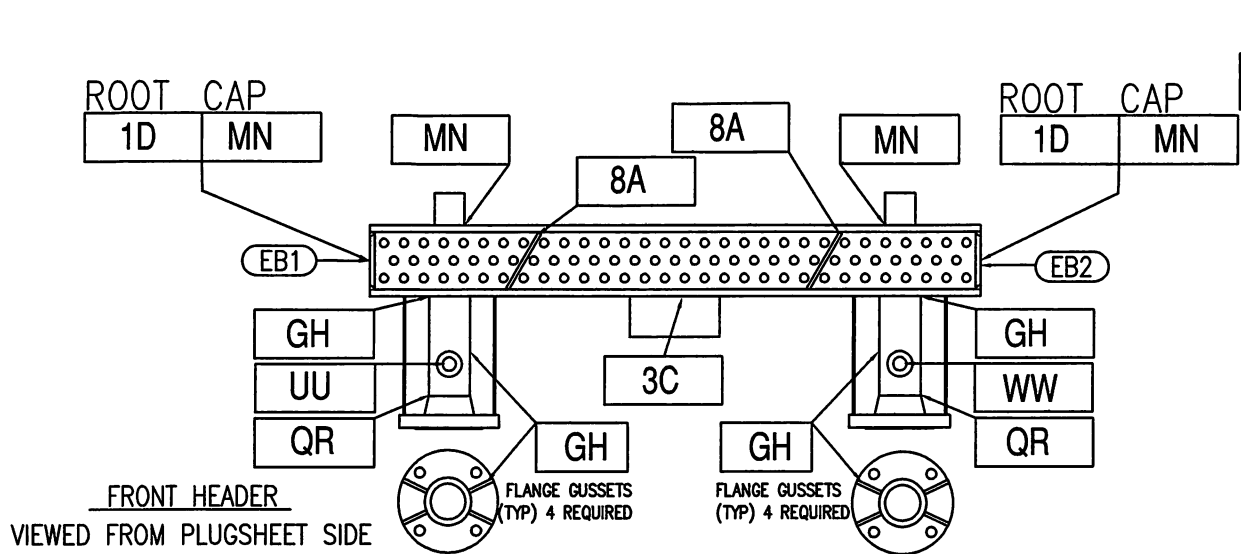
### Results Presentation Images

Stress

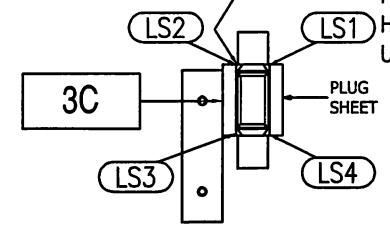
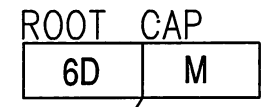
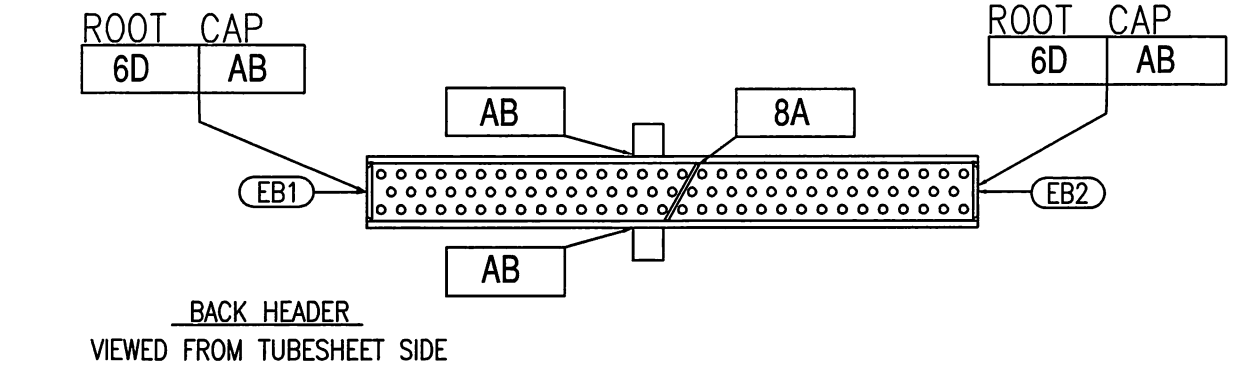
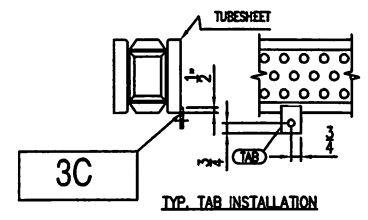


### Box Header 42ZF





FRONT HEAD  
 PWHT REPORT# 118454.1 PROD GAS FR  
 X-RAY FILM# 113770  
 HARDNESS REPORT# 118454.1 PROD GAS HEADS  
 UT REPORT# 118454.1 FR



BACK HEAD  
 PWHT REPORT# 118454.1 PROD GAS BK  
 X-RAY FILM# 113770  
 HARDNESS REPORT# 118454.1 PROD GAS HEADS  
 UT REPORT# 118454.1 BK

WISco  
 W O R  
 Initials: *RP*  
 Date: *3/28/12*  
 117

WELD PROCEDURES (LOW TEMP.)

< 5/8"	P1-P1-11	< 5/8"	P1-P1-11	< 5/8"	P1-P1-10	S.S.	P1-PB-05	< 5/8"	P1-P1-11	> 1" NPS & 36/8" WALL	P1-P1-11	P1-P1-11



CUSTOMER: ~	DRAWN BY: ~	CHECKED BY: ~
P.O. NO.: ~	SCALE: ~	
NO. OF UNITS: 118454 (1 UNIT)	DATE: 01/26/2012	
DESCRIPTION: PRODUCED GAS WELD MAP & NDE MAP 42 ZF-R	JOB NUMBER: 118454	SHEET: GAS-WP
LOCATION: ~	REV. NO.:	~









AXH air-coolers, LLC  
401 E. Lowry Road  
Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: CAMP, GREG Stamp: 1D

Test WPS No.: P1-P1-02 Rev.: 0 WPQ No.: P1-P1-02

Date: 10/21/2010

Welding process(es) / type(s) used: GMAW / Semiautomatic and FCAW / Semiautomatic

Type of joint welded: Plate Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-516, Grade 70 to SA-516, Grade 70

Welder Variables (QW-350)	Actual Values Used		Range Qualified	
	P-No. 1 to P-No. 1		P-1 thru P-15F, P-34 & P-4X	
P- or S-Number to P- or S-Number	1		WPS Limits	
Base metal thickness (in.)	N/A		2.875" minimum	
Pipe diameter (in.)	<b>GMAW / Semiauto</b>	<b>FCAW / Semiauto</b>	<b>GMAW / Semiauto</b>	<b>FCAW / Semiauto</b>
	No backing used	Backing used	With or without backing	With backing only
Backing **	ER70S-6	E71T-1		
AWS classification	5.18	5.20	5.xx	5.xx
Filler metal specification (SFA)	6	6	F-No. 6	F-No. 6
Filler metal F-No.	N/A	N/A	N/A	N/A
Filler metal product form	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Deposit thickness (in.) [ $\geq$ 3 layers]	0.25 [N/A]	0.75 [Yes]	0.2750" maximum	WPS Limits
Welding position	2G - Horizontal	2G - Horizontal	Flat & Horizontal	Flat & Horizontal
Weld progression	N/A	N/A	N/A	N/A
Backing gas	No backing gas used	No backing gas used	W/WO backing gas	W/WO backing gas
GMAW / FCAW transfer mode	Short-circuiting arc	Spray arc	Short-circuiting arc	Spray, Pulsed, or Globular

Machine Welding Variables (QW-360)	Actual Values Used		Range Qualified	
	Direct / remote visual control	N/A	N/A	N/A
Automatic voltage control	N/A	N/A	N/A	N/A
Automatic joint tracking	N/A	N/A	N/A	N/A
Welding position	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Backing **	N/A	N/A	N/A	N/A
Single / multiple pass per side	N/A	N/A	N/A	N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

Notes:

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.2 Side bend	Satisfactory	QW-462.2 Side bend	Satisfactory
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Radiographic test results: None

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: AXH air-coolers, LLC Lab test no.: 10/21/2010

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME code.

Certified By: Steve D. Little Organization: AXH air-coolers, LLC  
STEVE D. LITTLE Date: 10/21/2010 QC MANAGER



AXH air-coolers, LLC  
 401 E. Lowry Road  
 Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: CAMP, GREG Stamp: 1D  
 Test WPS No.: P1-P1-03 Rev.: 0 WPQ No.: P1-P1-03 Date: 4/15/2011  
 Welding process(es) / type(s) used: SMAW / Manual  
 Type of joint welded: Plate Groove weld Joint type(s) qualified: Groove and Fillet Welds  
 Base metal(s) welded: SA-516, Grade 70 to SA-516, Grade 70

Welder Variables (QW-350)	Actual Values Used	Range Qualified
P- or S-Number to P- or S-Number	P-No. 1 to P-No. 1	P-1 thru P-15F, P-34 & P-4X
Base metal thickness (in.)	0.75	WPS Limits
Pipe diameter (in.)	N/A	2.875" minimum
	<b>SMAW / Manual</b>	<b>SMAW / Manual</b>
Backing **	No backing used	With or without backing
AWS classification	E7018-1	
Filler metal specification (SFA)	5.1	5.xx
Filler metal F-No.	4	F 4 (F 1 - F 3 w/backing)
Filler metal product form	N/A	N/A
Consumable insert	N/A	N/A
Deposit thickness (in.) [ $\geq 3$ layers]	0.75 [Yes]	WPS Limits
Welding position	2G - Horizontal	Flat & Horizontal
Weld progression	N/A	N/A
Backing gas	N/A	N/A

Machine Welding Variables (QW-360)	Actual Values Used	Range Qualified
Direct / remote visual control	N/A	N/A
Automatic voltage control	N/A	N/A
Automatic joint tracking	N/A	N/A
Welding position	N/A	N/A
Consumable insert	N/A	N/A
Backing **	N/A	N/A
Single / multiple pass per side	N/A	N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.  
 \*\* Welds with backing include fillets and double-welded groove welds.  
**Notes:**

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
None		None	
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194  
 Volumetric test results: Acceptable Per QW-302.2 and QW-191  
 Welding test conducted by: AXH air-coolers, LLC  
 Mechanical/Radiographic tests conducted by: IRIS NDT Lab test no.: 4/15/2011

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

Certified By: Steve D Little Organization: AXH air-coolers, LLC  
 STEVE D. LITTLE Date: 4/15/2011 QC MANAGER



AXH air-coolers, LLC  
 401 E. Lowry Road  
 Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: ADKINS, RONNIE Stamp: MN

Test WPS No.: P1-P1-02 Rev.: 0 WPQ No.: P1-P1-02

Date: 9/8/2010

Welding process(es) / type(s) used: GMAW / Semiautomatic and FCAW / Semiautomatic

Type of joint welded: Plate Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-516, Grade 70 to SA-516, Grade 70

Welder Variables (QW-350)	Actual Values Used		Range Qualified	
	P-No. 1 to P-No. 1		P-1 thru P-15F, P-34 & P-4X	
P- or S-Number to P- or S-Number	1		WPS Limits	
Base metal thickness (in.)	N/A		2.875" minimum	
Pipe diameter (in.)	<u>GMAW / Semiauto</u>	<u>FCAW / Semiauto</u>	<u>GMAW / Semiauto</u>	<u>FCAW / Semiauto</u>
	No backing used	Backing used	With or without backing	With backing only
Backing **				
AWS classification	ER70S-6	E71T-1		
Filler metal specification (SFA)	5.18	5.20	5.xx	5.xx
Filler metal F-No.	6	6	F-No. 6	F-No. 6
Filler metal product form	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Deposit thickness (in.) [ $\geq 3$ layers]	0.25 [N/A]	0.75 [Yes]	0.2750" maximum	WPS Limits
Welding position	2G - Horizontal	2G - Horizontal	Flat & Horizontal	Flat & Horizontal
Weld progression	N/A	N/A	N/A	N/A
Backing gas	No backing gas used	No backing gas used	W/WO backing gas	W/WO backing gas
GMAW / FCAW transfer mode	Short-circuiting arc	Spray arc	Short-circuiting arc	Spray, Pulsed, or Globular

Machine Welding Variables (QW-360)	Actual Values Used		Range Qualified	
	Direct / remote visual control	N/A	N/A	N/A
Automatic voltage control	N/A	N/A	N/A	N/A
Automatic joint tracking	N/A	N/A	N/A	N/A
Welding position	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Backing **	N/A	N/A	N/A	N/A
Single / multiple pass per side	N/A	N/A	N/A	N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

Notes:

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.2 Side bend	Satisfactory	QW-462.2 Side bend	Satisfactory
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Radiographic test results: None

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: AXH air-coolers, LLC

Lab test no.: 9/8/2010

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME code.

Certified By: Steve D Little  
 STEVE D. LITTLE

Organization: AXH air-coolers, LLC

9/8/2010 QC MANAGER  
 Date



AXH air-coolers, LLC  
401 E. Lowry Road  
Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: ADKINS, RONNIE Stamp: MN

Test WPS No.: P1-P1-03 Rev.: 0 WPQ No.: P1-P1-03

Date: 12/7/2010

Welding process(es) / type(s) used: SMAW / Manual

Type of joint welded: Plate Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-516, Grade 70 to SA-516, Grade 70

Welder Variables (QW-350)	Actual Values Used	Range Qualified
P- or S-Number to P- or S-Number	P-No. 1 to P-No. 1	P-1 thru P-15F, P-34 & P-4X
Base metal thickness (in.)	0.75	WPS Limits
Pipe diameter (in.)	N/A	2.875" minimum
	<b>SMAW / Manual</b>	<b>SMAW / Manual</b>
Backing **	No backing used	With or without backing
AWS classification	E7018-1	
Filler metal specification (SFA)	5.1	5.xx
Filler metal F-No.	4	F 4 (F 1 - F 3 w/backing)
Filler metal product form	N/A	N/A
Consumable insert	N/A	N/A
Deposit thickness (in.) [ $\geq 3$ layers]	0.75 [Yes]	WPS Limits
Welding position	2G - Horizontal	Flat & Horizontal
Weld progression	N/A	N/A
Backing gas	N/A	N/A

Machine Welding Variables (QW-360)	Actual Values Used	Range Qualified
Direct / remote visual control	N/A	N/A
Automatic voltage control	N/A	N/A
Automatic joint tracking	N/A	N/A
Welding position	N/A	N/A
Consumable insert	N/A	N/A
Backing **	N/A	N/A
Single / multiple pass per side	N/A	N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

Notes:

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
None		None	
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Radiographic test results: Acceptable Per QW-302.2 and QW-191

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: IRIS NDT

Lab test no.: 12/7/2010

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

Certified By: Steve D. Little  
STEVE D. LITTLE

Organization: AXH air-coolers, LLC

12/7/2010 QC MANAGER  
Date



AXH air-coolers, LLC  
 401 E. Lowry Road  
 Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: DOWLER, MARTY Stamp: 8A  
 Test WPS No.: P1-P1-02 Rev.: 0 WPQ No.: P1-P1-02 Date: 8/11/2010  
 Welding process(es) / type(s) used: GMAW / Semiautomatic and FCAW / Semiautomatic  
 Type of joint welded: Plate Groove weld Joint type(s) qualified: Groove and Fillet Welds  
 Base metal(s) welded: SA-516, Grade 70 to SA-516, Grade 70

Welder Variables (QW-350)	Actual Values Used		Range Qualified	
	P-No. 1 to P-No. 1		P-1 thru P-15F, P-34 & P-4X	
P- or S-Number to P- or S-Number	1		WPS Limits	
Base metal thickness (in.)	1		2.875" minimum	
Pipe diameter (in.)	N/A		2.875" minimum	
	GMAW / Semiauto	FCAW / Semiauto	GMAW / Semiauto	FCAW / Semiauto
Backing **	No backing used	Backing used	With or without backing	With backing only
AWS classification	ER70S-6	E71T-1		
Filler metal specification (SFA)	5.18	5.20	5.xx	5.xx
Filler metal F-No.	6	6	F-No. 6	F-No. 6
Filler metal product form	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Deposit thickness (in.) [ $\geq 3$ layers]	0.25 [N/A]	0.75 [Yes]	0.2750" maximum	WPS Limits
Welding position	2G - Horizontal	2G - Horizontal	Flat & Horizontal	Flat & Horizontal
Weld progression	N/A	N/A	N/A	N/A
Backing gas	No backing gas used	No backing gas used	W/WO backing gas	W/WO backing gas
GMAW / FCAW transfer mode	Short-circuiting arc	Spray arc	Short-circuiting arc	Spray, Pulsed, or Globular

Machine Welding Variables (QW-360)	Actual Values Used		Range Qualified	
Direct / remote visual control	N/A	N/A	N/A	N/A
Automatic voltage control	N/A	N/A	N/A	N/A
Automatic joint tracking	N/A	N/A	N/A	N/A
Welding position	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Backing **	N/A	N/A	N/A	N/A
Single / multiple pass per side	N/A	N/A	N/A	N/A

Fillet Welds: Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.  
 \*\* Welds with backing include fillets and double-welded groove welds.  
 Notes:

Guided Bend Test (QW-160)			
Figure Number and Type	Result	Figure Number and Type	Result
QW-462.2 Side bend	Satisfactory	QW-462.2 Side bend	Satisfactory
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194  
 Radiographic test results: None  
 Welding test conducted by: AXH air-coolers, LLC  
 Mechanical/Radiographic tests conducted by: AXH air-coolers, LLC Lab test no.: 8/11/2010

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME code.

Certified By: Steve D. Little Organization: AXH air-coolers, LLC  
 STEVE D. LITTLE Date: 8/11/2010 QC MANAGER



AXH air-coolers, LLC  
401 E. Lowry Road  
Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: DOWLER, MARTY Stamp: 8A

Test WPS No.: P1-P1-03 Rev.: 0 WPQ No.: P1-P1-03

Date: 10/28/2011

Welding process(es) / type(s) used: SMAW / Manual

Type of joint welded: Plate Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-516, Grade 70 to SA-516, Grade 70

Welder Variables (QW-350)	Actual Values Used	Range Qualified
P- or S-Number to P- or S-Number	P-No. 1 to P-No. 1	P-1 thru P-15F, P-34 & P-4X
Base metal thickness (in.)	0.75	WPS Limits
Pipe diameter (in.)	N/A	2.875" minimum
	<b>SMAW / Manual</b>	<b>SMAW / Manual</b>
Backing **	No backing used	With or without backing
AWS classification	E7018-1	
Filler metal specification (SFA)	5.1	5.xx
Filler metal F-No.	4	F 4 (F 1 - F 3 w/backing)
Filler metal product form	N/A	N/A
Consumable insert	N/A	N/A
Deposit thickness (in.) [ $\geq$ 3 layers]	0.75 [Yes]	WPS Limits
Welding position	2G - Horizontal	Flat & Horizontal
Weld progression	N/A	N/A
Backing gas	N/A	N/A

Machine Welding Variables (QW-360)	Actual Values Used	Range Qualified
Direct / remote visual control	N/A	N/A
Automatic voltage control	N/A	N/A
Automatic joint tracking	N/A	N/A
Welding position	N/A	N/A
Consumable insert	N/A	N/A
Backing **	N/A	N/A
Single / multiple pass per side	N/A	N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.  
**\*\* Welds with backing include fillets and double-welded groove welds.**  
**Notes:**

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
None		None	
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Volumetric test results: Acceptable Per QW-302.2 and QW-191

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: IRIS NDT

Lab test no.: 10/28/2011

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

Certified By: Steve D. Little  
STEVE D. LITTLE

Organization: AXH air-coolers, LLC

10/28/2011 QC MANAGER  
Date





AXH air-coolers, LLC  
401 E. Lowry Road  
Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: LOR, CHER Stamp: GH

Test WPS No.: P1-P1-02 Rev.: 0 WPQ No.: P1-P1-02

Date: 8/27/2010

Welding process(es) / type(s) used: GMAW / Semiautomatic and FCAW / Semiautomatic

Type of joint welded: Plate Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-516, Grade 70 to SA-516, Grade 70

**Welder Variables (QW-350)**

P- or S-Number to P- or S-Number  
Base metal thickness (in.)  
Pipe diameter (in.)

**Actual Values Used**

P-No. 1 to P-No. 1

**Range Qualified**

P-1 thru P-15F, P-34 & P-4X

Backing \*\*

AWS classification

Filler metal specification (SFA)

Filler metal F-No.

Filler metal product form

Consumable insert

Deposit thickness (in.) [ $\geq$  3 layers]

Welding position

Weld progression

Backing gas

GMAW / FCAW transfer mode

Actual Values Used		Range Qualified	
P-No. 1 to P-No. 1		P-1 thru P-15F, P-34 & P-4X	
I		WPS Limits	
N/A		2.875" minimum	
GMAW / Semiauto	FCAW / Semiauto	GMAW / Semiauto	FCAW / Semiauto
No backing used	Backing used	With or without backing	With backing only
ER70S-6	E71T-1		
5.18	5.20	5.xx	5.xx
6	6	F-No. 6	F-No. 6
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
0.25 [N/A]	0.75 [Yes]	0.2750" maximum	WPS Limits
2G - Horizontal	2G - Horizontal	Flat & Horizontal	Flat & Horizontal
N/A	N/A	N/A	N/A
No backing gas used	No backing gas used	W/WO backing gas	W/WO backing gas
Short-circuiting arc	Spray arc	Short-circuiting arc	Spray, Pulsed, or Globular

**Machine Welding Variables (QW-360)**

Direct / remote visual control

Automatic voltage control

Automatic joint tracking

Welding position

Consumable insert

Backing \*\*

Single / multiple pass per side

**Actual Values Used**

**Range Qualified**

Actual Values Used		Range Qualified	
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A

Fillet Welds: Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

Notes:

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.2 Side bend	Satisfactory	QW-462.2 Side bend	Satisfactory
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Radiographic test results: None

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: AXH air-coolers, LLC

Lab test no.: 8/27/2010

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME code.

Certified By: \_\_\_\_\_

Steve D. Little  
STEVE D. LITTLE

Organization: AXH air-coolers, LLC

8/27/2010 QC MANAGER

Date



AXH air-coolers, LLC  
 401 E. Lowry Road  
 Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: LOR, CHER Stamp: GH

Test WPS No.: P1-P1-03 Rev.: 0 WPQ No.: P1-P1-03

Date: 3/22/2011

Welding process(es) / type(s) used: SMAW / Manual

Type of joint welded: Plate Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-516, Grade 70 to SA-516, Grade 70

Welder Variables (QW-350)	Actual Values Used	Range Qualified
P- or S-Number to P- or S-Number	P-No. 1 to P-No. 1	P-1 thru P-15F, P-34 & P-4X
Base metal thickness (in.)	0.75	WPS Limits
Pipe diameter (in.)	N/A	2.875" minimum
	<b>SMAW / Manual</b>	<b>SMAW / Manual</b>
Backing **	No backing used	With or without backing
AWS classification	E7018-1	
Filler metal specification (SFA)	5.1	5.xx
Filler metal F-No.	4	F 4 (F 1 - F 3 w/backing)
Filler metal product form	N/A	N/A
Consumable insert	N/A	N/A
Deposit thickness (in.) [ $\geq$ 3 layers]	0.75 [Yes]	WPS Limits
Welding position	2G - Horizontal	Flat & Horizontal
Weld progression	N/A	N/A
Backing gas	N/A	N/A

Machine Welding Variables (QW-360)	Actual Values Used	Range Qualified
Direct / remote visual control	N/A	N/A
Automatic voltage control	N/A	N/A
Automatic joint tracking	N/A	N/A
Welding position	N/A	N/A
Consumable insert	N/A	N/A
Backing **	N/A	N/A
Single / multiple pass per side	N/A	N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.  
 \*\* Welds with backing include fillets and double-welded groove welds.  
**Notes:**

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
None		None	
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Volumetric test results: Acceptable Per QW-302.2 and QW-191

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: IRIS NDT

Lab test no.: 3/22/2011

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

Certified By: Steve D. Little  
 STEVE D. LITTLE

Organization: AXH air-coolers, LLC

3/22/2011 QC MANAGER  
 Date



AXH air-coolers, LLC  
401 E. Lowry Road  
Claremore, Oklahoma 74017

Welder or Welding Operator Performance Qualification (WPQ)

Welder's Name: **HOLLAND, RODNEY** Stamp: **WW**

Test WPS No.: **P1-P1-02** Rev.: **0** WPQ No.: **P1-P1-02**

Date: **7/29/2010**

Welding process(es) / type(s) used: **GMAW / Semiautomatic**

Type of joint welded: **Plate Groove weld** Joint type(s) qualified: **Groove and Fillet Welds**

Base metal(s) welded: **SA-516, Grade 70 to SA-516, Grade 70**

Welder Variables (QW-350)	Actual Values Used	Range Qualified
P- or S-Number to P- or S-Number	P-No. 1 to P-No. 1	P-1 thru P-15F, P-34 & P-4X
Base metal thickness (in.)	0.375	WPS Limits
Pipe diameter (in.)	N/A	2.875" minimum
	<b>GMAW / Semiauto</b>	<b>GMAW / Semiauto</b>
Backing **	No backing used	With or without backing
AWS classification	ER70S-6	
Filler metal specification (SFA)	5.18	5.xx
Filler metal F-No.	6	F-No. 6
Filler metal product form	N/A	N/A
Consumable insert	N/A	N/A
Deposit thickness (in.) [ $\geq 3$ layers]	0.375 [N/A]	0.4125" maximum
Welding position	2G - Horizontal	Flat & Horizontal
Weld progression	N/A	N/A
Backing gas	No backing gas used	With or Without backing gas
GMAW / FCAW transfer mode	Short-circuiting arc	Short-circuiting arc

Machine Welding Variables (QW-360)	Actual Values Used	Range Qualified
Direct / remote visual control	N/A	N/A
Automatic voltage control	N/A	N/A
Automatic joint tracking	N/A	N/A
Welding position	N/A	N/A
Consumable insert	N/A	N/A
Backing **	N/A	N/A
Single / multiple pass per side	N/A	N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

Notes:

Guided Bend Test (QW-160)

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.3(a) Face bend	Satisfactory	QW-462.3(a) Root bend	Satisfactory
None		None	
None		None	

Visual examination results: **Visual exam satisfactory per QW-302.4 and QW-194**

Radiographic test results: **None**

Welding test conducted by: **AXH air-coolers, LLC**

Mechanical/Radiographic tests conducted by: **AXH air-coolers, LLC**

Lab test no.: **7/29/2010**

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME code.

Certified By:

STEVE D. LITTLE

Organization: **AXH air-coolers, LLC**

7/29/2010 **QC MANAGER**

Date



AXH air-coolers, LLC  
 401 E. Lowry Road  
 Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: HOLLAND, RODNEY Stamp: WW

Test WPS No.: P1-P1-02 Rev.: 0 WPQ No.: P1-P1-02

Date: 11/4/2010

Welding process(es) / type(s) used: GMAW / Semiautomatic and FCAW / Semiautomatic

Type of joint welded: Pipe Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-106, Grade B to SA-106, Grade B

**Welder Variables (QW-350)**

P- or S-Number to P- or S-Number

**Actual Values Used**

P-No. 1 to P-No. 1

**Range Qualified**

P-1 thru P-15F, P-34 & P-4X

Base metal thickness (in.)

0.375

WPS Limits

Pipe diameter (in.)

2.875

1.00" minimum

Backing \*\*

**GMAW / Semiauto**

**FCAW / Semiauto**

**GMAW / Semiauto**

**FCAW / Semiauto**

AWS classification

No backing used

Backing used

With or without backing

With backing only

Filler metal specification (SFA)

ER70S-6

E71T-1

5.xx

5.xx

Filler metal F-No.

5.18

5.20

F-No. 6

F-No. 6

Filler metal product form

6

6

N/A

N/A

Consumable insert

N/A

N/A

N/A

N/A

Deposit thickness (in.) [ $\geq 3$  layers]

0.1875 [N/A]

0.1875 [N/A]

0.2063" maximum

0.3750" maximum

Welding position

1GR - Rotated

1GR - Rotated

Flat only

Flat only

Weld progression

N/A

N/A

N/A

N/A

Backing gas

No backing gas used

No backing gas used

W/WO backing gas

W/WO backing gas

GMAW / FCAW transfer mode

Short-circuiting arc

Spray arc

Short-circuiting arc

Spray, Pulsed, or Globular

**Machine Welding Variables (QW-360)**

**Actual Values Used**

**Range Qualified**

Direct / remote visual control

N/A

N/A

N/A

N/A

Automatic voltage control

N/A

N/A

N/A

N/A

Automatic joint tracking

N/A

N/A

N/A

N/A

Welding position

N/A

N/A

N/A

N/A

Consumable insert

N/A

N/A

N/A

N/A

Backing \*\*

N/A

N/A

N/A

N/A

Single / multiple pass per side

N/A

N/A

N/A

N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

**\*\* Welds with backing include fillets and double-welded groove welds.**

**Notes:**

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.3(a) Face bend	Satisfactory	QW-462.3(a) Root bend	Satisfactory
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Radiographic test results: None

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: Sherry Laboratories

Lab test no.: 10110043-002-v1

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME code.

Organization: AXH air-coolers, LLC

Certified By:

*Steve D. Little*  
 STEVE D. LITTLE

11/4/2010

QC MANAGER

Date



AXH air-coolers, LLC  
401 E. Lowry Road  
Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: **HOLLAND, RODNEY** Stamp: **WW**

Test WPS No.: **P1-P1-02** Rev.: **0** WPQ No.: **P1-P1-02**

Date: **11/19/2010**

Welding process(es) / type(s) used: **GMAW / Semiautomatic and FCAW / Semiautomatic**

Type of joint welded: **Pipe Groove weld** Joint type(s) qualified: **Groove and Fillet Welds**

Base metal(s) welded: **SA-106, Grade B to SA-106, Grade B**

**Welder Variables (QW-350)**

P- or S-Number to P- or S-Number	Actual Values Used		Range Qualified	
	P-No. 1 to P-No. 1		P-1 thru P-15F, P-34 & P-4X	
Base metal thickness (in.)	0.531		WPS Limits	
Pipe diameter (in.)	4.5		2.875" minimum	
	<b>GMAW / Semiauto</b>	<b>FCAW / Semiauto</b>	<b>GMAW / Semiauto</b>	<b>FCAW / Semiauto</b>
Backing **	No backing used	Backing used	With or without backing	With backing only
AWS classification	ER70S-6	E71T-1		
Filler metal specification (SFA)	5.18	5.20	5.xx	5.xx
Filler metal F-No.	6	6	F-No. 6	F-No. 6
Filler metal product form	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Deposit thickness (in.) [ $\geq 3$ layers]	0.1875 [N/A]	0.3435 [N/A]	0.2063" maximum	0.6870" maximum
Welding position	IGR - Rotated	IGR - Rotated	Flat only	Flat only
Weld progression	N/A	N/A	N/A	N/A
Backing gas	No backing gas used	No backing gas used	W/WO backing gas	W/WO backing gas
GMAW / FCAW transfer mode	Short-circuiting arc	Spray arc	Short-circuiting arc	Spray, Pulsed, or Globular

**Machine Welding Variables (QW-360)**

	Actual Values Used		Range Qualified	
	Direct / remote visual control	N/A	N/A	N/A
Automatic voltage control	N/A	N/A	N/A	N/A
Automatic joint tracking	N/A	N/A	N/A	N/A
Welding position	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Backing **	N/A	N/A	N/A	N/A
Single / multiple pass per side	N/A	N/A	N/A	N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

Notes:

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.2 Side bend	Satisfactory	QW-462.2 Side bend	Satisfactory
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Radiographic test results: None

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: Sherry Laboratories

Lab test no.: 10110673-001-v1

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME code.

Certified By:

*Steve D. Little*  
STEVE D. LITTLE

Organization: AXH air-coolers, LLC

11/19/2010 QC MANAGER

Date



AXH air-coolers, LLC  
401 E. Lowry Road  
Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: GARTRELL, MIKE Stamp: QR

Test WPS No.: P1-P1-02 Rev.: 0 WPQ No.: P1-P1-02

Date: 10/6/2010

Welding process(es) / type(s) used: GMAW / Semiautomatic and FCAW / Semiautomatic

Type of joint welded: Plate Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-516, Grade 70 to SA-516, Grade 70

**Welder Variables (QW-350)**

P- or S-Number to P- or S-Number	Actual Values Used		Range Qualified	
	P-No. 1 to P-No. 1		P-1 thru P-15F,P-34 & P-4X	
Base metal thickness (in.)	1		WPS Limits	
Pipe diameter (in.)	N/A		2.875" minimum	
	<b>GMAW / Semiauto</b>	<b>FCAW / Semiauto</b>	<b>GMAW / Semiauto</b>	<b>FCAW / Semiauto</b>
Backing **	No backing used	Backing used	With or without backing	With backing only
AWS classification	ER70S-6	E71T-1		
Filler metal specification (SFA)	5.18	5.20	5.xx	5.xx
Filler metal F-No.	6	6	F-No. 6	F-No. 6
Filler metal product form	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Deposit thickness (in.) [ $\geq 3$ layers]	0.25 [N/A]	0.75 [Yes]	0.2750" maximum	WPS Limits
Welding position	2G - Horizontal	2G - Horizontal	Flat & Horizontal	Flat & Horizontal
Weld progression	N/A	N/A	N/A	N/A
Backing gas	No backing gas used	No backing gas used	W/WO backing gas	W/WO backing gas
GMAW / FCAW transfer mode	Short-circuiting arc	Spray arc	Short-circuiting arc	Spray, Pulsed, or Globular

**Machine Welding Variables (QW-360)**

	Actual Values Used		Range Qualified	
	Direct / remote visual control	N/A	N/A	N/A
Automatic voltage control	N/A	N/A	N/A	N/A
Automatic joint tracking	N/A	N/A	N/A	N/A
Welding position	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Backing **	N/A	N/A	N/A	N/A
Single / multiple pass per side	N/A	N/A	N/A	N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

Notes:

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.2 Side bend	Satisfactory	QW-462.2 Side bend	Satisfactory
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Radiographic test results: None

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: AXH air-coolers, LLC

Lab test no.: 10/6/2010

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME code.

Organization: AXH air-coolers, LLC

Certified By: \_\_\_\_\_

*Steve D. Little*  
STEVE D. LITTLE

10/6/2010

Date

QC MANAGER



AXH air-coolers, LLC  
 401 E. Lowry Road  
 Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: GARTRELL, MIKE Stamp: QR

Test WPS No.: P1-P1-02 Rev.: 0 WPQ No.: P1-P1-02

Date: 3/14/2011

Welding process(es) / type(s) used: GMAW / Semiautomatic and FCAW / Semiautomatic

Type of joint welded: Pipe Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-106, Grade B to SA-106, Grade B

Welder Variables (QW-350)	Actual Values Used		Range Qualified	
	P-No. 1 to P-No. 1		P-1 thru P-15F, P-34 & P-4X	
P- or S-Number to P- or S-Number	0.375		WPS Limits	
Base metal thickness (in.)	2.875		1.00" minimum	
Pipe diameter (in.)	<u>GMAW / Semiauto</u>	<u>FCAW / Semiauto</u>	<u>GMAW / Semiauto</u>	<u>FCAW / Semiauto</u>
	No backing used	Backing used	With or without backing	With backing only
Backing **	ER70S-6		E71T-1	
AWS classification	5.18		5.20	
Filler metal specification (SFA)	6		6	
Filler metal F-No.	N/A		N/A	
Filler metal product form	N/A		N/A	
Consumable insert	N/A		N/A	
Deposit thickness (in.) [ $\geq 3$ layers]	0.1875 [N/A]		0.1875 [N/A]	
Welding position	1GR - Rotated		1GR - Rotated	
Weld progression	N/A		N/A	
Backing gas	No backing gas used		No backing gas used	
GMAW / FCAW transfer mode	Short-circuiting arc		Spray arc	
			W/WO backing gas	
			Short-circuiting arc	
			Spray, Pulsed, or Globular	

Machine Welding Variables (QW-360)	Actual Values Used		Range Qualified	
	Direct / remote visual control	N/A	N/A	N/A
Automatic voltage control	N/A	N/A	N/A	N/A
Automatic joint tracking	N/A	N/A	N/A	N/A
Welding position	N/A	N/A	N/A	N/A
Consumable insert	N/A	N/A	N/A	N/A
Backing **	N/A	N/A	N/A	N/A
Single / multiple pass per side	N/A	N/A	N/A	N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

Notes:

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.3(a) Face bend	Satisfactory	QW-462.3(a) Root bend	Satisfactory
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Volumetric test results: None

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: Sherry Laboratories

Lab test no.: 11030472-001-v1

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

Organization: AXH air-coolers, LLC

Certified By: \_\_\_\_\_

Steve D. Little  
 STEVE D. LITTLE

3/14/2011  
 Date

QC MANAGER



AXH air-coolers, LLC  
401 E. Lowry Road  
Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: GOURD, STEVE Stamp: UU

Test WPS No.: P1-P1-02 Rev.: 0 WPQ No.: P1-P1-02

Date: 7/28/2010

Welding process(es) / type(s) used: GMAW / Semiautomatic and FCAW / Semiautomatic

Type of joint welded: Pipe Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-106, Grade B to SA-106, Grade B

**Welder Variables (QW-350)**

P- or S-Number to P- or S-Number  
Base metal thickness (in.)  
Pipe diameter (in.)

**Actual Values Used**

P-No. 1 to P-No. 1

0.674

4.5

**Range Qualified**

P-1 thru P-15F, P-34 & P-4X

WPS Limits

2.875" minimum

Backing \*\*

AWS classification

Filler metal specification (SFA)

Filler metal F-No.

Filler metal product form

Consumable insert

Deposit thickness (in.) [ $\geq 3$  layers]

Welding position

Weld progression

Backing gas

GMAW / FCAW transfer mode

**GMAW / Semiauto**

**FCAW / Semiauto**

No backing used

Backing used

ER70S-6

E71T-1

5.18

5.20

6

6

N/A

N/A

N/A

N/A

0.1875 [N/A]

0.4865 [N/A]

IGR - Rotated

IGR - Rotated

N/A

N/A

No backing gas used

No backing gas used

Short-circuiting arc

Spray arc

**GMAW / Semiauto**

**FCAW / Semiauto**

With or without backing

With backing only

5.xx

5.xx

F-No. 6

F-No. 6

N/A

N/A

N/A

N/A

0.2063" maximum

0.9730" maximum

Flat only

Flat only

N/A

N/A

W/WO backing gas

W/WO backing gas

Short-circuiting arc

Spray, Pulsed, or Globular

**Machine Welding Variables (QW-360)**

Direct / remote visual control

Automatic voltage control

Automatic joint tracking

Welding position

Consumable insert

Backing \*\*

Single / multiple pass per side

**Actual Values Used**

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

**Range Qualified**

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

Notes:

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.2 Side bend	Satisfactory	QW-462.2 Side bend	Satisfactory
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Radiographic test results: None

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: Sherry Laboratories

Lab test no.: 10071155-001-v1

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME code.

Certified By:

Steve D. Little  
STEVE D. LITTLE

Organization: AXH air-coolers, LLC

7/28/2010  
Date

QC MANAGER





AXH air-coolers, LLC  
 401 E. Lowry Road  
 Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: GOURD, STEVE Stamp: UU

Test WPS No.: P1-P1-02 Rev.: 0 WPQ No.: P1-P1-02

Date: 7/26/2010

Welding process(es) / type(s) used: GMAW / Semiautomatic and FCAW / Semiautomatic

Type of joint welded: Pipe Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-106, Grade B to SA-106, Grade B

**Welder Variables (QW-350)**

P- or S-Number to P- or S-Number  
 Base metal thickness (in.)  
 Pipe diameter (in.)

**Actual Values Used**

P-No. 1 to P-No. 1

0.375

2.875

**Range Qualified**

P-1 thru P-15F, P-34 & P-4X

WPS Limits

1.00" minimum

Backing \*\*

AWS classification

Filler metal specification (SFA)

Filler metal F-No.

Filler metal product form

Consumable insert

Deposit thickness (in.) [ $\geq$  3 layers]

Welding position

Weld progression

Backing gas

GMAW / FCAW transfer mode

Actual Values Used	
GMAW / Semiauto	FCAW / Semiauto
No backing used	Backing used
ER70S-6	E71T-1
5.18	5.20
6	6
N/A	N/A
N/A	N/A
0.1875 [N/A]	0.1875 [N/A]
IGR - Rotated	IGR - Rotated
N/A	N/A
No backing gas used	No backing gas used
Short-circuiting arc	Spray arc

Range Qualified	
GMAW / Semiauto	FCAW / Semiauto
With or without backing	With backing only
5.xx	5.xx
F-No. 6	F-No. 6
N/A	N/A
N/A	N/A
0.2063" maximum	0.3750" maximum
Flat only	Flat only
N/A	N/A
W/WO backing gas	W/WO backing gas
Short-circuiting arc	Spray, Pulsed, or Globular

**Machine Welding Variables (QW-360)**

Direct / remote visual control

Automatic voltage control

Automatic joint tracking

Welding position

Consumable insert

Backing \*\*

Single / multiple pass per side

**Actual Values Used**

N/A

N/A

N/A

N/A

N/A

N/A

N/A

**Range Qualified**

N/A

N/A

N/A

N/A

N/A

N/A

N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

**\*\* Welds with backing include fillets and double-welded groove welds.**

**Notes:**

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.3(a) Face bend	Satisfactory	QW-462.3(a) Root bend	Satisfactory
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Radiographic test results: None

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: Sherry Laboratories

Lab test no.: 10071155-002-v1

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME code.

Certified By:

Steve D. Little  
 STEVE D. LITTLE

Organization: AXH air-coolers, LLC

7/28/2010  
 Date

QC MANAGER



AXH air-coolers, LLC  
 401 E. Lowry Road  
 Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: GOURD, STEVE Stamp: UU

Test WPS No.: P1-P1-03 Rev.: 0 WPQ No.: P1-P1-03

Date: 7/28/2010

Welding process(es) / type(s) used: SMAW / Manual

Type of joint welded: Plate Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-516, Grade 70 to SA-516, Grade 70

Welder Variables (QW-350)	Actual Values Used	Range Qualified
P- or S-Number to P- or S-Number	P-No. 1 to P-No. 1	P-1 thru P-15F, P-34 & P-4X
Base metal thickness (in.)	0.75	WPS Limits
Pipe diameter (in.)	N/A	2.875" minimum
	<b>SMAW / Manual</b>	<b>SMAW / Manual</b>
Backing **	No backing used	With or without backing
AWS classification	E7018-1	
Filler metal specification (SFA)	5.1	5.xx
Filler metal F-No.	4	F 4 (F 1 - F 3 w/backing)
Filler metal product form	N/A	N/A
Consumable insert	N/A	N/A
Deposit thickness (in.) [ $\geq$ 3 layers]	0.75 [Yes]	WPS Limits
Welding position	2G - Horizontal	Flat & Horizontal
Weld progression	N/A	N/A
Backing gas	N/A	N/A

Machine Welding Variables (QW-360)	Actual Values Used	Range Qualified
Direct / remote visual control	N/A	N/A
Automatic voltage control	N/A	N/A
Automatic joint tracking	N/A	N/A
Welding position	N/A	N/A
Consumable insert	N/A	N/A
Backing **	N/A	N/A
Single / multiple pass per side	N/A	N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

Notes:

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
None		None	
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Radiographic test results: Acceptable Per QW-302.2 and QW-191

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: IRIS NDT

Lab test no.: 7/28/2010

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME code.

Certified By: Steve D. Little  
 STEVE D. LITTLE

Organization: AXH air-coolers, LLC

7/28/2010 QC MANAGER  
 Date



AXH air-coolers, LLC  
 401 E. Lowry Road  
 Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: GOURD, STEVE Stamp: UU

Test WPS No.: P1-P1-14 Rev.: 0 WPQ No.: P1-P1-14

Date: 7/27/2010

Welding process(es) / type(s) used: GTAW / Manual

Type of joint welded: Pipe Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-106, Grade B to SA-106, Grade B

Welder Variables (QW-350)	Actual Values Used	Range Qualified
P- or S-Number to P- or S-Number	P-No. 1 to P-No. 1	P-1 thru P-15F, P-34 & P-4X
Base metal thickness (in.)	0.375	WPS Limits
Pipe diameter (in.)	2.875	1.00" minimum
	<b>GTAW / Manual</b>	<b>GTAW / Manual</b>
Backing **	No backing used	With or without backing
AWS classification	ER70S-6	
Filler metal specification (SFA)	5.18	5.xx
Filler metal F-No.	6	F-No. 6
Filler metal product form	Bare (Solid)	Bare / metal cored
Consumable insert	No insert used	Without insert only
Deposit thickness (in.) [ $\geq 3$ layers]	0.375 [N/A]	0.7500" maximum
Welding position	1GR - Rotated	Flat only
Weld progression	N/A	N/A
Backing gas	No backing gas used	With or Without backing gas
GTAW welding current / polarity	DCEN (straight)	DCEN (straight)

Machine Welding Variables (QW-360)	Actual Values Used	Range Qualified
Direct / remote visual control	N/A	N/A
Automatic voltage control	N/A	N/A
Automatic joint tracking	N/A	N/A
Welding position	N/A	N/A
Consumable insert	N/A	N/A
Backing **	N/A	N/A
Single / multiple pass per side	N/A	N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.  
**\*\* Welds with backing include fillets and double-welded groove welds.**  
**Notes:**

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
None		None	
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Radiographic test results: Acceptable Per QW-302.2 and QW-191

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: IRIS NDT

Lab test no.: 7/27/2010

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME code.

Certified By: Steve D. Little  
 STEVE D. LITTLE

Organization: AXH air-coolers, LLC

7/27/2010 QC MANAGER  
 Date



AXH air-coolers, LLC  
401 E. Lowry Road  
Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: KINZEY, JOHN Stamp: M

Test WPS No.: PI-PI-01 Rev.: 0 WPQ No.: PI-PI-01

Date: 3/15/2005

Welding process(es) / type(s) used: SAW / Machine

Type of joint welded: Plate Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-516, Grade 70 to SA-516, Grade 70

Welder Variables (QW-350)	Actual Values Used	Range Qualified
P- or S-Number to P- or S-Number	P-No. 1 to P-No. 1	All base metals
Base metal thickness (in.)	2.5	WPS Limits
Pipe diameter (in.)	N/A	All diameters
	<b>SAW / Machine</b>	<b>SAW / Mach. and Auto.</b>
Backing **	N/A	N/A
AWS classification	N/A	N/A
Filler metal specification (SFA)	N/A	N/A
Filler metal F-No.	N/A	N/A
Filler metal product form	N/A	N/A
Consumable insert	N/A	N/A
Weld deposit thickness (in.)	N/A	N/A
Welding position	N/A	N/A
Weld progression	N/A	N/A
Backing gas	N/A	N/A

Machine Welding Variables (QW-360)	Actual Values Used	Range Qualified
Direct / remote visual control	Direct control used	Direct control required
Automatic voltage control	N/A	N/A
Automatic joint tracking	Manual tracking	With or Without auto tracking
Welding position	IG - Flat	Flat only
Consumable insert	N/A	N/A
Backing **	Backing used	With backing only
Single / multiple pass per side	Multipass	Single or multipass

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

**Notes:** MACRO ETCH ACCEPTABLE PER ASME SECTION VIII DIV. 1, APP. 28  
RANGE: 5/8" TO 1", 1-1/4" TO 2", 1-3/4" TO 2-3/4", 2-1/2" TO 3-3/4"

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.2 Side bend	Satisfactory	QW-462.2 Side bend	Satisfactory
QW-462.2 Side bend	Satisfactory	QW-462.2 Side bend	Satisfactory
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Radiographic test results: None

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: Metallurgical Services

Lab test no.: 3/14/05

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME code.

Certified By:

STEVE D. LITTLE

Organization: AXH air-coolers, LLC

3/14/2005  
Date

QC MANAGER



AXH air-coolers, LLC  
401 E. Lowry Road  
Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: KINZEY, JOHN Stamp: M

Test WPS No.: P10H-P10H-04 Rev.: 0 WPQ No.: P10H-P10H-04

Date: 6/28/2005

Welding process(es) / type(s) used: SAW / Machine

Type of joint welded: Plate Groove weld

Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-240, Grade S31803 to SA-240, Grade S31803

**Welder Variables (QW-350)**

P- or S-Number to P- or S-Number

**Actual Values Used**

P-No. 10H to P-No. 10H

**Range Qualified**

All base metals

Base metal thickness (in.)

2.5

WPS Limits

Pipe diameter (in.)

N/A

All diameters

**SAW / Machine**

**SAW / Mach. and Auto.**

Backing \*\*

N/A

N/A

AWS classification

N/A

N/A

Filler metal specification (SFA)

N/A

N/A

Filler metal F-No.

N/A

N/A

Filler metal product form

N/A

N/A

Consumable insert

N/A

N/A

Weld deposit thickness (in.)

N/A

N/A

Welding position

N/A

N/A

Weld progression

N/A

N/A

Backing gas

N/A

N/A

**Machine Welding Variables (QW-360)**

**Actual Values Used**

**Range Qualified**

Direct / remote visual control

Direct control used

Direct control required

Automatic voltage control

N/A

N/A

Automatic joint tracking

Manual tracking

With or Without auto tracking

Welding position

IG - Flat

Flat only

Consumable insert

N/A

N/A

Backing \*\*

Backing used

With backing only

Single / multiple pass per side

Multipass

Single or multipass

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

**Notes:** MACRO ETCH ACCEPTABLE PER ASME SECTION VIII DIV. 1, APP. 28

RANGE: 5/8" TO 1", 1-1/4" TO 2", 1-3/4" TO 2-3/4", 2-1/2" TO 3-3/4"

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.2 Side bend	Satisfactory	QW-462.2 Side bend	Satisfactory
QW-462.2 Side bend	Satisfactory	QW-462.2 Side bend	Satisfactory
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Radiographic test results: None

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: Bennett Testing

Lab test no.: 6/28/05

We certify that the statements in this record are correct and that the test coupons were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME code.

Certified By:

Steve D. Little  
STEVE D. LITTLE

Organization: AXH air-coolers, LLC

6/28/2005 QC MANAGER  
Date



AXH air-coolers, LLC  
401 E. Lowry Road  
Claremore, Oklahoma 74017

Welder or Welding Operator Performance Qualification (WPQ)

Welder's Name: BLAN, RYAN D. Stamp: 6D

Test WPS No.: P1-P1-02 Rev.: 0 WPQ No.: P1-P1-02

Date: 1/24/2011

Welding process(es) / type(s) used: GMAW / Semiautomatic

Type of joint welded: Plate Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-516, Grade 70 to SA-516, Grade 70

Welder Variables (QW-350)	Actual Values Used	Range Qualified
P- or S-Number to P- or S-Number	P-No. 1 to P-No. 1	P-1 thru P-15F, P-34 & P-4X
Base metal thickness (in.)	0.375	WPS Limits
Pipe diameter (in.)	N/A	2.875" minimum
	<b>GMAW / Semiauto</b>	<b>GMAW / Semiauto</b>
Backing **	No backing used	With or without backing
AWS classification	ER70S-6	
Filler metal specification (SFA)	5.18	5.xx
Filler metal F-No.	6	F-No. 6
Filler metal product form	N/A	N/A
Consumable insert	N/A	N/A
Deposit thickness (in.) [ $\geq 3$ layers]	0.375 [N/A]	0.4125" maximum
Welding position	2G - Horizontal	Flat & Horizontal
Weld progression	N/A	N/A
Backing gas	No backing gas used	With or Without backing gas
GMAW / FCAW transfer mode	Short-circuiting arc	Short-circuiting arc

Machine Welding Variables (QW-360)	Actual Values Used	Range Qualified
Direct / remote visual control	N/A	N/A
Automatic voltage control	N/A	N/A
Automatic joint tracking	N/A	N/A
Welding position	N/A	N/A
Consumable insert	N/A	N/A
Backing **	N/A	N/A
Single / multiple pass per side	N/A	N/A

Fillet Welds: Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

Notes:

Guided Bend Test (QW-160)

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.3(a) Face bend	Satisfactory	QW-462.3(a) Root bend	Satisfactory
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Volumetric test results: None

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: AXH air-coolers, LLC

Lab test no.: 1/24/2011

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

Certified By:

Steve D Little  
STEVE D. LITTLE

Organization: AXH air-coolers, LLC

1/24/2011 QC MANAGER  
Date



AXH air-coolers, LLC  
 401 E. Lowry Road  
 Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: BLAN, RYAN D. Stamp: 6D

Test WPS No.: P1-P1-02 Rev.: 0 WPQ No.: P1-P1-02

Date: 8/12/2011

Welding process(es) / type(s) used: GMAW / Semiautomatic and FCAW / Semiautomatic

Type of joint welded: Plate Groove weld Joint type(s) qualified: Groove and Fillet Welds

Base metal(s) welded: SA-516, Grade 70 to SA-516, Grade 70

**Welder Variables (QW-350)**

P- or S-Number to P- or S-Number

Base metal thickness (in.)

Pipe diameter (in.)

Backing \*\*

AWS classification

Filler metal specification (SFA)

Filler metal F-No.

Filler metal product form

Consumable insert

Deposit thickness (in.) [ $\geq 3$  layers]

Welding position

Weld progression

Backing gas

GMAW / FCAW transfer mode

	Actual Values Used		Range Qualified	
	P-No. 1 to P-No. 1		P-1 thru P-15F,P-34 & P-4X	
	0.75		WPS Limits	
	N/A		2.875" minimum	
	<b>GMAW / Semiauto</b>	<b>FCAW / Semiauto</b>	<b>GMAW / Semiauto</b>	<b>FCAW / Semiauto</b>
	No backing used	Backing used	With or without backing	With backing only
	ER70S-6	E71T-1		
	5.18	5.20	5.xx	5.xx
	6	6	F-No. 6	F-No. 6
	N/A	N/A	N/A	N/A
	N/A	N/A	N/A	N/A
	0.25 [N/A]	0.5 [Yes]	0.2750" maximum	WPS Limits
	2G - Horizontal	2G - Horizontal	Flat & Horizontal	Flat & Horizontal
	N/A	N/A	N/A	N/A
	No backing gas used	No backing gas used	W/WO backing gas	W/WO backing gas
	Short-circuiting arc	Spray arc	Short-circuiting arc	Spray, Pulsed, or Globular

**Machine Welding Variables (QW-360)**

Direct / remote visual control

Automatic voltage control

Automatic joint tracking

Welding position

Consumable insert

Backing \*\*

Single / multiple pass per side

	Actual Values Used		Range Qualified	
	N/A	N/A	N/A	N/A
	N/A	N/A	N/A	N/A
	N/A	N/A	N/A	N/A
	N/A	N/A	N/A	N/A
	N/A	N/A	N/A	N/A
	N/A	N/A	N/A	N/A
	N/A	N/A	N/A	N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

Notes:

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.2 Side bend	Satisfactory	QW-462.2 Side bend	Satisfactory
None		None	
None		None	

Visual examination results: Visual exam satisfactory per QW-302.4 and QW-194

Volumetric test results: None

Welding test conducted by: AXH air-coolers, LLC

Mechanical/Radiographic tests conducted by: AXH air-coolers, LLC

Lab test no.: 8/12/2011

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

Certified By:

Steve D Little  
 STEVE D. LITTLE

Organization: AXH air-coolers, LLC

8/12/2011 QC MANAGER  
 Date



AXH air-coolers, LLC  
401 E. Lowry Road  
Claremore, Oklahoma 74017

**Welder or Welding Operator Performance Qualification (WPQ)**

Welder's Name: **HUTCHINSON, EDGAR** Stamp: **AB**

Test WPS No.: **P1-P1-02** Rev.: **0** WPQ No.: **P1-P1-02**

Date: **1/23/2012**

Welding process(es) / type(s) used: **GMAW / Semiautomatic and FCAW / Semiautomatic**

Type of joint welded: **Plate Groove weld** Joint type(s) qualified: **Groove and Fillet Welds**

Base metal(s) welded: **SA-516, Grade 70 to SA-516, Grade 70**

**Welder Variables (QW-350)**

P- or S-Number to P- or S-Number

Base metal thickness (in.)

Pipe diameter (in.)

**Actual Values Used**

P-No. 1 to P-No. 1

1

N/A

**Range Qualified**

P-1 thru P-15F, P-34 & P-4X

WPS Limits

2.875" minimum

Backing \*\*

AWS classification

Filler metal specification (SFA)

Filler metal F-No.

Filler metal product form

Consumable insert

Deposit thickness (in.) [ $\geq 3$  layers]

Welding position

Weld progression

Backing gas

GMAW / FCAW transfer mode

**GMAW / Semiauto**

**FCAW / Semiauto**

**GMAW / Semiauto**

**FCAW / Semiauto**

No backing used

Backing used

With or without backing

With backing only

ER70S-6

E71T-1

5.xx

5.xx

5.18

5.20

F-No. 6

F-No. 6

6

6

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

0.25 [N/A]

0.75 [Yes]

0.2750" maximum

WPS Limits

2G - Horizontal

2G - Horizontal

Flat & Horizontal

Flat & Horizontal

N/A

N/A

N/A

N/A

No backing gas used

No backing gas used

W/WO backing gas

W/WO backing gas

Short-circuiting arc

Spray arc

Short-circuiting arc

Spray, Pulsed, or Globular

**Machine Welding Variables (QW-360)**

Direct / remote visual control

Automatic voltage control

Automatic joint tracking

Welding position

Consumable insert

Backing \*\*

Single / multiple pass per side

**Actual Values Used**

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

**Range Qualified**

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

**Fillet Welds:** Qualified to make fillet welds of any size on all base material thicknesses and pipe diameters of any size.

\*\* Welds with backing include fillets and double-welded groove welds.

Notes:

**Guided Bend Test (QW-160)**

Figure Number and Type	Result	Figure Number and Type	Result
QW-462.2 Side bend	Satisfactory	QW-462.2 Side bend	Satisfactory
None		None	
None		None	

Visual examination results: **Visual exam satisfactory per QW-302.4 and QW-194**

Volumetric test results: **None**

Welding test conducted by: **AXH air-coolers, LLC**

Mechanical/Radiographic tests conducted by: **AXH air-coolers, LLC**

Lab test no.: **1/23/2012**

We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.

Organization: **AXH air-coolers, LLC**

Certified By:

*Steve D. Little*  
STEVE D. LITTLE

1/23/2012

Date

QC MANAGER

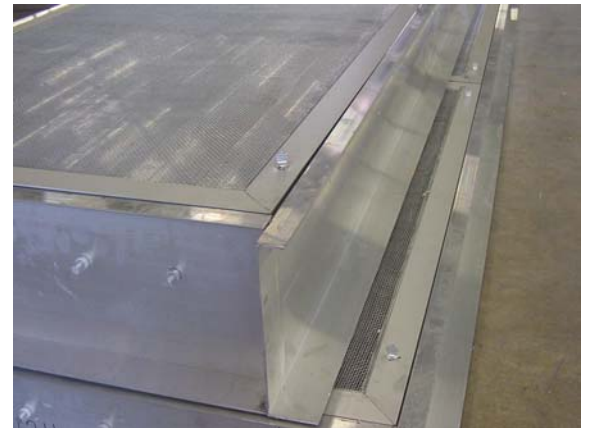


# Duraflow Industrial Louvers

- Aluminum or Galvanized Steel Construction
- Built to Heavy Duty Airtech Standards
- Optional API 661 Compliance
- Bolted or Welded Construction
- Internal Mechanism / Actuation



- Bug Screens & Hail Guards
  - Wire Cloth
  - Expanded Metal
  - Vinyl
- Fan Guards
- Recirc Doors with Frames



- Short Lead Times
- Built to Customer Specifications
- Competitive Pricing
- Domestic or Export Crating

*AIRTECH Products, Inc.*  
P.O. Box 790  
Sand Springs, OK 74063  
Phone: 918-241-0264  
Fax: 918-241-0270  
Email: [info@airtechinc.biz](mailto:info@airtechinc.biz)

# Technical Information / Standard Configurations

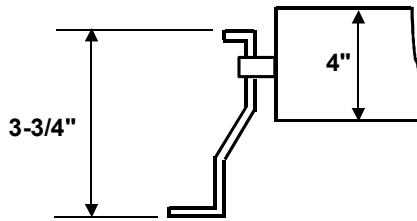
Aluminum Frame (extrusion):	6063-T5
Aluminum Frame (folded sheet):	3003-H14
Galvanized Steel Frame:	A653-G90 Carbon Steel (Mechanical Galvanized Finish)
Blades:	6063-T6 Aluminum
Blade Pins:	
Aluminum:	6061-T6 Aluminum
Stainless Steel:	303 Stainless Steel
Torque Tube:	6063-T6 Aluminum
Actuator Rod:	6063-T6 Aluminum
Actuator Lever Arm:	6061-T6 Aluminum
Clevis:	1018 Carbon Steel
Clevis to Arm Connecting Link:	6061-T6 Aluminum

## Assembly Hardware:

Cap Screws:	ANSI/ASME 18.2.1 Grade 5, Zinc Plate
Nuts:	Locking nut, Performance Spec IFI/100, MIL/N/25027, Light Hex, Standard Height, Zinc Plate
Bearings:	Glass Filled Nylon, (Per API Specification 661)

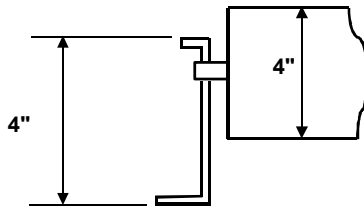
### Series 300

- 3 3/4" Frame
- 4" Blade



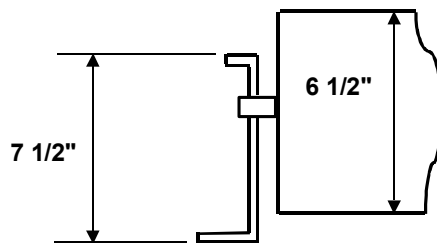
### Series 400

- 4" Frame
- 4" Blade



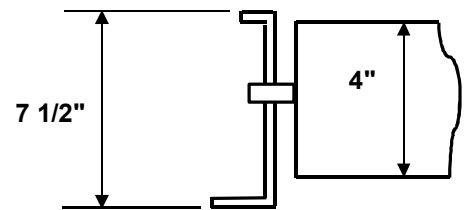
### Series 700

- 7 1/2" Frame
- 6 1/2" Blade



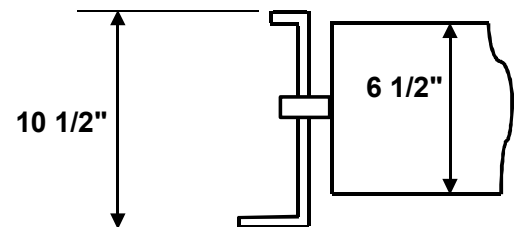
### Series 740

- 7 1/2" Frame
- 4" Blade



### Series 1000

- 10 1/2" Frame
- 6 1/2" Blade



**Airtech Products, Inc., P.O. Box 790, Sand Springs, OK 74063**  
**Phone: 918-241-0264, Fax: 918-241-0270**  
**Email: [info@airtechinc.biz](mailto:info@airtechinc.biz)**

# AIRTECH PRODUCTS, INC.

P.O. Box 790  
8101 West 16<sup>th</sup> Street  
Sand Springs, OK 74063  
Email: info@airtechinc.biz

918-241-0264 (Phone)

918-241-0270 (Fax)

## Duraflow Industrial Louvers

### Installation and Maintenance Instructions

#### **PRE-INSTALLATION ACTIVITIES:**

1. With the louver crate resting firmly on either saw horses or a smooth and level area at grade, remove packing crate top and sides.
2. Make a visual inspection of the louver frame, blades and all linkages/drive mechanisms to ensure there was no shipping damage.
3. Various small parts needed to connect the drive linkages are shipped in a separate and smaller cardboard box. Keep this box at hand but out of the way and in a safe place.
4. Inspect the mounting surface of the cooler giving particular attention to ensure it provides uniform support of the louver perimeter and that it is structurally adequate to support all static and dynamic loadings.
  - a. If the louver is to be mounted in a horizontal configuration, it is **CRITICALLY IMPORTANT** to ensure the mounting surface is uniform and level to +/- .25" over 20'. Airtech louvers are manufactured to precise tolerances and bolting to an off-level surface will cause binding in the moving parts. This will result in inconsistent operation, shorten product life and can cause permanent damage that voids the manufacturers warranty.
  - b. If the louver is to be mounted in a vertical configuration, the installer must confirm there will be uniform support / attachment to the mounting surface at spacing not greater than 18" centers on the louver perimeter flange. Failure to do so may result in bending of the louver frame and inconsistent operation, a shortened product life and can cause damage that voids the manufacturers warranty.
5. Take a moment to visualize the installation and plan the placement of individual louver sub-assemblies. Although all louver installations involve essentially the same procedure, any given application will have some unique characteristics. Some projects will require louver sections to link together at the side via torque tube connectors while others may link together at the ends via end links on the actuator rod. Small projects may require neither type of connection while large projects will require both.
6. Open the cardboard box of small parts and confirm all the necessary pieces are at hand. Depending on the application, this could be torque tube couplings, actuator rod end links, grade level operator components, clevises, etc. Please note, unless the louvers are to be attached via angle clips, the actual attachment hardware won't be included in the louver shipment.
7. Most of the time, louver installation is easiest done using self-drilling speed screws, 1/4" x 1 1/4" long, fine thread. Ensure a screw is in place on all corners and not greater than 18" centers around the louver perimeter. Simply drill through the louver flange into the host structure making sure the screw is completely pulled down tight. If retaining clips is your preferred method of attachment, please review to "Reference A" for instructions on use and installation.

## **MOUNTING & ATTACHMENT**

1. Hoist the louver (or first louver sub-section) into place making sure the lift is well supported around the perimeter. DO NOT ALLOW THE LOUVER TO RACK or excessively bend during the lifting process.
  - a. **For horizontal applications**, set the louver onto the mounting surface and visually confirm 100% of the perimeter is supported and resting flat upon the top of the cooler. Make sure the operating mechanism travels freely through the entire range of motion and there is no interference from complete shut to complete open. If the louver is supplied in multiple sections, install the section with the operator first and perform the motion/operation test noted above. Square the louver to the cooler as best you can but above all, be sure the louver remains square – do not force to the louver out of square to accommodate the cooler. THE LOUVER MUST BE SQUARE to operate properly. After confirming the louver is properly placed relative to the mounting surface (and to other subsequent sections, if applicable), install a self-drilling screw at each corner and at no greater than 18” centers along all flanges. If applicable, hoist subsequent sections into place and following the above instructions, attach each to the host structure. DO NOT STEP ON LOUVER BLADES AT ANY TIME. If you must step out onto the louver, use dimension lumber or plywood as a walking surface.
  - b. **For vertical applications**, hoist the louver (or first louver section) into place and after checking for clearance on moving parts, attach to the cooler with a self drilling screw at each corner and at no greater than 18” spaces along all flanges. Install all attachment screws before releasing hoist cables or hoisting device to ensure the louver is fully attached and there is no deflection in the louver frame. If applicable, hoist subsequent sections into place and following the above instructions, attach each to the host structure.
2. If the louver is supplied in multiple sections, remove the connecting links / couplers from the shipping box and install them as required at the ends of actuator rods and torque tubes. End link installation instructions are detailed as attached “Reference B” and Torque Tube coupling installation instructions are detailed as attached “Reference C”.
3. When all sections are installed and connected, test the drive mechanism to ensure it moves freely, without binding or interference. On very large louvers with multiple sections, this may require use of a lever. Small to average size louvers should easily operate by hand strength on the torque tube.
4. Complete the installation by attaching any remaining components such as pneumatic actuator or grade level operators. Detailed installation instructions for actuator can be found in its shipping carton. For instructions on grade level operators, see attached “Reference D”.
5. After installing any remaining operators, complete the installation process by cycling the louver several times to ensure it moves freely, without interference and isn’t binding at any location. Some adjustment of end links may be required to ensure all louver blades open and shut consistently down the entire length of the louver.
6. Check all attachment fasteners to ensure all are properly tightened and completely engaged to the louver flange.
7. If applicable, check all end link connections and torque tube couplers to ensure they are properly tightened and fasteners are completely engaged.

**MAINTENANCE INSTRUCTIONS (Annual)**

1. Visually inspect all blade pins to ensure the pin bearings are in place and do not have unacceptable wear.
2. Visually inspect all connections between blade horns and actuator rod to confirm all connecting bearing, bolts and nuts are in place and not showing unacceptable wear.
3. Visually inspect all attachment screws to ensure none have backed off or are missing.
4. If dirt or grease buildup is excessive, clean louver blades and operating mechanisms with high pressure clear water wash.
5. Operate any manual levers or grade level operators to confirm all are in good working order and move freely without binding or interference.
6. If actuators are installed, visually inspect the mounting bolts to ensure all are tight and in place. Visually inspect the condition of all connecting links, the clevis and clevis pin.
7. Visually inspect all actuator rod end links and torque tube connectors to confirm all are in place and properly engaged.
8. Remove any leaves or other debris that may have collected in corners or between the louver blades and integral hailguards.

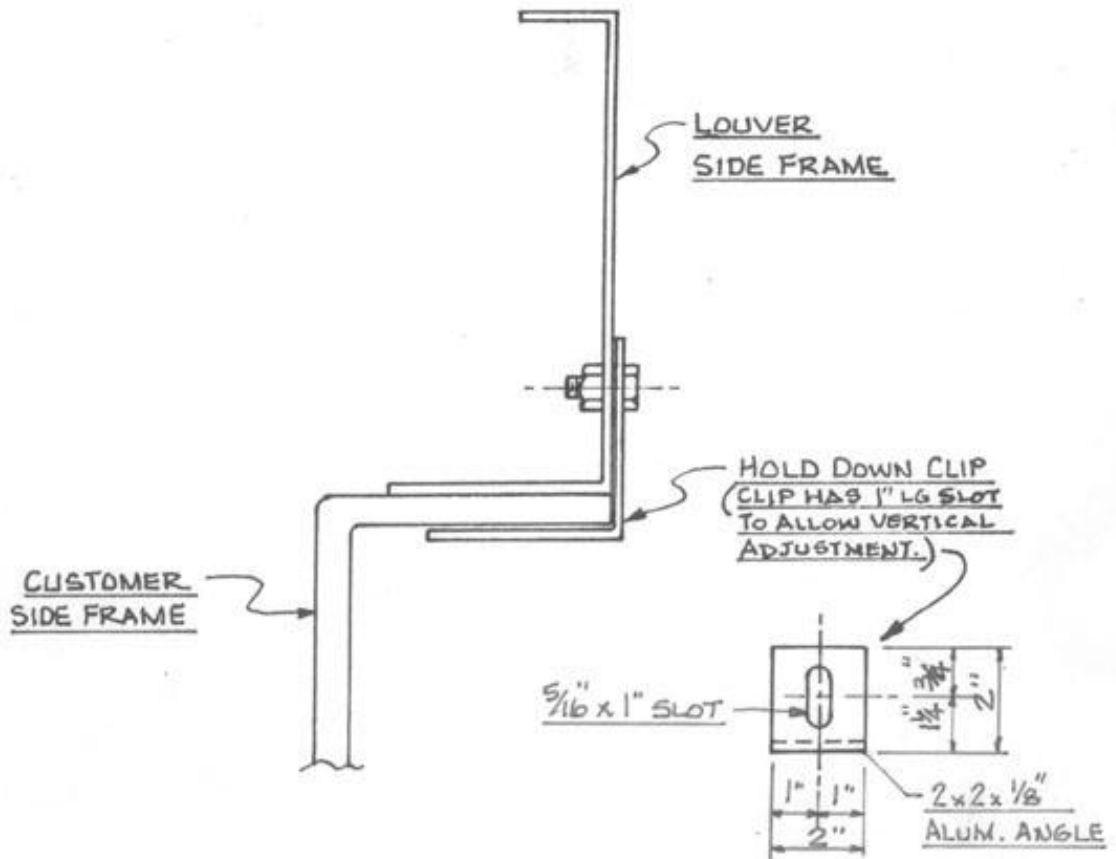
**RECOMMENDED SPARE PARTS LIST**

<b>Item Description</b>	<b>Suggested Quantity</b>
1. Blade horn bearing, bolt and nut kit	1 per 5 Ft <sup>2</sup> louver area
2. Actuator rod end link kit	1 per 2 connections
3. Torque Tube couplings	1 per 2 torque tube connections
4. Blade Pin and Pin Bearing kits	5 per 10 Ft <sup>2</sup> louver area
5. Manual handle kits	1

# AIRTECH Products Inc.

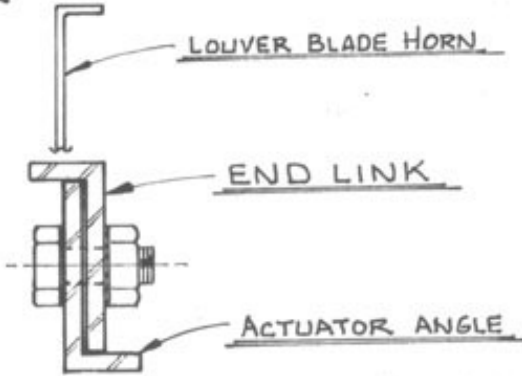
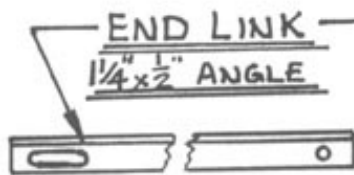
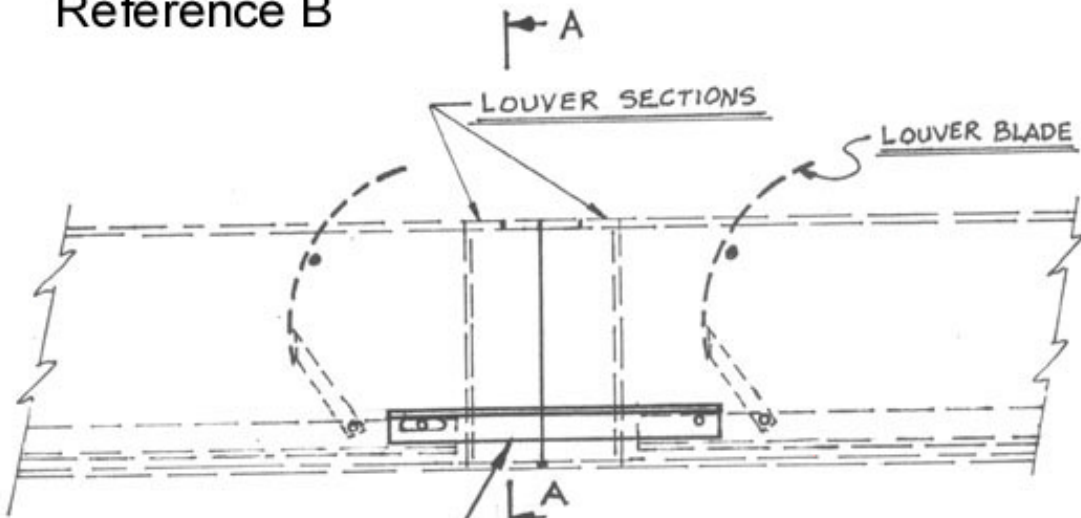
## Reference A

### MOUNTING CLIP DETAIL



P.O. BOX 790  
SAND SPRINGS, OK 74063  
(918) 241-0264

Reference B



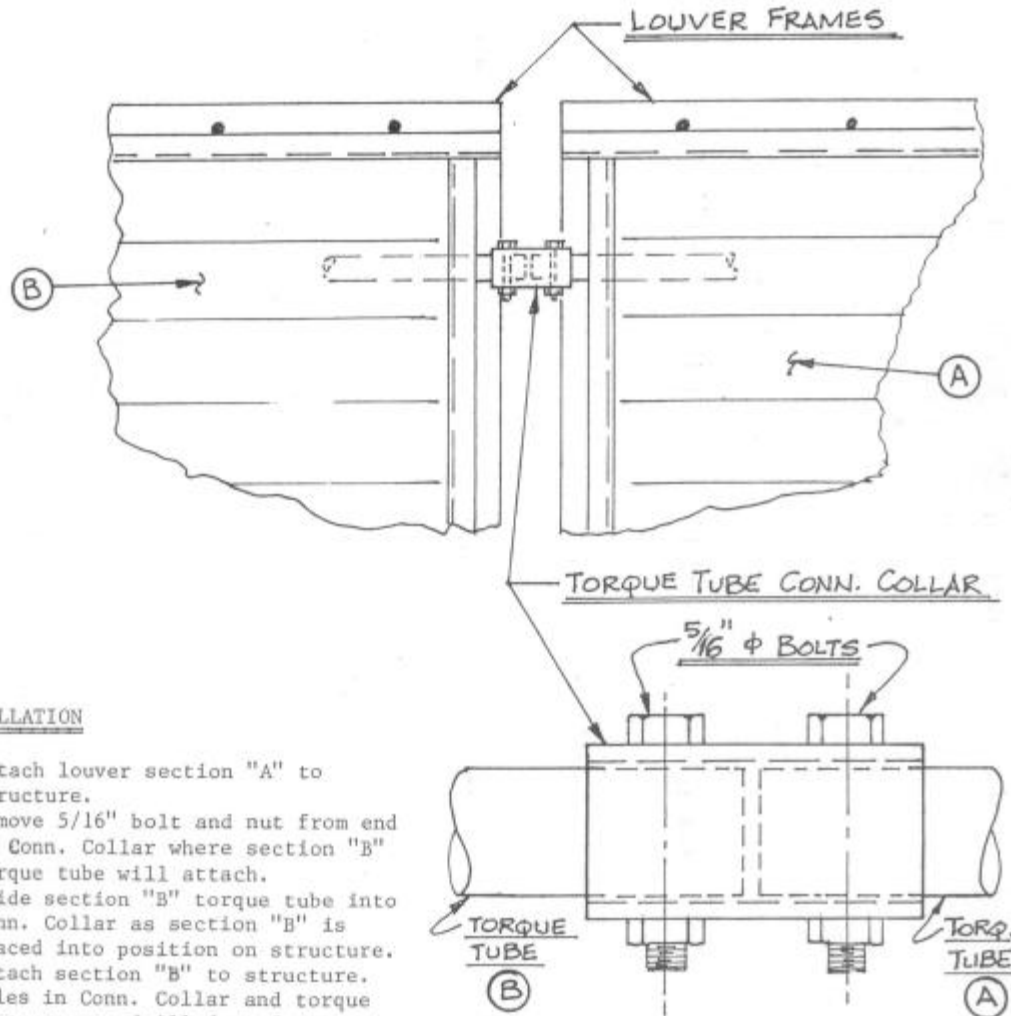
INSTALLATION

1. Position blades in each louver section to same percent of opening.
2. Insert End Link through slots in louver section end frames.
3. Install End Link by attaching to louver actuator rods using the 1/4" bolts and locknuts provided.

END LINKS ARE \$3.25 each including bolts & nuts.

<b>AIRTECH</b>	
INDUSTRIAL SHUTTERS	
<b>END LINK INSTALLATION</b>	
Cust. _____	Dwg. 700-4
Date _____	

## Reference C



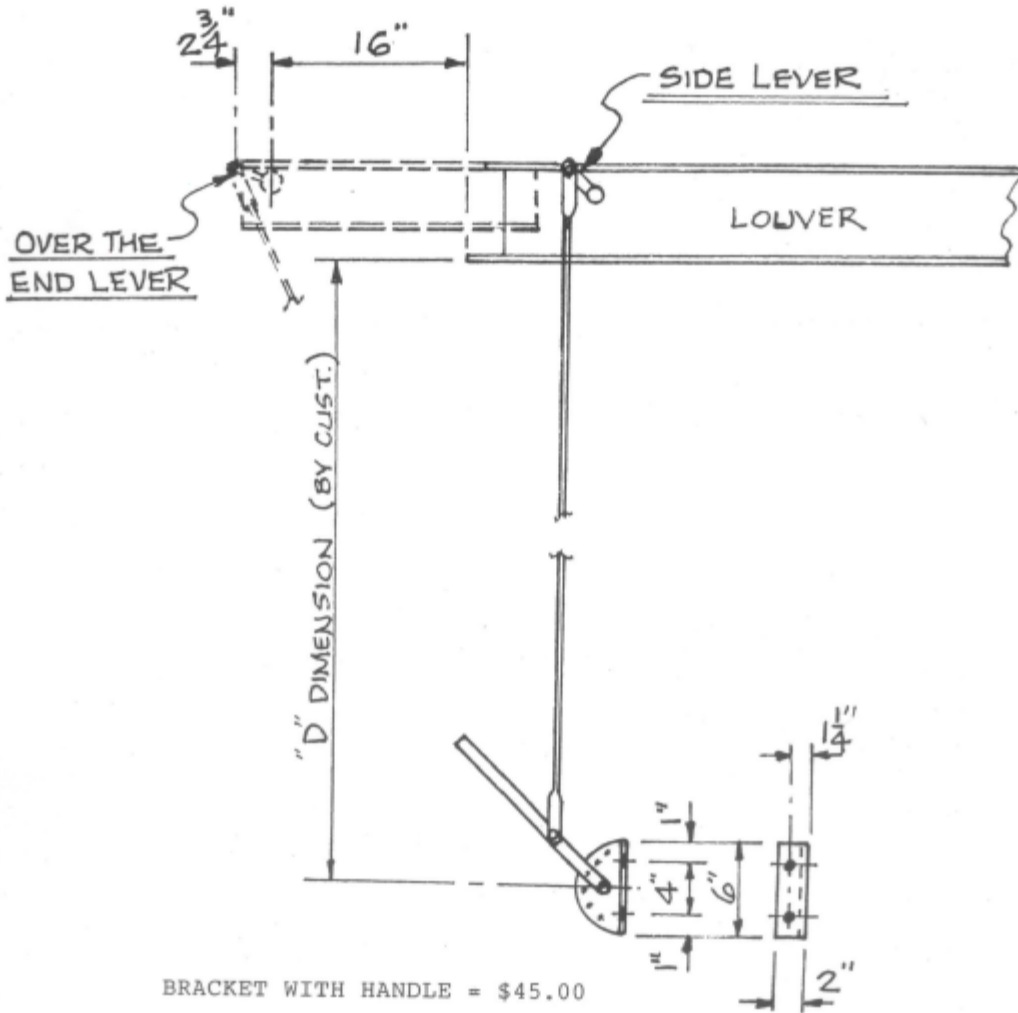
### INSTALLATION

1. Attach louver section "A" to structure.
2. Remove 5/16" bolt and nut from end of Conn. Collar where section "B" torque tube will attach.
3. Slide section "B" torque tube into Conn. Collar as section "B" is placed into position on structure.
4. Attach section "B" to structure.
5. Holes in Conn. Collar and torque tube are pre-drilled at factory to assure proper opening and closing of louver blades. Be sure all louver blades are in same percent of opening before replacing 5/16" bolt and nut to Conn. Collar and section "B" torque tube.

<b>AIRTECH</b>	
INDUSTRIAL SHUTTERS	
<b>Connecting Collar Installation</b>	
Cust. _____	Dwg. 700-4
Date _____	



### Reference D



**AIRTECH**

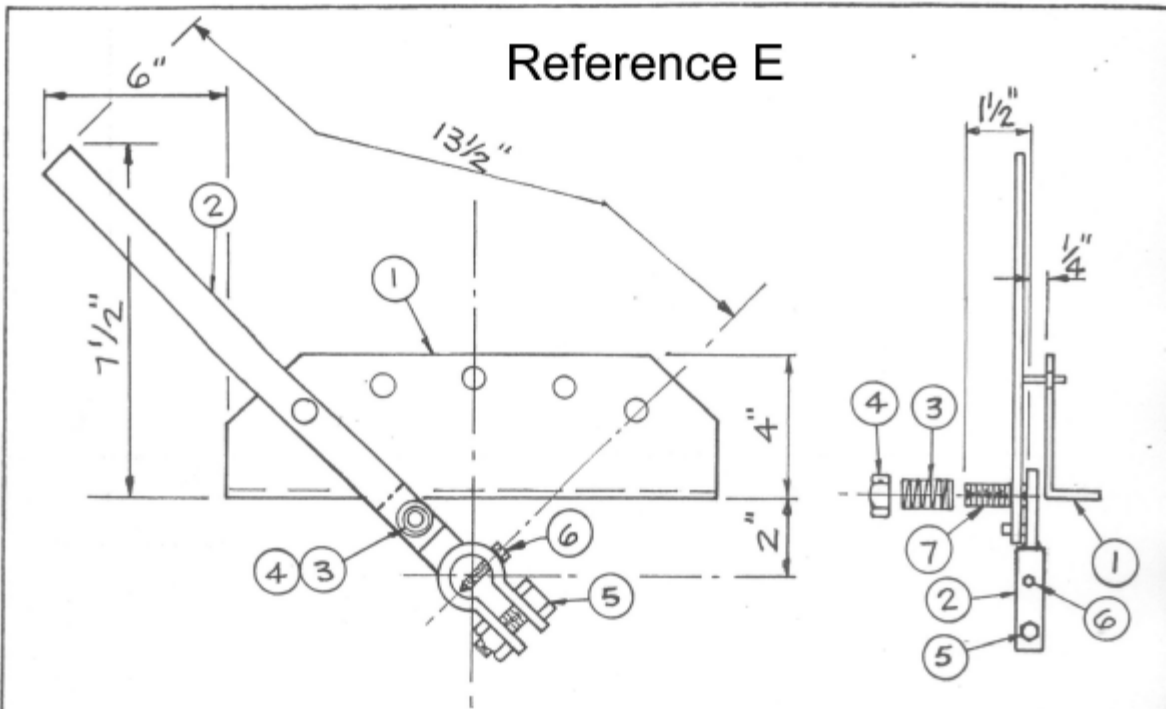
INDUSTRIAL SHUTTERS

MANUAL GRADE LEVEL OPERATOR

Cust.

Date

Dwg. 700-5



Reference E

MANUAL OPERATOR DETAIL

- (1) = Manual Operator Bracket.
- (2) = Manual Operator Handle.
- (3) = Manual Operator Handle Spring.
- (4) = Manual Handle Nut.
- (5) = Manual Handle Clamp Bolt & Nut.
- (6) = Set Screw
- (7) = 3/8" dia. all-thread.

<b>AIRTECH</b>	
INDUSTRIAL SHUTTERS	
MANUAL OPERATOR PARTS	
Cust.	
Date	Dwg. 700 - 3

## Reference F

**AIRTECH PRODUCTS, INC.**

P.O. Box 790  
8101 West 16<sup>th</sup> Street  
Sand Springs, OK 74063

918-241-0264 (Phone)  
918-241-0270 (Fax)

**Louver Materials of Construction**

Aluminum Frame (extrusion):	6063 T5
Aluminum Frame (folded sheet):	3003 H14
Galvanized Steel Frame:	A653-G90 10 Ga. Carbon Steel (Mechanical Galvanized Finish)
Blades:	6063-T6 Aluminum
Blade Pins:	
Aluminum:	6061-T6 Aluminum
Stainless Steel:	303 Stainless Steel
Torque Tube:	6063-T6 Aluminum
Actuator Rod:	6063-T6 Aluminum
Actuator Lever Arm:	6061-T6 Aluminum
Clevis:	1018 Carbon Steel
Clevis to Arm Connecting Link:	6061-T6 Aluminum
Assembly Hardware:	
Cap Screws:	ANSI/ASME 18.2.1 ¼-20, Grade 5, Zinc Plate
Nuts:	Nylon Insert lock nut, Performance Spec IFI/100, MIL/N/25027, Light Hex, Standard Height, Zinc Plate
Bearings:	Glass Filled Nylatron, (Per API Specification 661)

*Airtech Products, Inc.*

*P.O. Box 790*

*8101 West 16th Street*

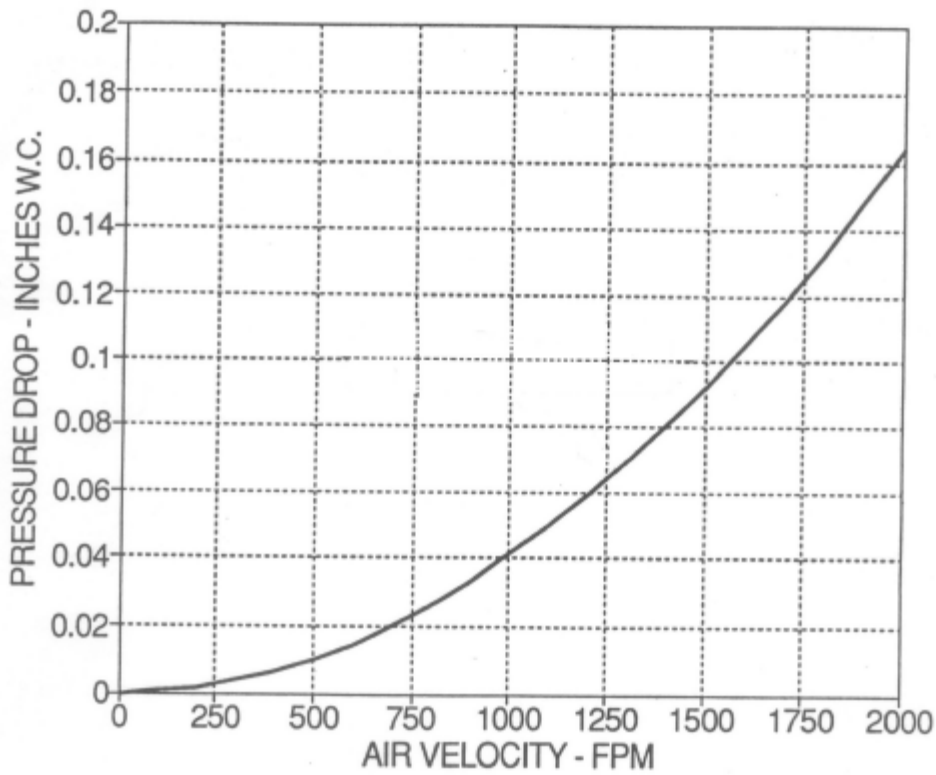
*Sand Springs, OK 74063*

Reference G

*918-241-0264 Phone*

*918-241-0270 Fax*

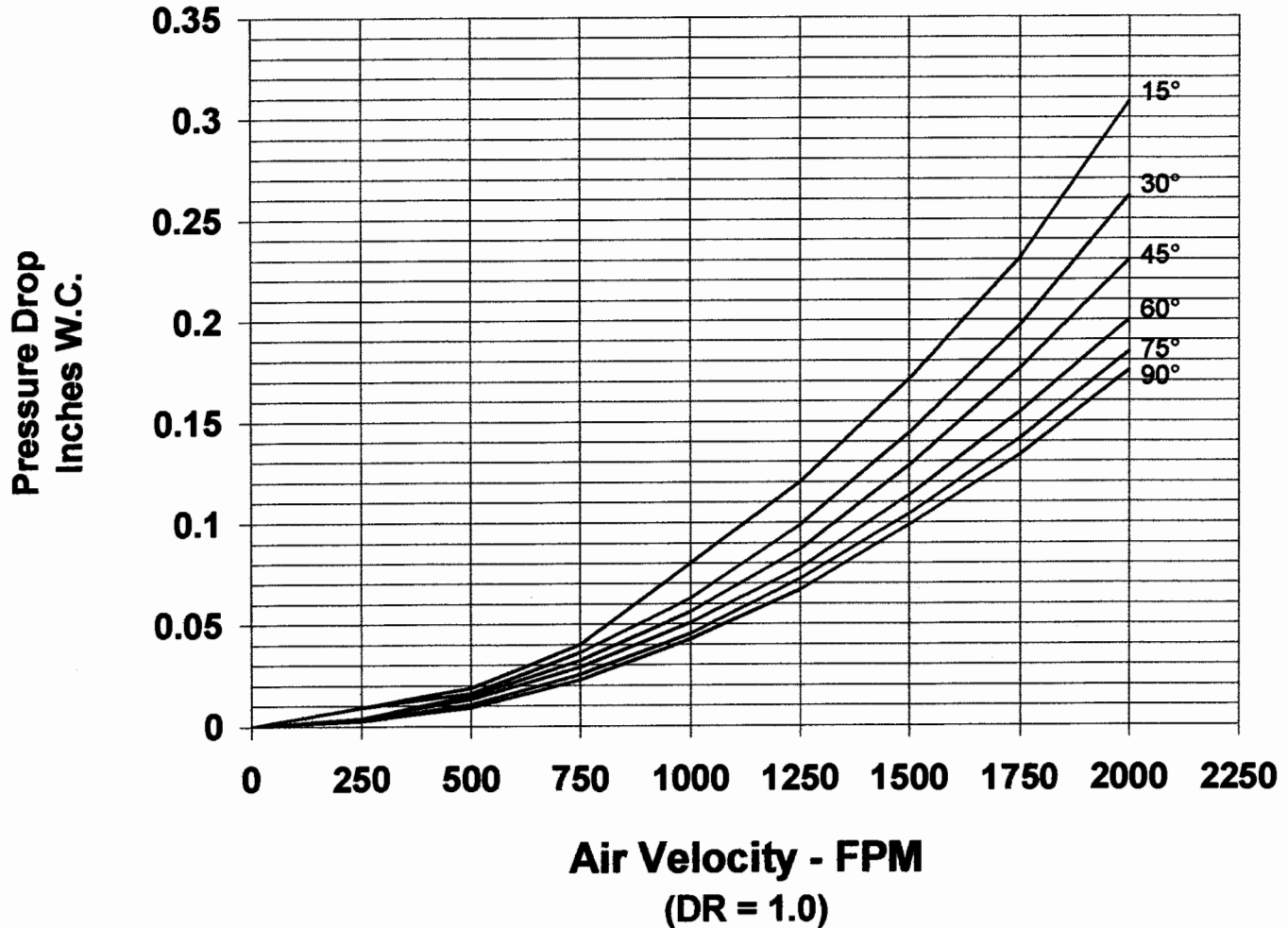
LOUVER PRESSURE DROP CURVE



DENSITY RATIO = 1.0

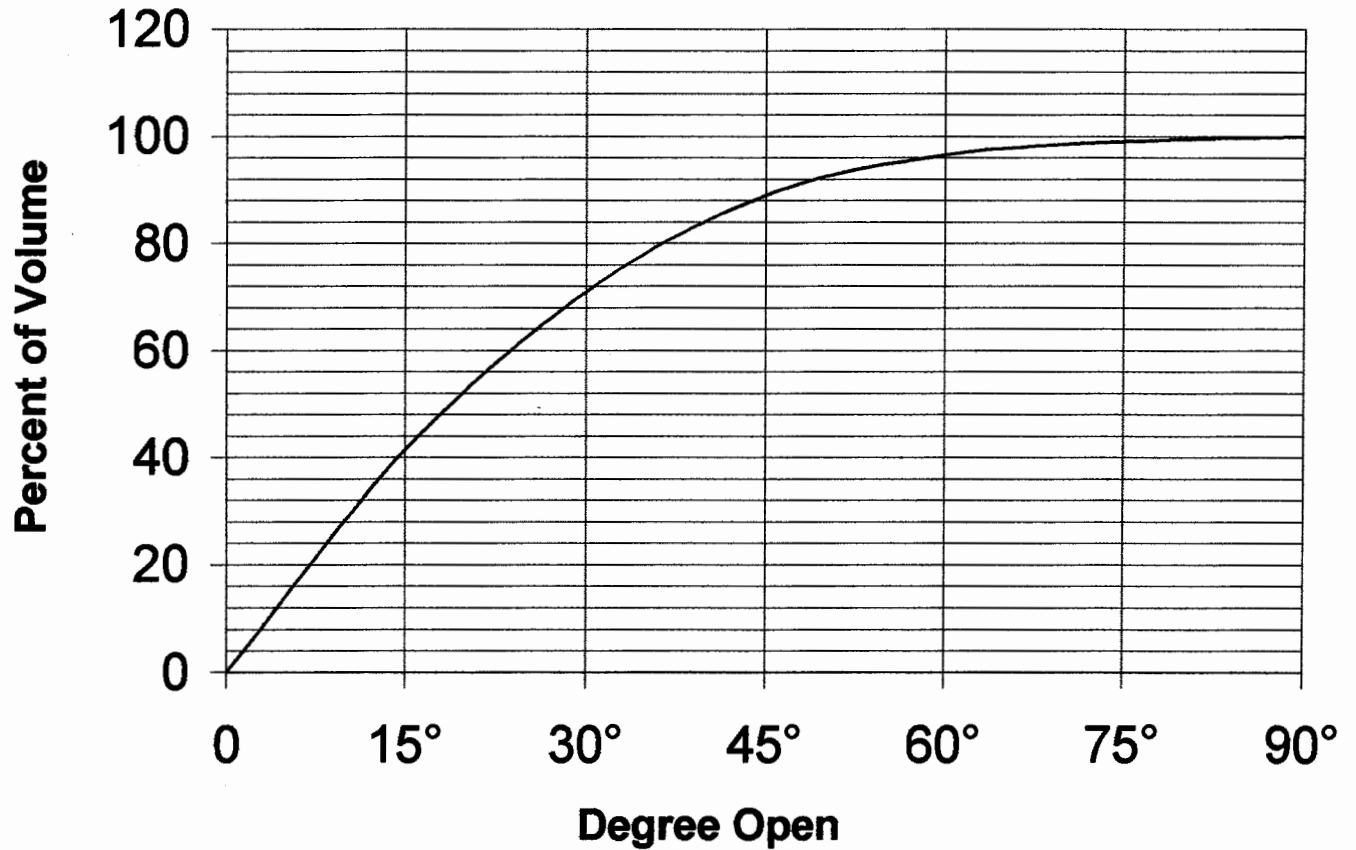
Corrected Pressure Drop Across The Louvers As A  
Function of Air Speed Within The Wind Tunnel.

## Pressure Drop vs Degree of Opening





## Percent of Volume Per Degree Open





# Multi-Wing<sup>®</sup> Z Series Fans.

## Outstanding performance.

Multi-Wing Z Series Fans feature a unique airfoil profile blade design that produces a most efficient combination of high air volume, low power consumption and low noise.

## Strong, lightweight components.

Injection molded engineered thermoplastic or cast aluminum blades and pressure die cast aluminum hubs are strong and lightweight—resulting in less wear and stress on motors and bearings.

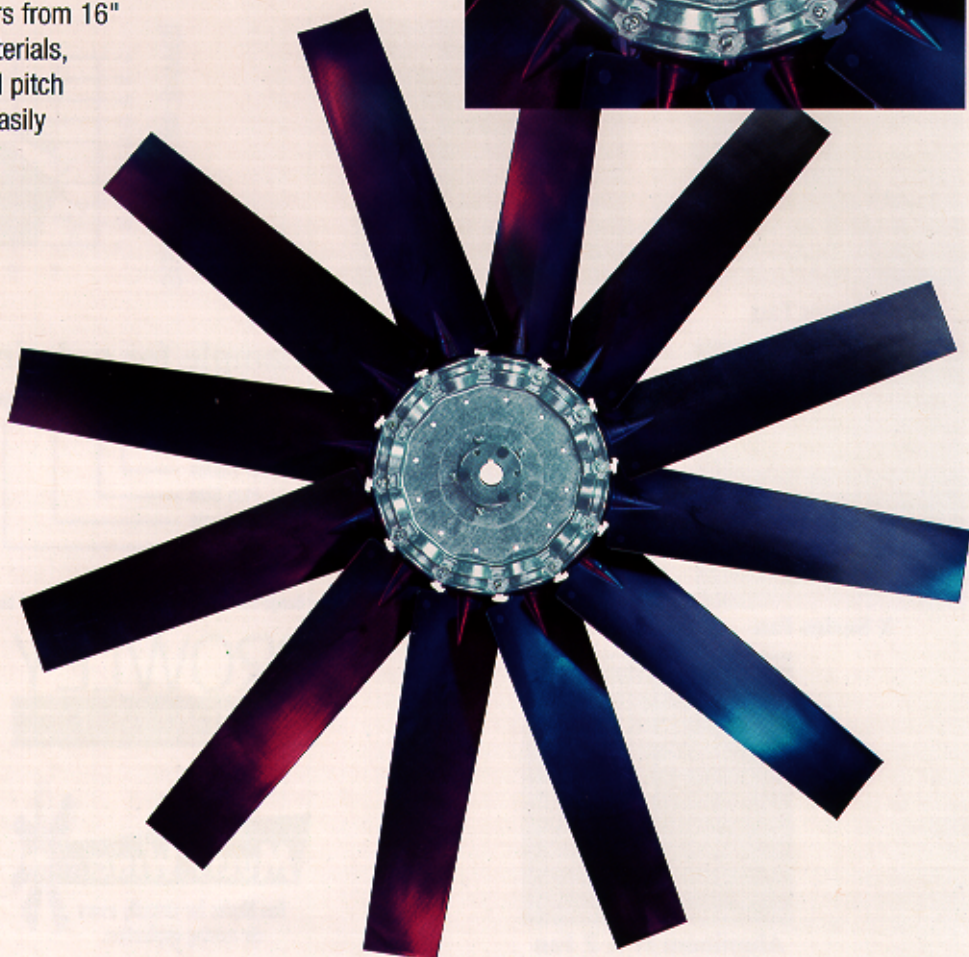
## Z Series applications include:

- HVAC
- Engine cooling
- Heat exchangers
- Evaporators
- Cooling towers

## Flexible choices.

Z Series Fans are available in diameters from 16" to 49", 5 corrosion-resistant blade materials, configurations from 3 to 16 blades and pitch angles from 20° to 50°, making them easily customized to your application.

## Exceptional efficiency by design.



**MULTI-WING<sup>®</sup>**

Fan blades for virtually every air-moving application.

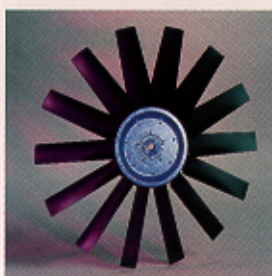


## Multi-Wing® Z Series Fans.

Put application specific, budget friendly Z Series Fans together with short lead times, emergency service, engineering support and no restrictions on minimum order size, and you've got the whole package. Contact us for all the details.

### The Multi-Wing System Design Matrix

Fan Series	H	Z	X	6Z	Aluminum
Blade Profile	twisted airfoil	twisted airfoil	twisted airfoil	increasing arc	twisted airfoil
Blades	2-14	3-16	3-10	3-16	2-16
Diameter	7"-29"	16"-49"	36"-78"	24"-49"	7"-49"
Angles	fixed pitch 25°-50°	adjustable pitch 20°-50°	adjustable pitch 22.5°-50°	adjustable pitch 20°-35°	adjustable or fixed pitch 20°-50°
Application	all	all	all	off highway	all



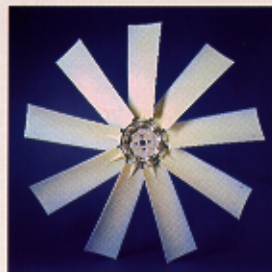
H Series Fan



Z Series Fan



X Series Fan

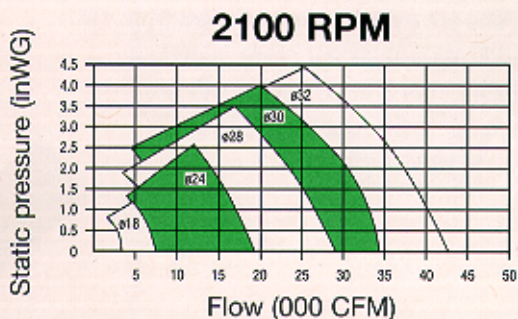
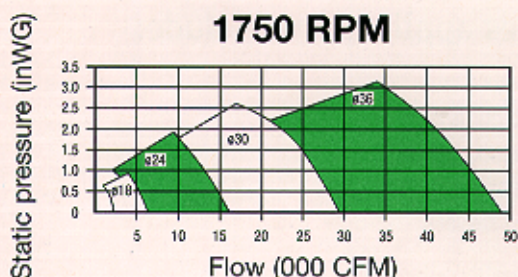
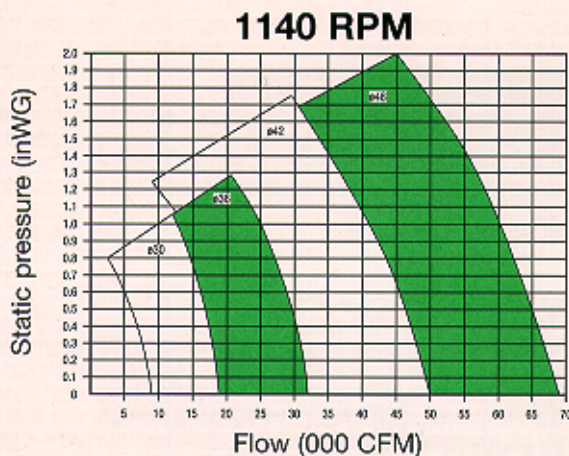


6Z Series Fan

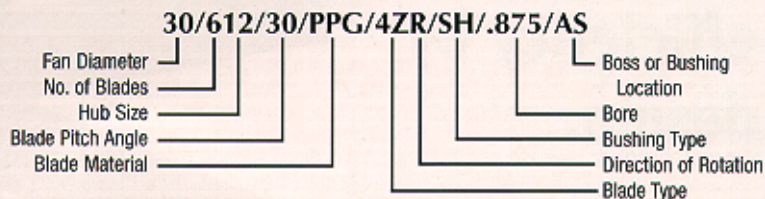


Aluminum H & Z Fan

### Selection Guide



### Example for ordering



For flange mounting, specify bolt pattern (pilot hole diameter, number of bolts, bolt hole size, bolt circle diameter).

**CROWLEY**  
COMPANY, INC.

P.O. Box 425  
15030 Berkshire Industrial Parkway  
Burton, Ohio 44021  
Phone: 440-834-9400  
Toll Free: 800-311-8465  
Fax: 440-834-0449  
Web Site: [www.crowleyfans.com](http://www.crowleyfans.com)  
E-Mail: [engineering@crowleyfans.com](mailto:engineering@crowleyfans.com)



Note: Specifications subject to change without notice.



CROWLEY COMPANY

# Multi-Wing<sup>®</sup> Z Series Fans.

## Features:

- High efficiency
- Low noise
- Lightweight
- High strength
- Corrosion resistant
- Flexibility to customize
- Diameters from 16" to 49"

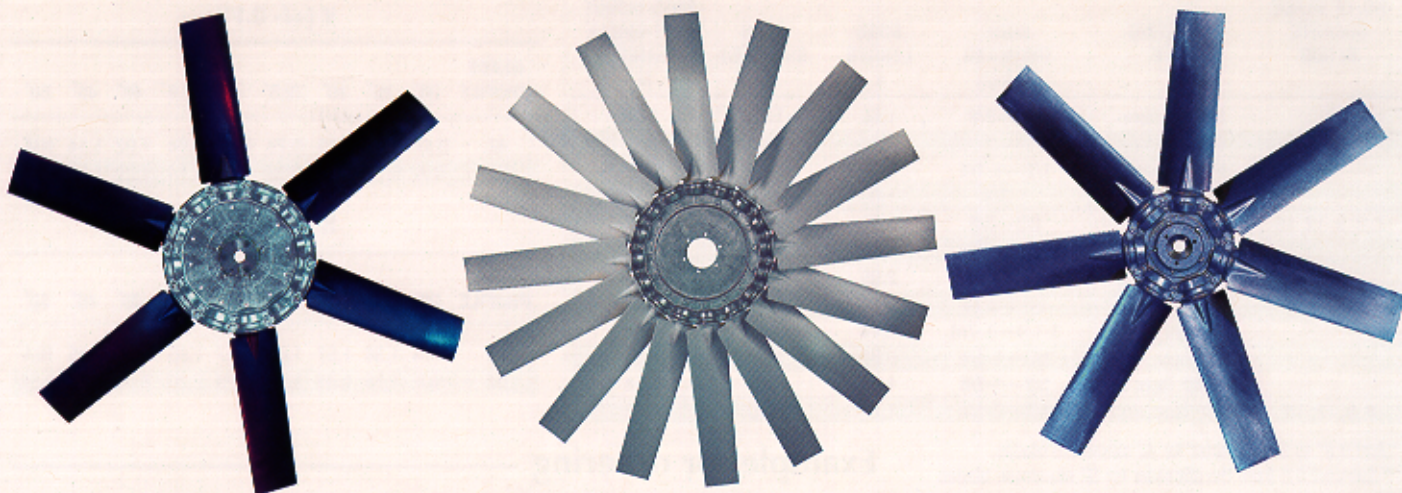


## Z Series Fan Specifications

Blade Material	Symbol	Temperature Range	Maximum Tip Speed	Application Duty
Glass Reinforced Polypropylene	PPG	-40° F to +185° F	320 ft/sec	Standard Material
Glass Reinforced Nylon	PAG	-50° F to +250° F	395 ft/sec	Heavy Duty, Engine Driven
"Super Tuff" Nylon	PAGST	-50° F to +250° F	395 ft/sec	Extreme Vibration
Electro Anti-Static Nylon	PAGAS	-40° F to +250° F	395 ft/sec	Hazardous Conditions
Die Cast Aluminum	AL	-60° F to +300° F	275 ft/sec	Temperature Extremes

All materials are corrosion resistant and spark proof on impact.

PAGAS blades are suitable for underground mining, oil and gas platforms, chemical processing plants, or any application where there is potential for an explosion.



*From 3 blades to 16 blades, 16" in diameter to 49", there's a Crowley Z Series Fan to fit your HVAC, engine cooling, chemical duty or severe duty application.*

**CROWLEY**  
COMPANY, INC.

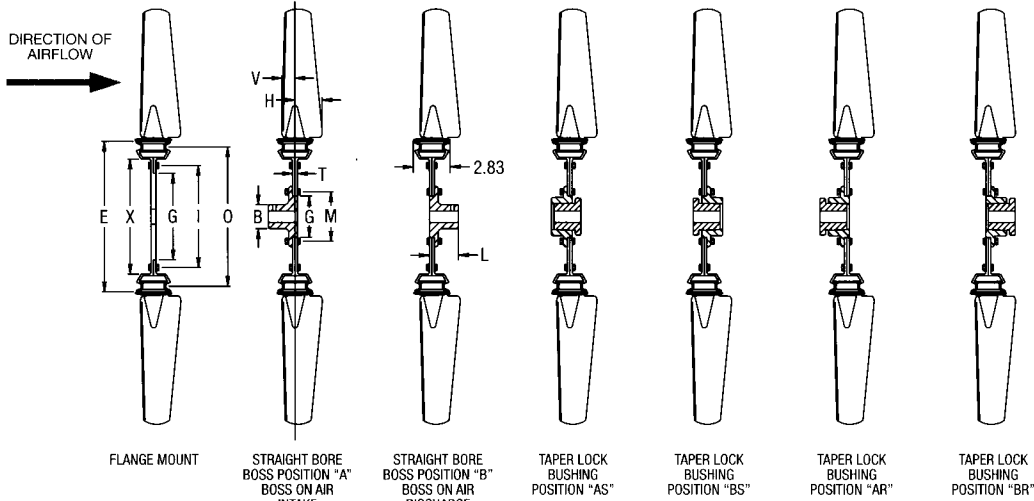
P.O. Box 425 • 15030 Berkshire Industrial Parkway • Burton, Ohio 44021  
Phone: 440-834-9400 • Toll Free: 800-311-8465 • Fax: 440-834-0449  
Web Site: [www.crowleyfans.com](http://www.crowleyfans.com) • E-Mail: [engineering@crowleyfans.com](mailto:engineering@crowleyfans.com)

**MULTI-WING**

Fan blades for virtually every  
air-moving application.



# Multi-Wing<sup>®</sup> Z Series Fan Specifications



## Hub Dimensions

NO. OF BLADE SOCKETS IN HUB	MOUNTING TYPE	BORE DIAMETER (Inches)	MAXIMUM FAN DIAMETER 4Z*	MAXIMUM FAN DIAMETER 5Z**	HUB DIAMETER E	RETAINER PILOT G	HUB THICKNESS T	MAXIMUM SPACER DIAMETER X	INSIDE BOLT CIRCLE DIAMETER I	OUTSIDE BOLT CIRCLE DIAMETER O
5	Shaft Mount	1/2—1-1/4	30.0	40.6	5.69	2.17	0.25	2.88	N/A	5.47
	Shaft Mount	1-3/8	30.0	40.6	5.69	2.17	0.25	2.88	2.50	5.47
	Flange Mount	Custom	30.0	40.6	5.69	2.17	0.25	2.88	N/A	5.47
7	Shaft Mount	1/2—1-7/8	31.5	42.2	7.32	2.95	0.27	4.62	N/A	6.85
	Flange Mount	Custom	31.5	42.2	7.32	2.95	0.27	4.62	N/A	6.85
8	Shaft Mount	1/2—1-7/8	34.7	45.3	10.49	2.95	0.27	7.60	6.93	9.84
	Flange Mount	Custom	34.7	45.3	10.49	2.95	0.27	7.60	6.93	9.84
9	Shaft Mount	1/2—1-7/8	32.1	42.9	7.87	2.95	0.27	5.20	N/A	7.44
	Flange Mount	Custom	32.1	42.9	7.87	3.74	0.27	5.20	N/A	7.44
12	Shaft Mount	1/2—1-7/8	35.3	46.0	11.02	2.95	0.35	8.20	7.28	10.45
	Flange Mount	Custom	35.3	46.0	11.02	6.69	0.35	8.20	7.28	10.45
16	Shaft Mount	1/2—1-7/8	39.0	49.7	14.76	2.95	0.31	12.00	11.02	14.21
	Shaft Mount	1/2—2-1/4	39.0	49.7	14.76	3.54	0.31	12.00	11.02	14.21
	Flange Mount	Custom	39.0	49.7	14.76	9.45	0.31	12.00	11.02	14.21

## Shaft Mounting Boss Dimensions

NO. OF BLADE SOCKETS IN HUB	MOUNTING TYPE	BORE DIAMETER (Inches)	BOSS LENGTH L	BOSS DIAMETER B	BOSS MOUNT BOLT CIRCLE DIAMETER M
5	Straight Bore	5/8—7/8	1.65	1.73	N/A
	Straight Bore	15/16—1-1/8	2.44	2.05	N/A
	JA Taper Lock	1/2—1-1/4	0.75	2.13	N/A
	H Taper Lock	1-3/8	1.00	2.88	2.50
7, 8, 9, 12, 16	Straight Bore	1/2—5/8	1.22	1.10	3.54
	Straight Bore	5/8—3/4	1.65	1.57	3.54
	Straight Bore	7/8	2.05	1.77	3.54
	Straight Bore	1—1-3/16	2.44	2.01	3.54
	Straight Bore	1-1/4—1-7/8	2.44	2.87	3.54
	G/JA Taper Lock	1/2—1-1/4	0.91	2.87	3.54
	SH/P1/SD Taper Lock	1/2—1-7/8	1.50	3.23	3.54
8, 9, 12, 16	SK/SF Taper Lock	1/2—2-1/4	1.77	5.00	4.33

\* Add 0.9" to the diameter for 4Z aluminum blades.

\*\* Subtract 0.5 from the diameter for 5Z aluminum blades.

For severe duty corrosive applications, aluminum hubs can be supplied with protective coatings and stainless steel fasteners. Contact factory for available coatings.

Shaft surfaces should be clean before installation.

Metric bore and shaft sizes also available. Contact factory for availability.

All specifications are subject to change without notice.

Please contact the factory for the latest specifications.

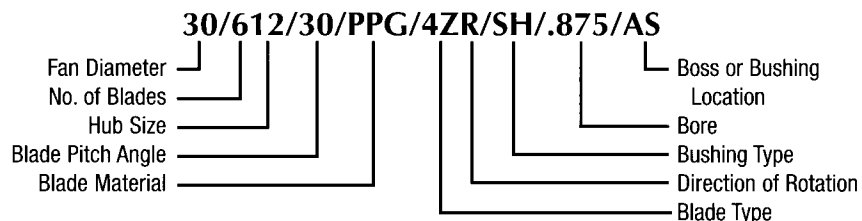
## Blade Dimensions

		V (+/- 0.1")								
BLADE PROFILE		20°	25°	30°	32.5°	35°	37.5°	40°	45°	50°
4Z		0.47	0.59	0.75	0.79	0.87	0.94	1.02	1.14	N/A
5Z		N/A	0.67	0.87	0.98	1.06	1.14	1.22	1.34	1.50

		H (+/- 0.1")								
BLADE PROFILE		20°	25°	30°	32.5°	35°	37.5°	40°	45°	50°
4Z		1.14	1.38	1.57	1.69	1.77	1.85	1.93	2.05	N/A
5Z		N/A	1.65	1.89	2.01	2.09	2.20	2.32	2.48	2.64

## Example for ordering



For flange mounting, specify bolt pattern (pilot hole diameter, number of bolts, bolt hole size, bolt circle diameter).



Multi-Wing Z Series Fans  
Blade Pitch Angle Setting Instructions

Before You Begin:

To maintain balance of fan:

- Mark the hub castings across a joint, so the fan hub can be reassembled in the same orientation.
- Mark the location of any balancing weight. Balancing weight will be on the outer bolt circle, in the form of washers, and/or longer bolts, or an additional balancing nut.
- Number the blades and blade sockets, so that they are replaced into their original position.

If possible, note the location of the pitch setting pin in the blade socket, and whether pin is located in the Hub or Retainer half of the fan (see step 7 for detailed definition).

Step 1 – Determine Blade Type: “4Z”, “5Z”, or “6Z”

If the blade is wider at the tip than at the base near the hub, then you have a 6Z.

Otherwise, look for 4Z or 5Z markings on blade which are in one of two places:

Look on cone section at base of blade (visible when fan is assembled), or

Look inside the bottom of the socket (blade must be removed from hub).

Alternatively, measure the width of the blade at the widest portion at base of blade:

4Z blade is approximately 4-1/2 inches

5Z blade is approximately 5-1/4 inches.

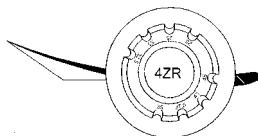
Step 2 – Determine Rotation Code: “L” or “R”

For all fans, if the fan rotates clockwise facing air discharge, it is an R rotation. Otherwise, it is an L rotation.

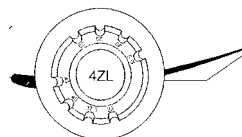
For 4Z and 5Z blades, the rotation code is molded into the blade. The location of the rotation code is either on the cone section at base of blade, or inside bottom of the socket. It is the letter R or L after the 4Z or 5Z molded into the blade.

Example drawings are below for 4Z blades, and 5Z is similar. Viewing socket end of blade, rotation is:

R, or clockwise



L, or counterclockwise







**Step 5 – Determine Hub/Retainer Code: “HUB” or “RET”**

Find “HUB” or “RET” in chart below:

Type	Rotation	Boss Pos.	Blade Pitch Angle									
			20°	25°	27.5°	30°	32.5°	35°	37.5°	40°	45°	50°
4Z	R or L	A	RET	RET	-	RET	RET	HUB	HUB	HUB	HUB	-
4Z	R or L	B	HUB	HUB	-	HUB	HUB	RET	RET	RET	RET	-
5Z	R or L	A	-	RET	-	RET	RET	RET	HUB	HUB	HUB	HUB
5Z	R or L	B	-	HUB	-	HUB	HUB	HUB	RET	RET	RET	RET
6Z	R	A	RET	RET	HUB	RET	HUB	RET	-	-	-	-
6Z	R	B	HUB	HUB	RET	HUB	RET	HUB	-	-	-	-
6Z	L	A	HUB	HUB	RET	HUB	RET	HUB	-	-	-	-
6Z	L	B	RET	RET	HUB	RET	HUB	RET	-	-	-	-

**Step 6 – Determine Groove Number: 1 or 2 or 3 or 4**

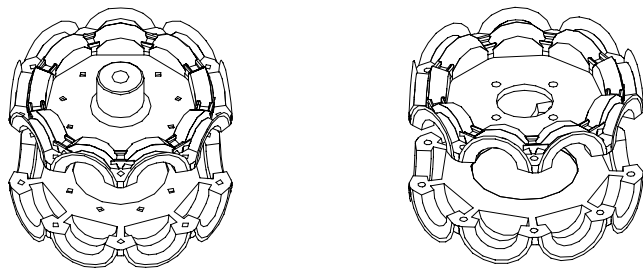
Find the groove number in chart below:

Type	Rotation	Blade Pitch Angle									
		20°	25°	27.5°	30°	32.5°	35°	37.5°	40°	45°	50°
4Z	R	4	3	-	2	1	4	3	2	1	-
4Z	L	1	2	-	3	4	1	2	3	4	-
5Z	R	-	4	-	3	2	1	4	3	2	1
5Z	L	-	1	-	2	3	4	1	2	3	4
6Z	R	1	2	1	3	2	4	-	-	-	-
6Z	L	1	2	4	3	3	4	-	-	-	-

**Step 7 – Final Assembly**

Definition of HUB and RET for purposes of these instructions:

For 2-piece hubset like below:

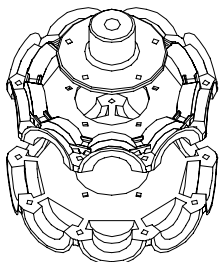


Top half is the HUB, and bottom half is the RET or retainer ring.



Step 7 – Final Assembly continued

For 3-piece hubset as below:



Top two pieces together are considered the HUB, and bottom piece is considered the RET or retainer ring.

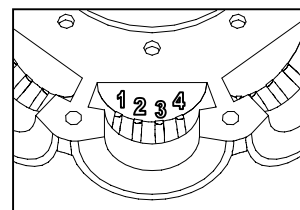
Using the HUB or RET code found in Step 5:

If code is HUB, place the hub down on work surface first (one or two pieces, depending on above).  
If code is RET, place one retainer ring only down on the work surface first.

A weighted coffee can could be used to elevate the fan from the work surface.

Using the Groove Number found in Step 6:

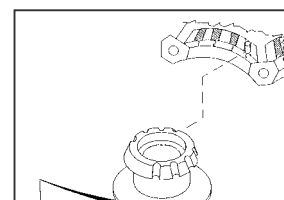
Using picture to right, place the locking pin in the groove number that you found in Step 6 above.



Finally, Insert Blades:

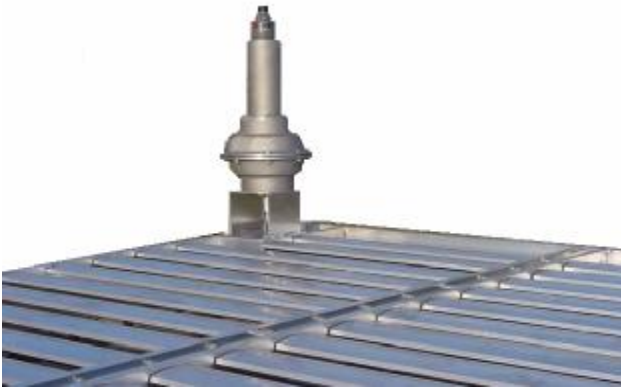
- Place the blade over the pin in the hub/retainer blade socket, so that the pin also fits into the appropriate pitch angle groove in the blade. See example picture to the right.

For 6Z fans, use the pitch angle groove in the blade marked with your rotation (R or L) and pitch angle. Example: L35 is “L” rotation and 35-degree pitch angle.



- Repeat for all blades.
- Assemble hubset together, aligning the match marks you made.
- Replace any balancing weight to its original position.
- To finish, tighten the bolts in a cross pattern to 5 to 6 foot-pounds of torque.

## Durastroke Pneumatic Actuators



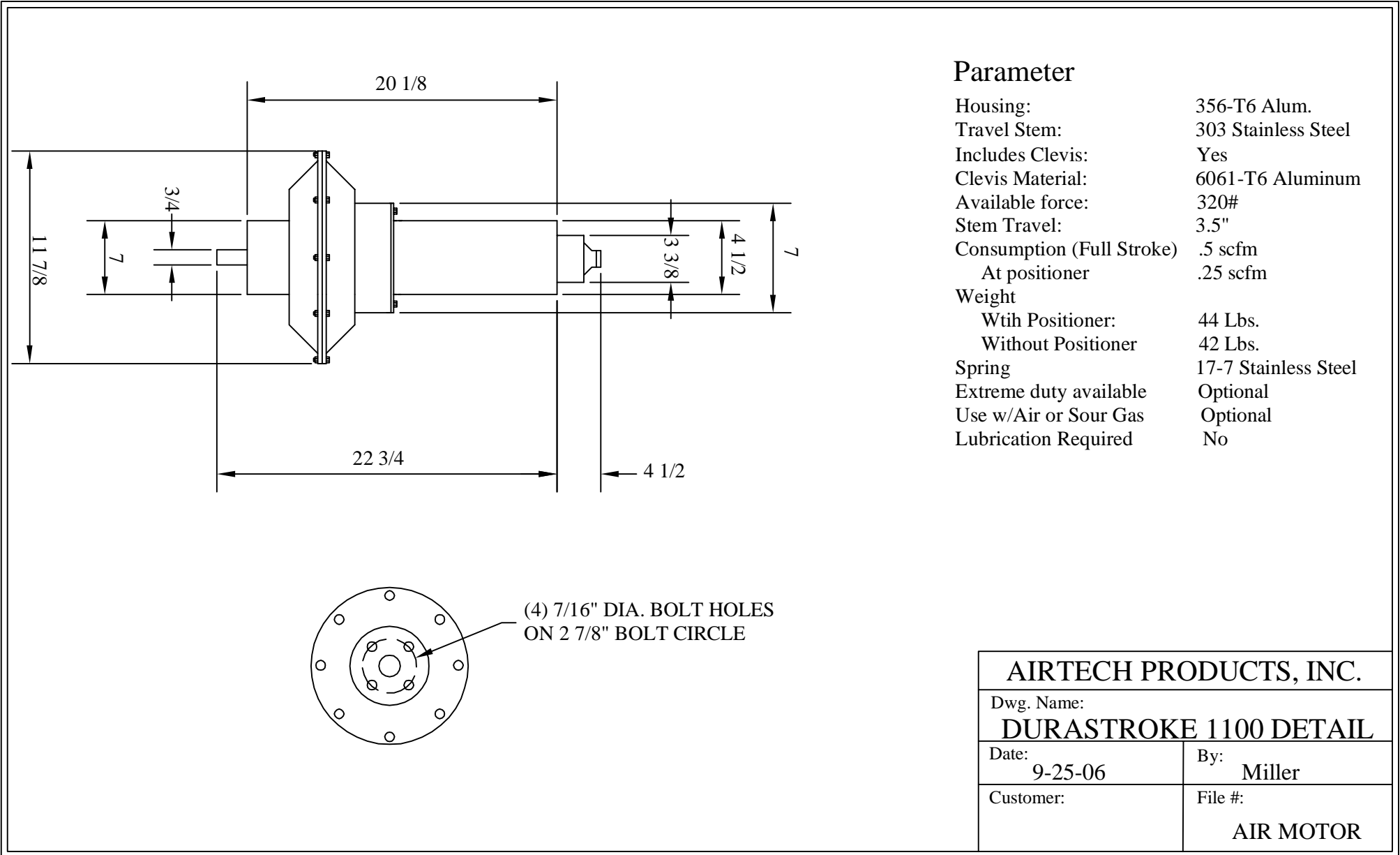
- Heavy Duty Construction
  - Durable Cast Aluminum Housing
  - Available for “extreme duty” temperatures & climates
  - Mounting Versatility
  - Some models available with Fisher DVC Positioner
  - Long life diaphragms
  - Low maintenance
- 
- Short Lead Times
  - Competitive Pricing
  - Various spring rates available

**AIRTECH Products, Inc.**  
1550 S. 81<sup>st</sup> W. Avenue  
Tulsa, OK 74127  
Phone: 918-241-0264  
Fax: 918-241-0270  
[www.airtechproducts.com](http://www.airtechproducts.com)

# Technical Information

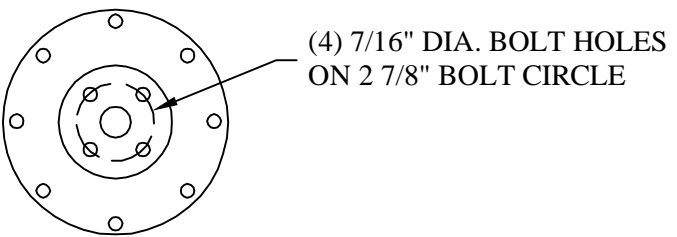
Parameter	Model		
	60 Series	120 Series	1000 – 2000 Series
356-T6 Alum Housing	yes	yes	yes
303 S.S. Travel Stem	yes	yes	yes
Piston	356-T6 Alum	356-T6 Alum	NA
Includes Clevis	yes	yes	yes
Clevis Material	Zinc Plate	Zinc Plate	6061-T6 Alum
Diaphragm	Polyester Fabric w/Nitrile		Nitrile / EPDM
Available Force			320 #
3-15 Spring	18# (20 psi)	36# (20 psi)	NA
6-30 Spring	36# (40 psi)	72# (40 psi)	NA
Stem Travel	4"	6"	3.5"
Consumption (full stroke)	.01 scfm	.03 scfm	.5 scfm
At positioner		.3 scfm (40 psi)	.25 scfm
Weight			
With positioner	8.25 #	14.75 #	44 #
Without positioner	6.25 #	12.75 #	42 #
Spring	Zinc Plate	Zinc Plate	17-7 SS
Extreme duty available	Optional	Optional	Optional
Use w/Air or Sour Gas	yes	yes	Optional
Lubrication Required	no	no	no



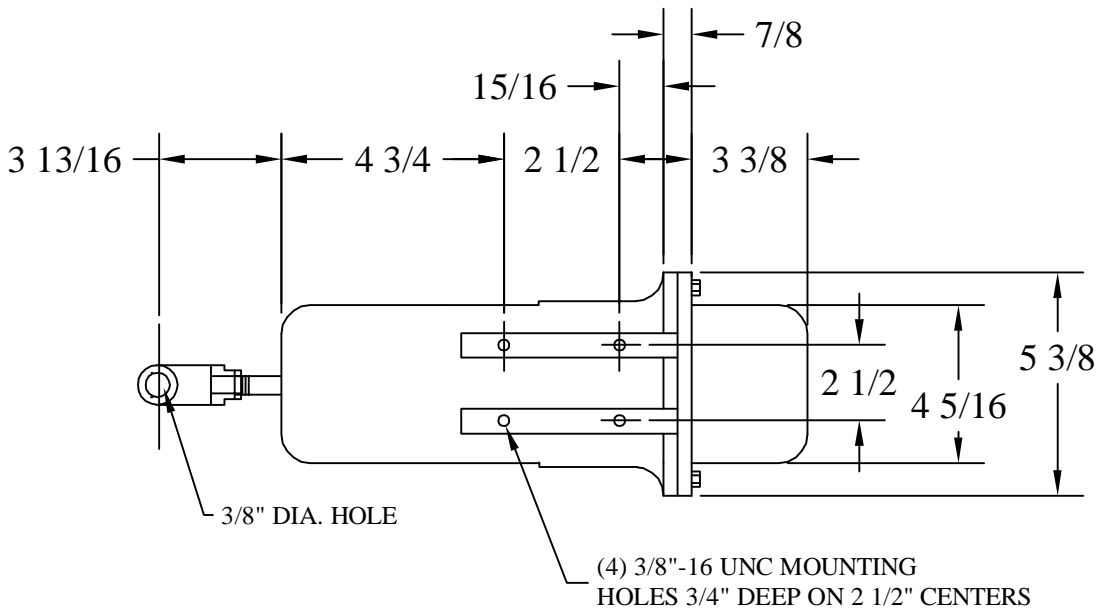
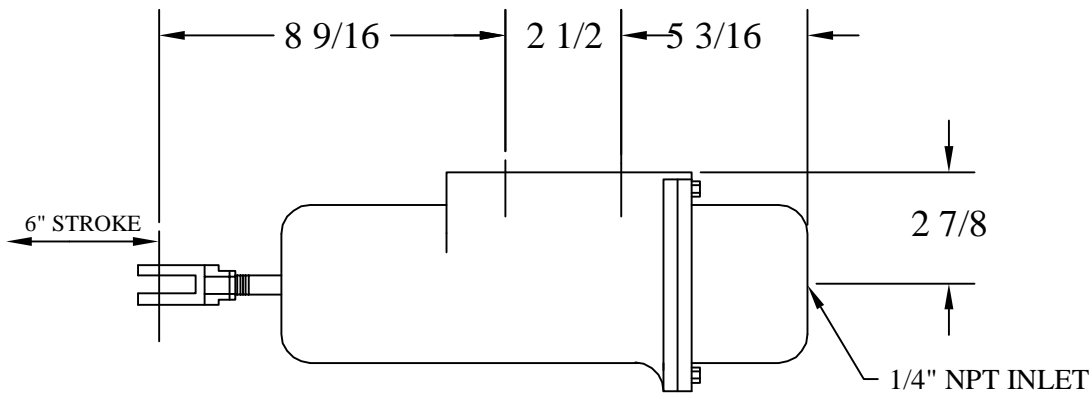


**Parameter**

Housing:	356-T6 Alum.
Travel Stem:	303 Stainless Steel
Includes Clevis:	Yes
Clevis Material:	6061-T6 Aluminum
Available force:	320#
Stem Travel:	3.5"
Consumption (Full Stroke)	.5 scfm
At positioner	.25 scfm
Weight	
With Positioner:	44 Lbs.
Without Positioner	42 Lbs.
Spring	17-7 Stainless Steel
Extreme duty available	Optional
Use w/Air or Sour Gas	Optional
Lubrication Required	No



<b>AIRTECH PRODUCTS, INC.</b>	
Dwg. Name: <b>DURASTROKE 1100 DETAIL</b>	
Date: 9-25-06	By: Miller
Customer:	File #: <b>AIR MOTOR</b>



## Parameter

Housing:	356-T6 Alum.
Travel Stem:	303 Stainless Steel
Piston:	356-T6 Alum.
Includes Clevis:	Yes
Clevis Material:	Zinc Plate
Available force	
3 - 15 Spring	18#
6 - 30 Spring	36#
Stem Travel:	4"
Consumption (Full Stroke)	.01 scfm
At positioner	.3 scfm (40 psi)
Weight	
With Positioner	14.75 Lbs.
Without Positioner	12.75 Lbs.
Spring	Zinc Plated
Extreme duty available	Optional
Use w/Air or Sour Gas	Yes
Lubrication Required	No

## AIRTECH PRODUCTS, INC.

Dwg. Name:

**DURASTOKE 120 ACTUATOR**

Date:

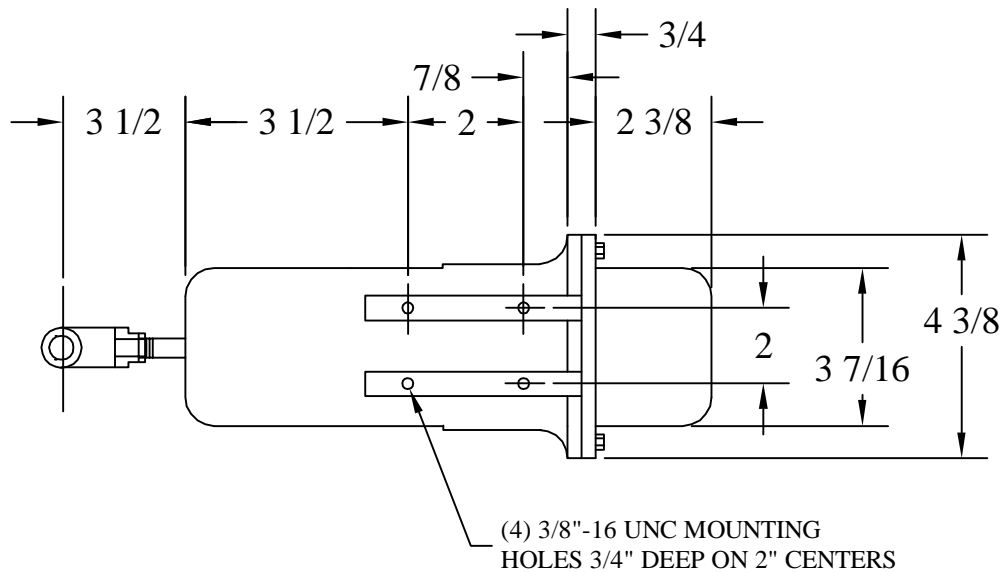
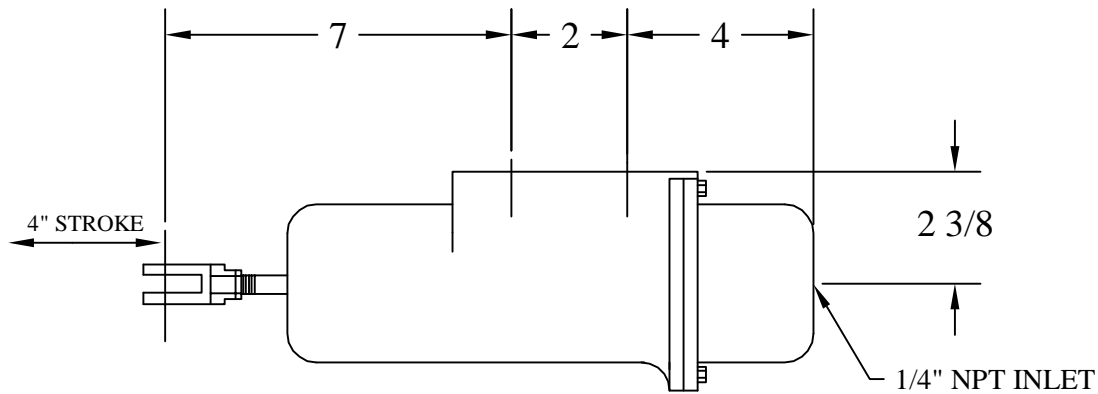
9-21-06

By:

Miller

Customer:

File #:



### Parameter

Housing:	356-T6 Alum.
Travel Stem:	303 Stainless Steel
Piston:	356-T6 Alum.
Includes Clevis:	Yes
Clevis Material:	Zinc Plate
Available force	
3 - 15 Spring	18#
6 - 30 Spring	36#
Stem Travel:	4"
Consumption (Full Stroke)	.01 scfm
At positioner	.3 scfm (40 psi)
Weight	
With Positioner	8.25 Lbs.
Without Positioner	6.25 Lbs.
Spring	Zinc Plated
Extreme duty available	Optional
Use w/Air or Sour Gas	Yes
Lubrication Required	No

### AIRTECH PRODUCTS, INC.

Dwg. Name:

**DURASTOKE 60 ACTUATOR**

Date:

9-21-06

By:

Miller

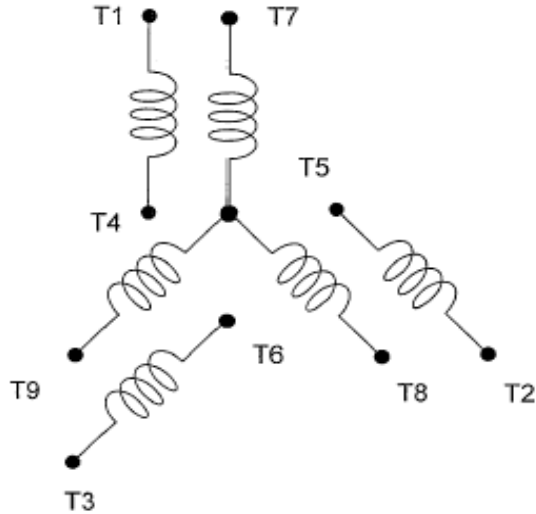
Customer:

File #:

DATE:  
May 12, 2005

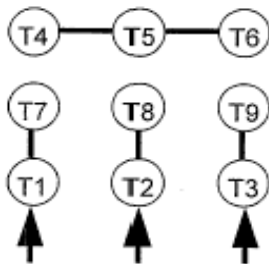
# CONNECTION DIAGRAM

CATALOG NO.:  
E0058

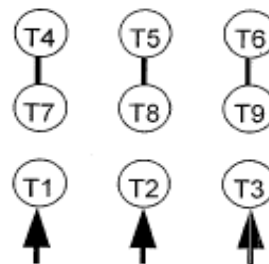


**SCHEMATIC - 2Y/Y CONNECTION**

## ACROSS THE LINE CONNECTION



**LINE  
230 VOLT CONNECTION**



**LINE  
460 VOLT CONNECTION**



OPERATION  
&  
MAINTENANCE  
MANUAL  
FOR  
THREE PHASE  
INDUCTION  
MOTORS

TECO-Westinghouse Motor Company  
5100 North IH-35  
Round Rock, Tx. 78681

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# 1. INTRODUCTION

This and the following instruction address the more common situations encountered in motor installation, operation and maintenance. For the TWMC motor warranty to be and to remain in effect, the motor must be installed and operated in strict accordance with the outline drawing, motor nameplates and these instructions and must not be altered or modified in any unauthorized manner.

During the installation and operation of motors in heavy industrial applications there is a danger of live electrical parts and rotating parts. Therefore to prevent injury and/or damage the basic planning work for installation, transportation, assembly, operation, etc... needs to be done and checked by authorized and competent personnel only.

Since these instructions cannot cover every eventuality of installation, operation and maintenance, the following points should be considered and checked.

- The technical data and information on permissible use such as assembly, connection, ambient and operating conditions given in the related catalogue, operating instructions, nameplates and other production documentation.
- The general erection and safety regulations.
- The local and plant-specific specifications and requirements.
- The proper use of transport, lifting devices and tools.
- The use of personal protective equipment.

Following indications should be observed when reading these instructions.

**Safety instructions are marked as follows:**



**Warning of electric hazards for personnel.**



**Warning of dangers for personnel.**

<b>ATTENTION!</b> <b>Warning of damage for the motor or installation.</b>
--

## **2. ACCEPTING, INSPECTION, STORAGE, TRANSPORTATION**

### **Inspection upon receipt**

Check to following points upon receipt:

- Are the nameplate ratings identical with what you ordered?
- Are dimensions and color in compliance with your specifications?
- Are the nameplate ratings for space heater, thermal protector, temperature detector, etc. identical with what you ordered?
- Is there any damage?
- Are all accessories and accompanying instruction manuals in good order?
- Please ensure that the arrow head indicator really indicates direction of rotation.
- If there are any specific requirements, please ensure they are in conformity with your specifications.

### **2.1 Storage**

When motors are not in operation, the following precautionary measures should be undertaken to assure best performance.

### **2.2 Place**

- (a) High and dry, well ventilated without direct sun, dust or corrosive gas.
- (b) Not located near to a boiler or freezer.
- (c) Entirely free from vibration and easy for movements.
- (d) Motors should be put on pallets to prevent moisture.

### **2.3 Moisture prevention**

Since moisture can be very detrimental to electrical components, the motor temperature should be maintained about 3°C above the dew point temperature by providing either external or internal heat. If the motor is equipped with space heaters, they should be energized at the voltage shown by the space heater nameplate attached to the motor. Incandescent light bulbs can be placed within the motor to provide heat. However, if used, they must not be allowed to come in contact with any parts of the motor because of the concentrated hot spot that could result.

### **2.4**

Even during storage, the insulation resistance should be kept above the specified values.

- (a) For measurement of insulation resistance and acceptable standard values, please refer to measures stated in 3.1.2 "Measurement of insulation resistance".
- (b) Insulation resistance test should be performed once every three months.



## 2.5

If the motor is not in operation for a long period (one week and above) after installation or has been in operation but stopped for a period of time, the following precautions must be taken.

- (a) Protect the motor as measures stated in 2.2.3.
- (b) Insulation resistance test should be performed as stated in 2.2.4.

## 2.6 Bearing protection

- (a) If the motor has been provided with a shaft shipping brace to prevent shaft movement during transit, it must be removed before operating the motor. It is very important that this brace be re-installed exactly as it was originally, before the motor is moved from storage or any time when the motor is being transported. This prevents axial rotor movement that might damage the bearings.
- (b) Motors equipped with sleeve bearings are shipped from the factory with the bearing oil reservoirs drained. In storage, the oil reservoirs should be properly filled to the center of the oil level gauge with a good grade of rust inhibiting oil. To keep the bearing journals well oiled and to prevent rusting, the motor shaft should be rotated several revolutions about every month ensuring the shaft does not come to rest in its original position. While the shaft is rotating, it should be pushed to both extremes of the endplay.
- (c) Motors with anti-friction bearings are properly lubricated with the correct grade of grease at the factory and no further greasing is required in storage. The shaft should be rotated several revolutions about every month to maintain proper distribution of the grease within the bearings.
- (d) Tilt-pad bearings are a type of sleeve bearing used in special design applications. Due to the nature of this bearing, a loose oil ring for delivering lubricant cannot be provided. Therefore, during the storage interval, oil must be periodically manually introduced into the pads and housing to prevent the occurrence of oxidation of the precision machined components.
  - (1) Remove the pipe plug from the bearing cap located above the tilt-bearing shell.
  - (2) Pour in approximately one cup of oil every month and rotate the shaft a few revolutions about every two (2) weeks.
  - (3) For long periods of storage, the oil that accumulates in the housing should be removed.

### **ATTENTION!**

**Care should be taken to keep parts such as fitting surfaces, key, shaft extension and axial central hole from any collision with foreign matter. Grease should also be generously applied to prevent rusting.**

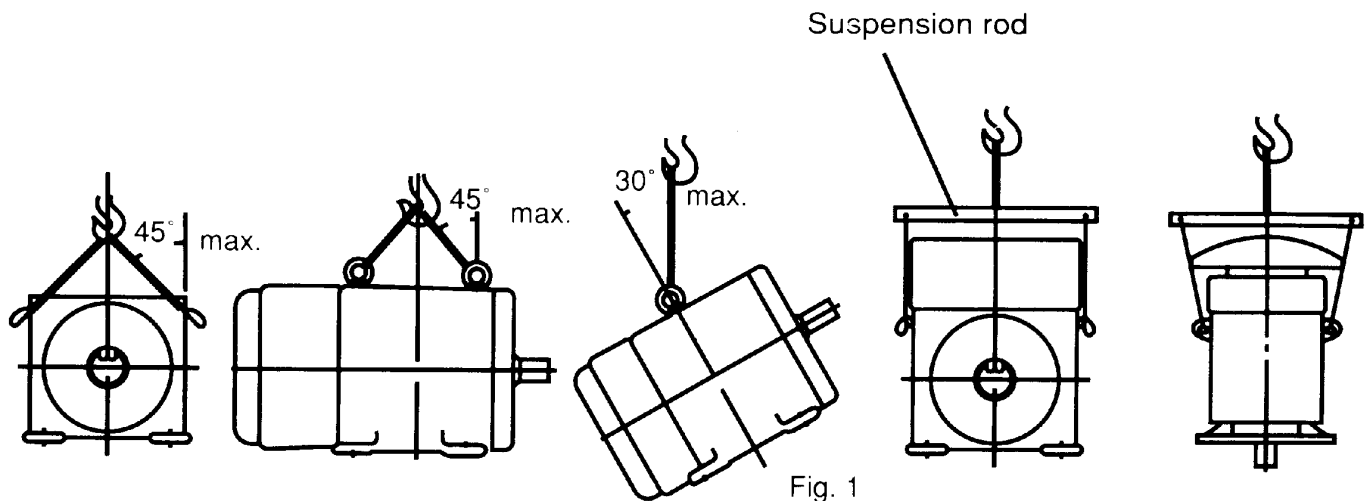
## 2.7 Transportation

To keep the rotating parts of motors from moving, thus preventing damage and scratching during transportation, they should be held securely with a locking device. Remove all transit clamps before operating the motor. It is very important that this device be reinstalled exactly as it was originally, before the motor is moved from storage or any time when the motor is being transported. The vertical mounting type motors should be transported in the vertical position.



Do not use the hoisting hook/eyebolts to lift more than the motor itself. They are designed to support the motor only. Make sure the hoisting hook is correctly attached to the eyebolt(s)/lug(s) are fully screwed in before hoisting. Also note such parts as fan cover, ventilation box, bracket, slip-ring, etc. may have their own hoisting lugs which can only carry their own weight. Nothing extra should be attached while hoisting.

Do not twist the steel wires and make sure the eyebolts have been firmly screwed and the sling angle is correct.



### 3 INSTALLATION

#### Site and environment for motor installation

##### 3.1.1

Standard environment and site conditions for the installation of motors are usually set as follows:

- Ambient temperature:  $-10\sim 40^{\circ}\text{C}$
- Humidity: Relative humidity below 90%RH for totally enclosed types, and below 80%RH for semi-enclosed types.
- Elevation: below 1000 meters or 3300 feet.
- Harmful gases, liquids, dusts, high moisture should be absent.
- Foundations should be strong and free of vibration.

If there are any special environmental conditions, please inform TWMC prior to ordering.

##### 3.1.2 Ventilation and space

- Installation area should be well ventilated.
- The installation space should be large enough to facilitate heat dissipation and maintenance.

#### 3.2 Foundation

##### 3.2.1

Use rigid and solid sole plate or common bed as foundation.

For best motor performance, it is advisable to use a sole plate or common bed, particularly when using a shaft coupling.

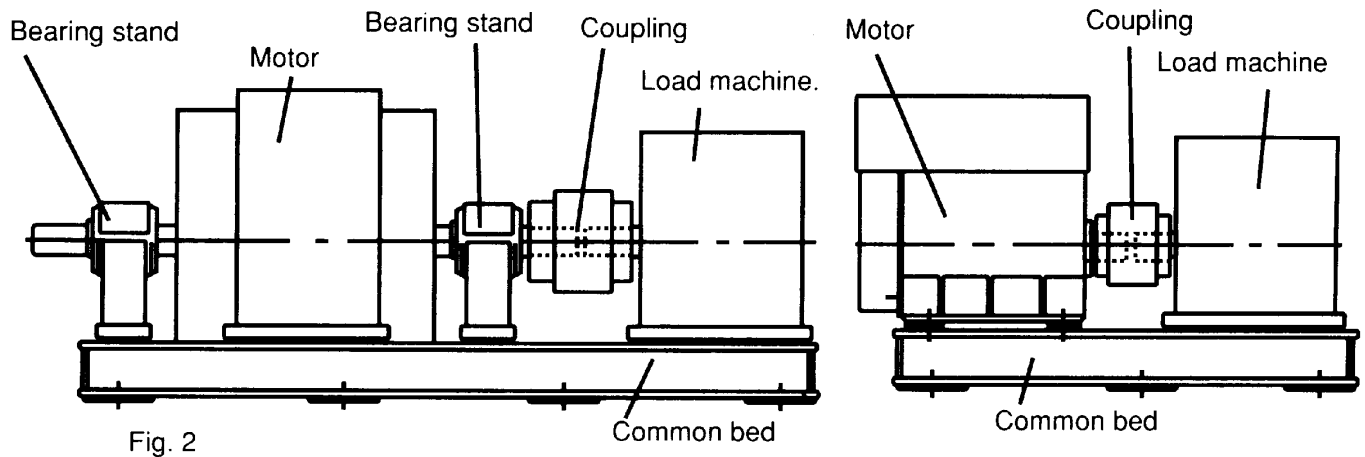


Fig. 2

### 3.2.2 Installation

- Select an appropriate foundation surface for the sole plate or common bed, which will be, considered the ultimate level.
- Align the position of the common bed with reference to that level.
- Align the level accuracy at least at four points such as bearing mounting, shaft extension etc. The accuracy should be within 0.04mm or .0015 inches
- Sole plate or common bed should be embedded in concrete foundation as illustrated in Fig. 3. Stiff pads should also be installed beneath the wedges, which are welded together at various spots about 400-500mm (15.75-19.70 inches) apart etc., to enable the foundation to carry evenly the weight of the whole motor.
- The base should be sturdy and rigid to keep it flat and level.
- Make sure the mortar and concrete are completely dry, and the precision of the level is acceptable, and then set the motor on the mounting foundation.
- Accurately install shaft couplings, belt sheaves etc., then weld the wedges solid to prevent untoward change in position.

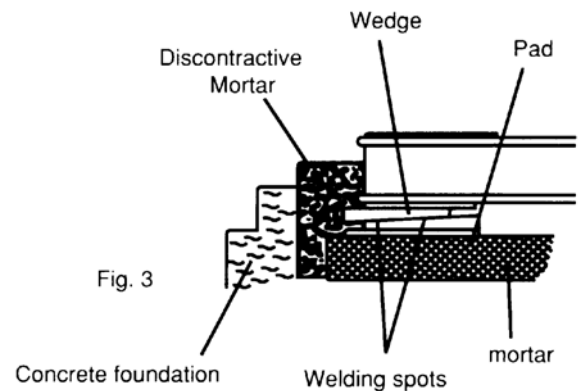


Fig. 3

### 3.2.3 The foundation of vertical induction motors: (Also the foundation of pump)

- Foundation of motor/pump must be rigid and secure to provide adequate support. There must be no vibration, twisting, misalignment etc. due to inadequate foundations.
- A massive concrete foundation is preferred in order to minimize vibration. Rigidity and stability are enhanced by prop plate and foundation bolt. As shown in Fig. 4.

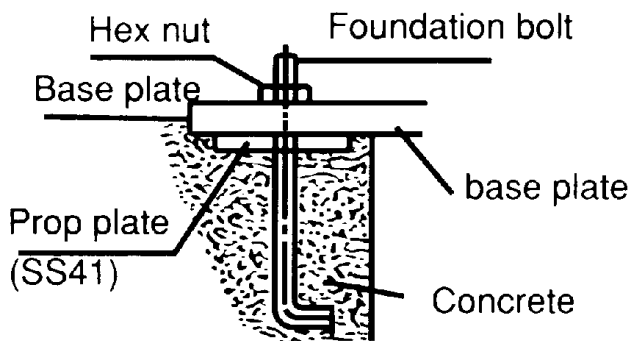


Fig. 4

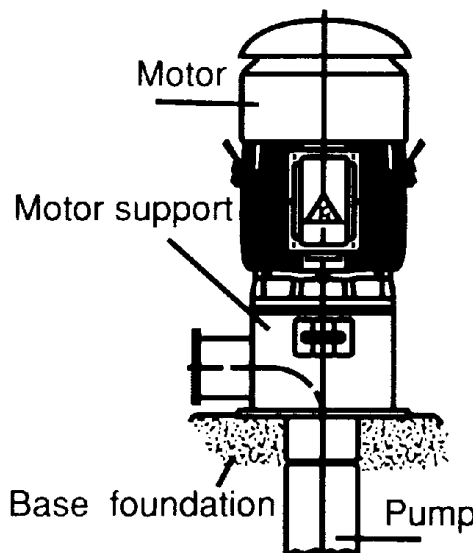


Fig. 5

### 3.2.4 Installation of vertical motors:

- (a) All mounting surfaces must be clean and level.
- (b) Foundation must be leveled at least at 4 points and guaranteed to be below 0.04mm (.0015 in.) flat and level.
- (c) Make sure the mortar and concrete are completely dry, and the precision of the level is acceptable, and then set the motor on the mounting foundation.
- (d) Accurately install shaft couplings.

### 3.3 Installation of shaft coupling

#### **ATTENTION!**

**Motors must always be accurately aligned, and this applies especially where they are directly coupled.**

**Incorrect alignment can lead to bearing failure, vibration and even shaft fracture. As soon as bearing failure or vibration is detected, the alignment should be checked.**

#### 3.3.1

Field application of a coupling to the motor shaft should follow the procedures recommended by the coupling manufacturer. The motor shaft extension must not be subjected to either extreme heat or cold during coupling installation.

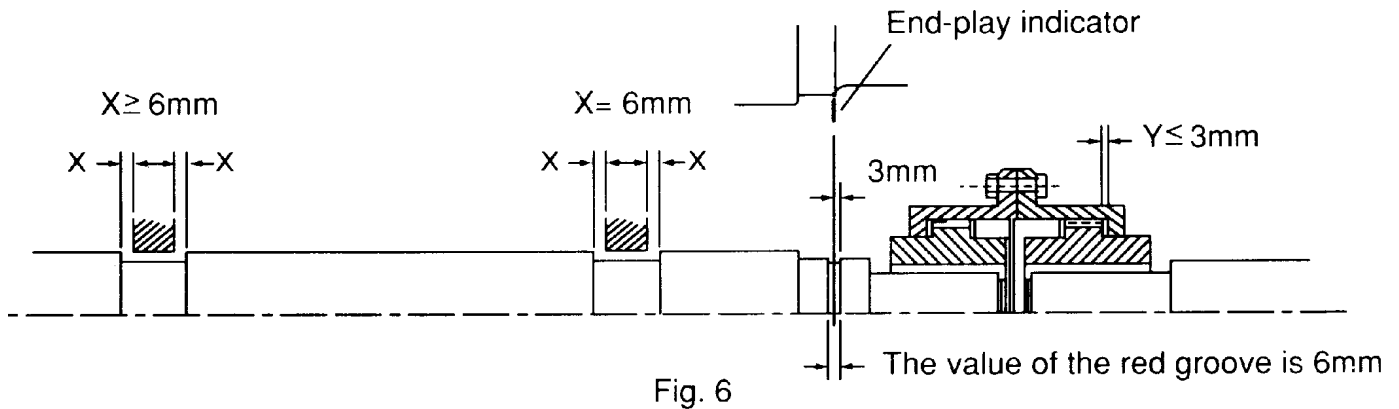
#### **ATTENTION!**

**Basically, the coupling should be heated and pushed onto the shaft extension with slight axial force. Do not hammer coupling to prevent bearing damage.**

#### 3.3.2

Although the sleeve bearings are equipped with thrust faces, these are intended only to provide momentary axial restraint of rotor movement either during start-up or when operating the motor disconnected from the driven equipment. They must not be operated under a constant thrust load unless they were originally designed for this condition.

Motors with either sleeve or anti-friction bearings are suitable for connection to the driven load through a flexible coupling. Coupling solidly to the load is not acceptable. With sleeve bearings, the flexible coupling should be of the limited end float type to prevent the possibility of any end thrust from load being transmitted to the motor bearings, which could cause bearing damage. The recommended limits of end float are as follows:



- When the motor is in operation after installation, be sure that the end-play indicator is within the 6mm (.236 in.) of the groove on the shaft or aligned to the shaft shoulder immediately outboard of the drive-end bearing to assure there is low friction between shaft and bearing.
- Unless otherwise specified, the designed end-play value  $X$  of the groove for TWMC motors in general is within 6mm (.236 in.) as illustrated in Fig. 6. In essence, the endplay indicator is adjusted to point at the center of the groove or the drive-end shaft shoulder; thus  $X$  equals to  $6 \pm 1\text{mm}$  or so, and the endplay value ( $Y$ ) of the couplings should equal or be smaller than 3mm (.118 in.).
- If the desired value  $Y$  is greater than 3mm (.118 in.) caused for instance by a thrust load and/or load machine with large end-play, please inform TWMC prior to entering an order.

### 3.3.3

In aligning the motor (and rotor) axially with the driven equipment, consideration should be given not only to the endplay indicator position but also to axial shaft expansion and increase in shaft centerline height due to thermal effects. In general, the axial shaft growth for motors can be disregarded since neither bearing is fixed and any shaft growth due to temperature increase will produce an elongation away from the coupling.

Shaft height growth (change in shaft centerline elevation) for TEFC machines can be calculated as follows:

$$\Delta = (0.0005") \times (\text{motor foot to shaft } \text{£} \text{ dimension})$$

For non-TEFC machines, divide the number by 2.

### 3.3.4

It is desirable, in normal operation that the motor operates on its magnetic center, so that no axial force is exerted on the coupling.

The motor shaft and the driven shaft should be aligned within the following tolerances in both angular and parallel alignment:

Unit: mm

TIR	Range of rotating speed	Solid coupling	Flexible coupling
C	2500 rpm and above	0.03	0.03
	Below 2500 rpm	0.04	0.05
A	2500 rpm and above	0.03	0.03
	Below 2500 rpm	0.03	0.04

Angular misalignment is the amount by which the centerlines of driver and driven shafts are skewed. It can be measured using a dial indicator set up as shown in Fig. 7. The couplings are rotated together through 360 degrees so that the indicator does not measure runout of the coupling hub face. The shafts should be forced against either the in or out extreme of their end float while being rotated.

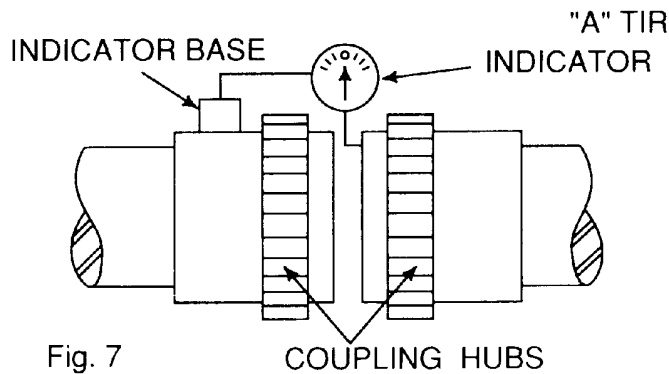


Fig. 7  
TIR=Total indicator reading (by dial indicator)

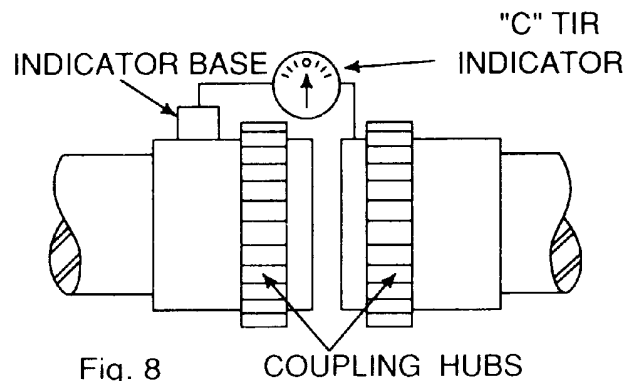


Fig. 8

Parallel misalignment is the amount by which the centerlines of the driver and driven shafts are out of parallel. It can be measured using a dial indicator set up as shown in Fig. 8. Again, the couplings are rotated together through 360 degrees so that the indicator does not measure runout of the coupling hub outside diameter.

### 3.3.5

After the motor has been properly aligned with the driven equipment and the hold-down bolts have been installed and tightened, for motors with fabricated frames, at least two dowel pins should be installed in two diagonally opposite motor feet.

### 3.3.6 Installation of shaft coupling: (Vertical hollow shaft motor only)

Bolted Coupling as shown in Fig. 9

- Bearings are provided to absorb some upward shaft thrust when the coupling is fitted.
- The coupling is fastened with bolts.
- This coupling type is not auto-release type.

Note: Standard high thrust motors can absorb momentary up-thrust load up to 30% of the standard down thrust load. If the up-thrust is long in duration (over 10 Seconds) and/or exceeds 30% of the standard high thrust rating, special design arrangements are required and standard motor is not suitable.

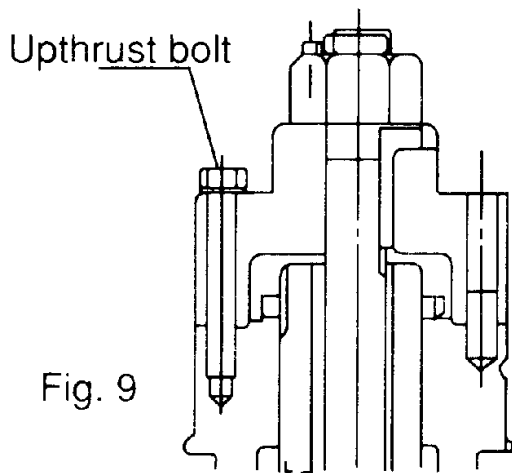


Fig. 9

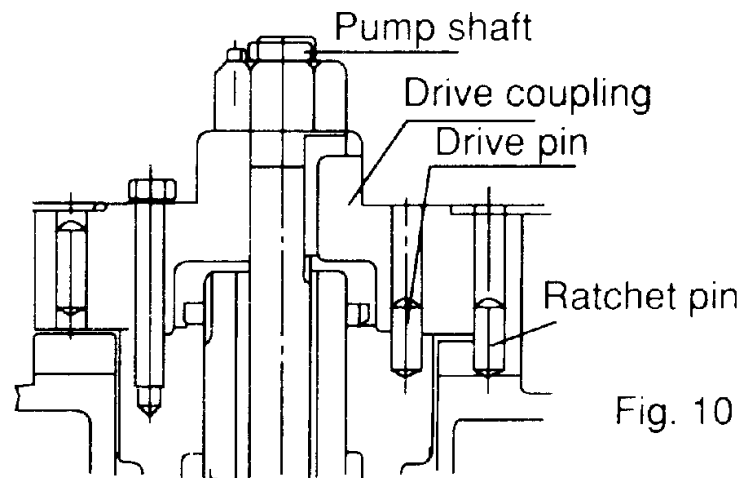


Fig. 10

### 3.3.7 Non-reverse ratchet/coupling, as Fig. 10 (If necessary)

The non-reverse coupling is also a bolted type and,

- (a) It prevents the pump and motor from rotating in the reverse direction.
- (b) It also prevents damage from over speeding and damage to pump shaft and bearings.
- (c) The ratchet pins are lifted by the ratchet teeth and are held clear by centrifugal force and friction as the motor comes up to speed.
- (d) When power is removed, speed decreases, and the pins fall. At the instant of reversal, a pin will catch in a ratchet tooth and prevent backward rotation.
- (e) When installing the non-reverse coupling, do not use lubricant. Lubricant will interfere with proper operation. The top half of the coupling should seat solidly on the lower half and the pins should touch the bottom of the pockets between the teeth in the plate.
- (f) As with the bolted coupling, the up-thrust capabilities are 30% of the standard high thrust rating for down thrust.

#### **ATTENTION!**

**Do not apply non-reverse ratchets on applications in which the pump reversal time from shutdown (the instant the stop button is pressed) to zero speed is less than one second.**

### 3.4 Installation for belt drive

In general, power transmission through direct flexible coupling is appropriate for large motors. Such motors are not suitable for belt, chain or gear connection unless specially designed for such service. However, for small and medium motors of which outputs within the ranges shown on table below, it is acceptable to use belt transmission as indicated. Beyond these ranges, do not apply belt sheaves unless specially designed.

#### 3.4.1

The diameter ratio between conveyance sheaves should not be greater than 5 to 1 for flat belts, and 8 to 1 for V-belts. It is also advisable to limit the belt velocity to under 35m/sec (115 ft/sec) to limit belt abrasion and vibration. The smaller the outer diameter of the V-belt sheave, the greater the shaft bending stress will be. If the bending stress is in excess of the shaft fatigue stress, the shaft may break. Therefore, please inform TWMC when you have decided the size of the sheaves and the length of the belts upon ordering.

**ATTENTION!**

Place the sheave and belt as close as possible to the motor body (it is advisable to make x as shown in Fig. 11 equal to 0) to reduce the bending moment and improve shaft life.

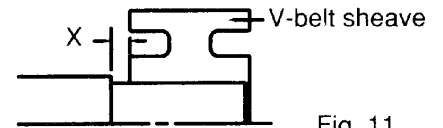


Fig. 11

**3.4.2 Table of belt-sheave application for general electric motors**

Output (KW/HP)			V-Belt Sheave							
4P	6P	8P	Conventional V-Belts				Narrow V-Belts			
			V-Belt Type	Number Of Belts	Min. PCD (mm)	Max Width (mm)	V-Belt Type	Number Of Belts	Min. PCD (mm)	Max Width (mm)
11/15	-	-	B	4	160	82	3V	4	125	48
-	11/15	-	B	5	170	101	3V	5	140	59
-	-	11/15	B	5	190	101	3V	6	160	69
15/20	-	-	B	5	170	101	3V	6	125	69
-	15/20	-	B	5	224	101	3V	6	160	69
-	-	15/20	C	4	224	111	5V	3	180	60
18.5/25	-	-	B	5	200	101	3V	6	140	69
-	18.5/25	-	C	4	224	111	5V	3	180	60
-	-	18.5/25	C	5	224	136	5V	4	180	78
22/30	-	-	B	5	224	101	5V	6	160	69
-	22/30	-	C	5	224	136	3V	4	180	78
-	-	22/30	C	5	250	136	5V	4	200	78
30/40	-	-	C	5	224	136	5V	4	180	78
-	30/40	-	C	5	265	136	5V	4	224	78
-	-	30/40	C	6	265	162	5V	5	224	95
37/50	-	-	C	6	224	162	5V	4	200	78
-	37/50	-	C	6	265	162	5V	4	224	78
-	-	37/50	C	7	280	187	5V	5	250	95
45/60	-	-	C	6	265	162	5V	4	224	78
-	45/60	-	C	7	280	187	5V	5	224	95
-	-	45/60	C	7	315	187	5V	6	250	113
55/75	-	-	C	7	265	187	5V	5	224	95
-	55/75	-	C	8	300	213	5V	6	250	113
-	-	55/75	D	5	355	196	5V	6	280	113
75/100	-	-	C	8	315	213	5V	6	250	113
-	75/100	-	D	6	355	233	5V	6	315	113
-	-	75/100	D	6	400	233	5V	6	355	113
-	90/120	-	D	6	400	233	5V	6	355	113
-	-	90/120	D	6	425	233	8V	4	355	124
-	110/150	-	D	7	400	270	8V	4	355	124
-	132/175	110/150	D	7	450	270	8V	4	400	124
-	160/200	132/175	D	9	450	344	8V	4	450	124

**3.5 Conveyance with chain or gear****3.5.1**

Make sure the loading capacity of shaft and bearings is appropriate for the size and installation position (overhung) of chain and gear. If necessary, please contact us to ensure the shaft and bearings will meet your requirements.



### 3.5.2

Pay close attention to ensure the parallelism of shafts.

### 3.5.3

The teeth of couplings should be correctly and precisely matched; the force conveyance centers should lie on the same line.

### 3.5.4

There should be no skip, jumping, vibration or unusual noises.

#### **ATTENTION!**

**Do not hammer the conveyance devices such as couplings, belt sheaves, chain wheels, gears etc. onto the shaft. Those shaft fitments should be fitted and removed only by means of suitable devices. Heat shrinking may be a better alternative to avoid damaging bearings and components.**



**The exposed rotating parts should be covered to prevent accidents.**

## 3.6 Electrical connections

All interconnecting wiring for controls and grounding should be in strict accordance with local requirements such as the USA National Electrical Code and UK IEE wiring regulations. Wiring of motor and control, overload protection and grounding should follow the instructions of connection diagrams attached to the motor.

### 3.6.1 Power

The rated conditions of operation for the motor are as shown on the nameplate. Within the limits, given below, of voltage and frequency variation from the nameplate values, the motor will continue to operate but with performance characteristics that may differ from those at rated conditions:

±10% of rated voltage

±5% of rated frequency

±10% combined voltage and frequency variation so long as frequency variation is no more than ±5% of rated.

Operating the motor at voltages and frequencies outside of the above limits can result in both unsatisfactory motor performance and damage to or failure of the motor.

### 3.6.2

The main lead box furnished with the motor has been sized to provide adequate space for the make-up of the connections between the motor lead cables and the incoming power cables.



**The bolted joints between the motor lead and the power cables must be made and insulated in a workman-like manner following the best trade practices.**

### 3.6.3

Either fabricated motors or fan cooled cast frame, motors are all provided with grounding pads or bolts.



**The motor must be grounded by proper connection to the electrical system ground.**

### 3.6.4

The rotation direction of the motor will be as shown by either a nameplate on the motor or the outline drawing. The required phase rotation of the incoming power for this motor rotation may also be stated. If either is unknown, the correct sequence can be determined in the following manner: While the motor is uncoupled from the load, start the motor and observe the direction of rotation. Allow the motor to achieve full speed before disconnecting it from the power source. Refer to the operation section of these instructions for information concerning initial start-up. If resulting rotation is incorrect, it can be reversed by interchanging any two (2) incoming cables.

### 3.6.5 Auxiliary devices

Auxiliary devices such as resistance temperature detectors, thermocouples, thermoguards, etc., will generally terminate on terminal blocks located in the auxiliary terminal box on the motor. Other devices may terminate in their own enclosures elsewhere on the motor. Such information can be obtained by referring to the outline drawing. Information regarding terminal designation and the connection of auxiliary devices can be obtained from auxiliary drawings or attached nameplates.

If the motor is provided with internal space heaters, the incoming voltage supplied to them must be exactly as shown by either a nameplate on the motor or the outline drawing for proper heater operation.



**Caution must be exercised anytime contact is made with the incoming space heater circuit as space heater voltage is often automatically applied when the motor is shutdown.**

## 4. OPERATION

### 4.1 Examination before start

#### 4.1.1

When motors are installed in good manner, ensure the wiring is according to the diagram. Also, the following points should be noted:

- (a) Make sure all wiring is correct.
- (b) Ensure the sizes of cable wires are appropriate and all connections are well made for the currents they will carry.
- (c) Ensure all connections are properly insulated for the voltage and temperature they will experience.
- (d) Ensure the capacity of fuses, switches, magnetic switches and thermo relays etc. are appropriate and the contactors are in good condition.
- (e) Make sure the frame and terminal box are grounded.
- (f) Make sure that the starting method is correct.
- (g) Make sure switches and starters are set at their right positions.
- (h) Motor heaters must be switched off when the motor is running.

#### 4.1.2 Measurement of insulation resistance



**During and immediately after measuring, the terminals must not be touched as they may carry residual dangerous voltages. Furthermore, if power cables are connected, make sure that the power supplies are clearly disconnected and there are no moving parts.**

- (a) For rated voltage below 1000V, measured with a 500VDC megger.
- (b) For rated voltage above 1000V, measured with a 1000VDC megger.
- (c) In accordance with IEEE 43, clause 9.3, the following formula should be applied:

$$R \geq \left( \frac{\text{Rated voltage (v)}}{1000} + 1 \right) \times 10(\text{M}\Omega)$$

- (d) On a new winding, where the contaminant causing low insulation resistance is generally moisture, drying the winding through the proper application of heat will normally increase the insulation resistance to an acceptable level. The following are several accepted methods for applying heat to the winding:
  - (1) If the motor is equipped with space heaters, they can be energized to heat the winding.
  - (2) Direct current (as from a welder) can be passed through the winding. The total current should not exceed approximately 50% of rated full load current. If the motor has only three leads, two must be connected together to form one circuit through the winding. In this case, one phase will carry the fully applied current and each of the others, one-half each. If the motor has six leads (3 mains and 3 neutrals), the three phases should be connected into one series circuit.



**Ensure there is adequate guarding so live parts cannot be touched.**

- (3) Heated air can either be blown directly into the motor or into a temporary enclosure surrounding the motor. The source of heated air should preferably be electrical as opposed to fueled (such as kerosene) where a malfunction of the fuel burner could result in carbon entering the motor.

**ATTENTION!**

**Caution must be exercised, when heating the motor with any source of heat other than self contained space heaters, to raise the winding temperature at a gradual rate to allow any entrapped moisture to vaporize and escape without rupturing the insulation. The entire heating cycle should extend over 15-20 hours.**

Insulation resistance measurements can be made while the winding is being heated. However, they must be corrected to 40°C for evaluation since the actual insulation resistance will decrease with increasing temperature. As an approximation for a new winding, the insulation resistance will approximately halve for each 10°C increase in insulation temperature above the dew point temperature.

- (e) Should the resistance fail to attain the specified value even after drying, careful examination should be undertaken to eliminate all other possible causes, if any.

**4.1.3 Power Source**

- (a) Ensure the capacity of the power source is sufficient.
- (b) Ensure the supply voltage and frequency ratings are identical to those on the nameplate.
- (c) Voltage variation should be confined to within ±10% of the rated value and the phase to phase voltages should be balanced.

#### 4.1.4 Bearing lubrication

- (a) For sleeve bearing motors, the oil reservoir must be filled with oil to the correct level. On self-lubricated bearings, the standstill oil level will be at the center of the oil gauge. The proper oil is a rust and oxidation inhibited, turbine grade oil. Refer to the lubrication nameplate for the recommended viscosity.
- (b) Motors, which are supplied with provision for flood lubrication, have an inlet orifice to meter the oil flow to the bearing. Refer to the outline drawing for these values. If the supply pressure does not match that stated on the outline, the orifice size must be adjusted to produce the specified flow rate. The drain adapter (also provided) has a weir plate fixed to the inside of the pipe to permit the establishment of the proper oil level. This weir plate must be located at the bottom of the pipe and must be parallel to the plane of the motor feet. To ensure optimum flow, the drain line should be vented to the atmosphere.

Oil inlet temperature:      Normal below 50°C  
   Alarm 60°C  
   Trip 65°C

- (c) If the motor is in storage for over three (3) months, refilling of some new oil should be undertaken before operation to prevent bearing damage due to dry friction. The oil level should be kept at the center of the oil gauge. If necessary, drain some oil after refilling.
- (d) Motors that have been designed with anti-friction bearings for use with an oil mist lubrication system have been packed at the factory with a small amount of grease for short test runs. Continuous running should not be considered unless the oil mist system is installed and operating.
- (e) Grease lubricant type
  - (1) The bearings have been well greased at the factory before delivery. However, regreasing is required if a significant period has elapsed between manufacture and use or in storage
  - (2) **All motors with ZZ bearings will have SHELL Alvania R3 (Lithium base grease).** All motors with open bearings will have Polyrex EM (polyurea base grease).

#### 4.1.5 Cooling water for the cooler on water-cooled motors

Make sure the quality, volume and inlet temperature of cooling water for the motors are normal before the machine is in operation.

Water: General tower water or industrial water.

Volume: Please see outline drawing

Inlet temperature:      Normal below 30°C  
   Alarm 35°C  
   Trip 40°C

#### **ATTENTION!**

**Make sure all locks, which fasten the movable parts of the motors during transportation, are dismantled and the shaft can rotate freely.**

#### **ATTENTION!**

**Ensure there is no foreign matter or tools inside the motors before starting motors.**

#### 4.1.6

Make sure the transmission system, including belts, screws, bolts, nuts and set pins are in good condition.



**The keys fitted to the shaft extensions are held by plastic tape only to prevent them from falling out during transportation or handling. The shaft key shall be removed to avoid flying out, when the motor is operated prior to the couplings etc. being fitted to the shaft extension.**

#### 4.1.7

Make sure the items above are examined. Test the motor running with or without load. Record and check according to "Maintenance" at 15-minute intervals during the first three hours of operation. Then regular examinations should take place at longer intervals. If all goes well the motor can be classified as "in good order".

### 4.2 Starting operation

#### 4.2.1 Starting load

Initially run the motor unloaded prior to coupling to other machines. Unless otherwise specified, a motor usually starts with light load, which is then gradually increased, proportional to the square of the speed and at last reaches 100% load at full load speed.

#### 4.2.2 Starting

Too frequent starts can be harmful to the motors. The following restrictions should be observed:

- (a) Motor can be restarted should the initial start fail. Two starts are generally permissible when the motor is cold.
- (b) Motor can be started only once when it is at normal running temperature.
- (c) Should additional starts be necessary beyond the conditions stated above, the following restrictions should be noted:
  - (1) Let the motor cool down for 60 minutes before restarting, fully loaded.
  - (2) Let the motor cool down for 30 minutes before restarting, unloaded.
  - (3) Two inching starts can be regarded as one normal start.

#### **ATTENTION!**

**If the motor rotor fails to start turning within one or two seconds, shut off the power supply immediately.  
Investigate thoroughly and take corrective action before attempting a restart.**

Possible reasons for not starting are:

- (1) Too low a voltage at the motor terminals.
- (2) The load is too much for the rotor to accelerate.
- (3) The load is frozen up mechanically.
- (4) All electrical connections have not been made.
- (5) Single-phase power has been applied.
- (6) Any combination of the above.

### 4.2.3 Rotating direction

- (a) Most TWMC motors are bi-directional. However, when some special types, such as high speed 2-Pole, certain large capacity motors, those with a non-reversing ratchet etc., should rotate in one direction, please ensure the rotation is in conformity with the directional arrow-mark shown on the attached nameplate.
- (b) To reverse a bi-directional motor, cut the power and wait until the motor stops. Then interchange any two of the three phases.

### 4.2.4 Power source, Voltage, Current

- (a) Ensure the voltage and frequency of the power source are identical to the ratings shown on the nameplate.
- (b) Voltage variation should be confined to within  $\pm 10\%$  of the rating and the three phase voltages should be in full balance
- (c) Ensure the motor phase currents, when without load, are within  $\pm 5\%$  of the average values.

### 4.2.5

Frequency variation should be confined to within  $\pm 5\%$  of the rating. The aggregate variation of voltage and frequency should be confined to within  $\pm 10\%$  of the absolute value of the ratings.

### Starting time and unusual noises

#### **ATTENTION!**

**Starting time is longer for the motors with large inertia. However, if starting time is longer than usual or if there is difficulty in starting, or there is abnormal noise, do not run the motor and refer to TWMC Service representative.**

### 4.2.6 Sleeve bearing oil rings (sleeve bearing types only)

As the oil ring is used to carry lubricant to sleeve bearings, frequently check to ensure the oil ring is in motion.

### 4.2.7 Bearing temperature rise

Following the initial start-up, the bearing temperatures should be closely monitored. The rate of rise in bearing temperature is more indicative of impending trouble than is the actual temperature.

#### **ATTENTION!**

**If the rate of rise in temperature is excessive or if the motor exhibits excessive vibration or noise, it should be shut down immediately and a thorough investigation made as to the cause before it is operated again.**

If the bearing temperature rise and motor operation appear to be normal, operation should continue until the bearing temperature stabilizes.

Recommended limits on bearing temperature are as follows:

<b>Sleeve Bearings</b>	<b>Total measured temperature</b>
• By permanently installed detector	90°C
• By temporary detector on top of the bearing sleeve near the oil ring	85°C

### Anti-Friction Bearings

- By permanently installed detector
- By temporary detector measuring the outside of the bearing housing

### Total measured temperature

100°C  
95°C

#### **ATTENTION! (For sleeve bearing)**

- (1) It must be noted that when operating flood lubricated sleeve bearings without outside lubrication supplied, the bearing temperature must not be allowed to exceed 85°C total temperature
- (2) Under normal condition, for the self-lube bearing, the rate of temperature rise should be from 11 to 14°C for the first ten (10) minutes after starting up and approximately 22°C at thirty (30) minutes. The rate of bearing temperature rise is a function of the natural ventilation and operating conditions.
- (3) When the rate of bearing temperature rise is less than 1°C per half-hour, the bearing temperature is considered to be stabilized.
- (4) If the total bearing temperature exceeds 95°C, the motor should be shut down immediately.

### Noise and Vibration

#### **ATTENTION!**

Any abnormal noise or vibration should be immediately investigated and corrected. Increased vibration can be indicative of a change in balance due to mechanical failure of a rotor part, a stator winding problem or a change in motor alignment.

## 5. MAINTENANCE

### 5.1 Major points in regular inspections and maintenance.



For safety, maintenance and repairs must only be carried out by properly trained personnel.



Some testing, such as insulation resistance, usually requires the motor to be stopped and isolated from power supply(ies).

Routine inspection and maintenance are usually performed by looking, listening, smelling and simple meters.



High temperature may arise under operating conditions on the motor surfaces, so that touching should be prevented or avoided. Keep away from moving and live parts. Unless deemed necessary, do not remove guards whilst assessing the motor.

Timely replacement of worn parts can assure longevity and prevent breakdown.

Routine inspection and regular inspection and maintenance are important in preventing breakdown and lengthening service life.

Owing to the varied time and circumstances, motors are used, it is difficult to set the items and periods for regular inspection and maintenance. However, as a guide it is recommended to be performed periodically according to factory maintenance program. Generally, the inspection scope determined by the following factors:

- (a) Ambient temperature.
- (b) Starting and stopping frequency.
- (c) Troublesome parts usually affecting motor functions.
- (d) Easily abraded parts.
- (e) The important position of motor in the operational system of a factory should be duly recognized. Therefore, its health and wellbeing should be fully protected especially when it is operating in severe conditions.

## **5.2 Motor windings:**

- (a) Measurement of insulation resistance and standards to determine quality of insulation resistance, please refer to measures stated in 3.1.2 "Measurement of insulation resistance".
- (b) Inspection of coil-ends:
  - (1) Grease and dust accumulated on coils may cause insulation deterioration and poor cooling effect.
  - (2) Moisture must not accumulate. Keep coils warm when motor is not in use if moisture can be seen.
  - (3) Discoloring. This is mainly caused by overheating.
- (c) Ensure no untoward change of wedges from original position.
- (d) Ensure the binding at the coil end is in its normal position.

## **5.3 Clean the interior of the motor:**

- (a) After a motor is in operation for some time, accumulation of dust, carbon powder and grease etc., on the inside is unavoidable, and may cause damage. Regular cleaning and examination is necessary to assure top performance.
- (b) Points to note during cleaning:
  - (1) If using compressed air or blower:
    - (a) Compressed air should be free of moisture.
    - (b) Maintain air pressure at 4 kg/cm<sup>2</sup>, since high pressure can cause damage to coils.
  - (2) Vacuum  
Vacuum cleaning can be used, both before and after other methods of cleaning, to remove loose dirt and debris. It is a very effective way to remove loose surface contamination from the winding without scattering. Vacuum cleaning tools should be non-metallic to avoid any damage to the winding insulation
  - (3) Wiping  
Surface contamination on the winding can be removed by wiping using a soft, lint-free wiping material. If the contamination is oily, the wiping material can be moistened (not dripping wet) with a safety type petroleum solvent. In hazardous locations, a solvent such as inhibited methyl chloroform may be used, but must be used sparingly and immediately removed. While this solvent is non-flammable under ordinary conditions, it is toxic and proper health and safety precautions should be followed while using it.



**ATTENTION!**

**Solvents of any type should never be used on windings provided with abrasion protection. Abrasion protection is a gray, rubber-like coating applied to the winding end-turns.**



Adequate ventilation must always be provided in any area where solvents are being used to avoid the danger of fire, explosion or health hazards. In confined areas (such as pits) each operator should be provided with an airline respirator, a hose mask or a self-contained breathing apparatus. Operators should wear goggles, aprons and suitable gloves. Solvents and their vapors should never be exposed to open flames or sparks and should always be stored in approved safety containers.

- (4) Keep core ducts completely clean. The difference in temperature rise could be around 10°C before and after cleaning

**5.4 Clean the exterior of the motor:**

- (a) On open ventilated motors, screens and louvers over the inlet air openings should not be allowed to accumulate any build-up of dirt, lint, etc. that could restrict free air movement.

**ATTENTION!**

**Screens and louvers should never be cleaned or disturbed while the motor is in operation because any dislodged dirt or debris can be drawn directly into the motor.**

- (b) If the motor is equipped with air filters, they should be replaced (disposable type) or cleaned and reconditioned (permanent type) at a frequency that is dictated by conditions. It is better to replace or recondition filters too often than not often enough.
- (c) Totally enclosed air to air cooled and totally enclosed fan cooled motors require special cleaning considerations. The external fan must be cleaned thoroughly since any dirt build-up not removed can lead to unbalance and vibration. All of the tubes of the air-to-air heat exchanger should be cleaned using a suitable tube brush having synthetic fiber bristles (not wire of any type).

**5.5 Maintenance of anti-friction bearings****5.5.1 Frequency of re-lubrication:**

The life of grease varies greatly as a result of types of model, revolution speed, temperature, operational conditions etc. It is, therefore, impossible to be precise about replenishment intervals. However, for normal direct coupling transmission, the periods shown as Table 1 may be used as a guide.

**Remarks:**

- (a) The periods shown in Table 1 should be halved where bearings are used for belt drive and/or in dirty or high ambient temperature or high humidity environments.
- (b) Please refer to the lubrication nameplate, if attached to the motor.
- (c) For bearing numbers outside the range of Table 1, please contact TWMC

- (d) If the periods referred to in Table 1 for drive-end bearing and opposite drive-end are different, for the convenience of maintenance operation, please take the shorter one the required grease replenishment period of these bearings.

### 5.5.1 Kinds of grease:

All motors with ZZ bearings will have SHELL Alvania R3 (lithium base grease). All motors with open bearings will have Polyrex EM (polyurea base grease).

Certain T-frame models will utilize special grease and will be noted on the lubrication nameplate. Please use identical grease or its equivalents when maintaining lubrication schedule.

#### **ATTENTION!**

**Do not mix different kinds of grease.**

**Mixing grease with different type of thickeners may destroy its composition and physical properties. Even if the thickeners are of the same type, possible differences in the additive may cause detrimental effects.**

### 5.5.2 Grease quantity

The amount of grease per replenishment depends on the type, size and construction of the bearings. The maximum amount of one replenishment for each bearing is shown in Table 2.

### 5.5.3 Re-greasing



**If re-lubrication is to be performed when the motor is running, stay clear of rotating parts.**

It is advisable to re-grease when the motor is running to allow the new grease to be evenly distributed inside the bearing.

Before re-greasing, the inlet fitting should be thoroughly cleaned to prevent any accumulated dirt from being carried into the bearing with the new grease. The outlet of grease drainage should be opened to allow the proper venting of old grease.

Use a grease gun to pump grease through grease nipple into the bearings. After re-greasing, operate the motor for 10-30 minutes to allow any excess grease to vent out.

**TABLE 1.**

Bearing Number	600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM	3000 RPM	3600 RPM
62XX 63XX 72XX 73XX	6210									
	12								2000 Hrs.	
	13									
	14								1000 Hrs.	
	15									
	16								720 Hrs.	
	17							2000 Hrs.		
	18			3000 Hrs.						
	20									
	22									
	24							1500 Hrs.		
	26									
	28					2000 Hrs.		1000 Hrs.		
	30									
	32							500 Hrs.		
	34					1500 Hrs.				
36										
38			2000 Hrs.		1000 Hrs.					

Bearing Number	600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM
NU2XX NU3XX	NU214							
	15						2000 Hrs.	
	16							
	17							
	18			3000 Hrs.			1500 Hrs.	
	20							
	22						1000 Hrs.	
	24							
	26					2000 Hrs.		
	28						500 Hrs.	
	30							
	32							
	34			2000 Hrs.		1000 Hrs.		
	36							
	38	2000 Hrs.						
	40							
44			1000 Hrs.					
48	1000 Hrs.							

Bearing Number	600 RPM	720 RPM	750 RPM	900 RPM	1000 RPM	1200 RPM	1500 RPM	1800 RPM
222XX 223XX	22220						300 Hrs.	
	22							
	24			1000 Hrs.		500 Hrs.		
	26							
	28							
	30					300 Hrs.		
	32			500 Hrs.				
	34							
	36							
	38	500 Hrs.						
	40			300 Hrs.				
	44							
48	300 Hrs.							

**TABLE 2.**

Bearing No.	Amount of replenishment	
62XX 72XX NU2XX 2222XX	6210	30 g
	6212	40
	6213	50
	6214	50
	6215	60
	6216	60
	6217	80
	6218	80
	6220	100
	6222	120
	6224	120
	6226	140
	6228	160
	6230	180
	6232	200
	6234	250
	6236	300
	6238	350
6240	400	
6244	450	
6248	500	

Bearing No.	Amount of replenishment	
63XX 73XX NU223XX 223XX	6310	40 g
	6312	60
	6313	80
	6314	80
	6315	100
	6316	100
	6317	120
	6318	120
	6320	160
	6322	220
	6324	270
	6326	300
	6328	400
	6330	450
	6332	500
	6334	600
	6336	700
	6338	800
6340	900	
6344	900	
6348	900	

\*Fill new grease until it overflows and the old grease is entirely replaced.

**5.5.4 Oil re-lubrication (For oil lubrication types only)**

Maintain proper lubrication by checking the oil level periodically and adding oil when necessary. Because of the initial clearing action of the bearing and the expansion of the oil as it comes up to operating temperature, the oil level will be higher after the motor has been in operation for a while than it is with the motor at standstill.

Overfilling should be avoided not only because of the possibility that expansion may force the oil over the oil sleeve and on to the rotor, but also because too high an operating oil level prevents the bearing from clearing itself of excess oil. The resultant churning can cause extra loss, high temperatures, and oxidized oil. If, during operation, the oil level goes above the maximum shown on the sight gauge, drain enough oil to bring the level back within the recommended operating range. **Do not permit the operating level to fall below the minimum shown on the gauge.**

**ATTENTION!**  
**Should it ever become necessary to add excessive amount of make-up oil, investigate immediately for oil leaks.**

Change the oil at regular intervals. The time between oil changes depends upon the severity of operating conditions and, hence, must be determined by the motor user. Two or three changes a year is typical, but special conditions, such as high ambient temperature, may require more frequent changes. Avoid operating the motor with oxidized oil. Use only good grade, oxidation-corrosion-inhibited turbine oils produced by reputable oil companies.

The viscosity of the oil to be used depends upon the type and size of the bearings, its load and speed, the ambient temperature, and the amount and temperature of the cooling water (if used)). The lubrication nameplate or instructions with each motor specifies the viscosity range of oil suitable for average conditions. The usual oil viscosity range of oil suitable for average conditions. The usual oil viscosity recommendations are summarized in Table 3. Operation in ambient temperatures that are near or below freezing may require preheating the oil or the use of special oil. Whenever the motor is disassembled for general cleaning and reconditioning, the bearing housing may be washed out with a suitable cleaning solvent. Be sure that the oil-metering hole is clear, and then dry the housing thoroughly before re-assembly, and ensure all traces of cleaning solvent have been removed.

**TABLE 3 Oil Viscosity\*\***

Bearing function and location	Bearing Type	Oil Viscosity - SSU	
		@ 100°F	@ 200°F
Thrust Bearing	72XX, 73XX Angular contact ball And/or (62XX, 63XX)	150	45
	Spherical roller	300	53
	Plate (Kingsbury Type)	300	53

\*\*Remark: When a lubrication nameplate attached to the motor, use lubrication oil it stipulates.

### 5.5.5 Cleaning and installation of bearings

- (a) Apply the proper amount of grease to the disassembled parts of the bearing after they have been thoroughly cleaned with high quality cleaning oil. Then protect them from contamination before and during assembly.
- (b) Bearing installation

#### **ATTENTION!**

**Before installing the bearings, make sure that the shaft mounted parts inside the bearings are in place before installation.**

Since the bearing is a high precision component, it is important to avoid ingress of dust and foreign matter, and hammering during cleaning and installation. Use extreme care and insure clean conditions during installation and assembly.

#### **ATTENTION!**

**The best way for bearing installation is heat shrinking. Knocking and hammering during installation should be avoided absolutely.**

The bearing should be heated in a bath of clean oil at a temperature of approximately 80°C. After warming, slide the bearings in place quickly and nimbly so that it has not shrunk before being fully in position. Grease the bearing after the temperature returns to normal, and then reassemble the motor.

## 5.6 Maintenance of sleeve bearings

### 5.6.1 Daily inspections

- (a) Ensure the volume and quality of lubrication oil are in compliance with specifications.

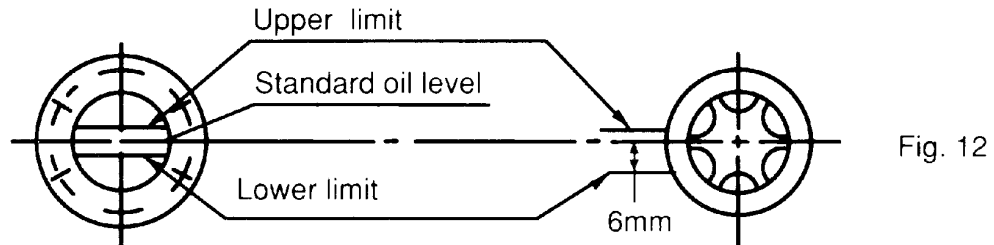


Fig. 12

- (b) Ensure there is motion of the oil ring and it is not clamped.  
 (c) The indicator of the shaft endplay should be restricted within the specified range of the red groove of the shaft or the  $\pm 3\text{mm}$  (.118 in.) range of the drive-end shaft shoulder, or the bearing may be damaged.

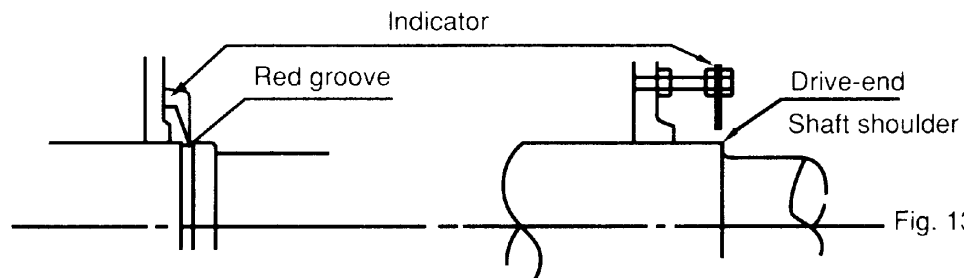


Fig. 13

### 5.6.2 Regular examination

- (a) Periodical change of oil

The oil reservoirs of self (not flood) lubricated bearings should be drained and refilled about every six (6) months. More frequent changes may be needed on high speed (3600 rpm) motors or if severe oil discoloration or contamination occurs. In conditions where contamination does occur, it may be advisable to flush the reservoir with kerosene to remove any sediment before new oil is added. Proper care must be taken to thoroughly drain the reservoir of the flushing material before refilling with the new oil.

Refill the reservoir to the center of oil sight glass with a rust and oxidation inhibited turbine grade oil. Refer to the outline and lubrication nameplate for the correct viscosity.

- (b) Quantity of lubrication oil  
 Please refer to the lubrication nameplate for oil quantity.  
 (c) Oil viscosity  
 (d)

ISO	Equivalents	Viscosity (SUS/100°F)
VG32	Esso Teresso 32	150
VG46	Esso Teresso 46	200
VG68	Esso Teresso 68	300

### 5.6.3 Disassembly



**Prior to disassembling, ensure the power supplies are disconnected and there are no moving parts.**

The bearing sleeve is of the spherically seated, self-aligning type. The opposite drive end bearing is normally insulated for larger motors (or when specified). On some motors, the insulation is bonded to the spherical seat of the bearing housing.

#### **ATTENTION!**

**Extreme care must be exercised in removing the bearing sleeve from the insulated support to avoid damaging this insulation.**

The following is the recommended procedure for removing the bearing sleeve:

- (a) Remove the oil drain plug in the housing bottom and drain the oil sump.
- (b) Remove all instrumentation sensors that are in contact with the bearing sleeve. These would include resistance temperature detectors, thermocouples, thermometers, etc..
- (c) Remove the socket head bolts holding the bearing cap and the inner air seal. The end cover plate must also be removed if the non-drive end bearing is being disassembled. Remove the bearing cap and top half of the inner air seal. Place them on a clean, dry surface to avoid damage to the parting surfaces.
- (d) Remove the top half of the bearing sleeve using suitable eyebolts in the tapped holes provided. Lift the bearing top straight up and avoid any contact with the shoulders of the shaft journals that might damage the thrust faces of the bearing. Place on a clean, dry surface taking care to prevent damage to either the parting surfaces or the locating pins that are captive in the top bearing half.
- (e) Remove the screws at the partings in the oil ring and dismantle the ring by gently tapping the dowel pin ends with a soft face mallet. Remove the ring halves and immediately reassemble them to avoid any mix up of parts or damage to the surfaces at the partings.
- (f) Pull up on the garter spring surrounding the floating labyrinth seal and carefully slip out the top half. Rotate the garter spring until the lock is visible. Twist counter-clockwise to disengage the lock, remove the garter spring then rotate the lower half of the seal out of the groove in the bearing housing. Note the condition of these floating labyrinth seals. If they are cracked or chipped, they must be replaced. Do not attempt to reuse a damaged seal.
- (g) To remove the bottom bearing half, the shaft must be raised a slight amount to relieve pressure on the bearing. On the drive end, this can be done by jacking or lifting on the shaft extension. Protect the shaft. On the non-drive, jacking or lifting can be done using bolts threaded into the tapped holes provided in the shaft end.

- (h) Roll the bottom bearing half to the top of the shaft journal and then lift it using suitable eyebolts threaded into the holes provided. Again avoid any contact with the shaft shoulders that could damage the bearing thrust faces. Place the lower bearing half on a clean, dry surface to protect the parting surfaces.



**Use extreme care when rolling out the lower bearing half. Keep the hands and fingers well clear of any position where they might be caught by the bearing half if it were accidentally released and rotated back to its bottom position. Serious personal injury could result.**

- (i) Protect the shaft journal by wrapping it with clean, heavy paper or cardboard.

#### **5.6.4 Re-assembly**

Bearing re-assembly is basically a reverse of the disassembly procedures outlined above, with the following suggestions:

- (a) The interior of the bearing housing should be cleaned and then flushed with clean oil or kerosene.
- (b) The bearing halves and the shaft journal should be wiped clean using lint-free cloth soaked with clean oil.
- (c) All parts should be carefully inspected for nicks, scratches, etc., in any contact surfaces. Such imperfections should be removed by an appropriate method such as stoning, scraping, filling, etc., followed by thorough cleaning.
- (d) Before installing the floating labyrinth seal halves, observe their condition. Do not attempt to use a cracked or chipped seal. The bottom half seal has a set of drilled holes in its side face. These must be placed at the bottom toward the inside of the bearing so that accumulating oil may drain back into the housing.
- (e) Put a bead of Curil-T around the seal half O.D.'s on both sides adjacent to the garter spring groove. This will prevent oil by-passing the seal around its outside.
- (f) Place the bottom seal half on top of the shaft and roll it into position. Install the top half and insert the garter spring pulling up on both ends to permit engaging the lock. Run a bead of Curil-T around the O.D.'s on both sides adjacent to the garter spring groove on this half also.
- (g) Carefully reassemble the two oil ring halves. Inspect the dowel pins for burrs and straightness and make any corrections required. Do not force the ring halves together. Excessive force may alter the roundness or flatness of the oil ring which can change its oil delivery performance.
- (h) Some of the pipe plugs in the housing are metric thread type. These are identified as those, which have a copper, lead, or similar material washer. If these plugs are removed,



be careful not to lose the washers. Before re-assembly, inspect the washers and replace them as required.

- (i) Before installing the bearing cap, observe the position of the floating labyrinth seal. The “tab” must be on top to engage the pocket. Failure to position the seal properly will result in damage when the cap is assembled.

**ATTENTION!**

- (1) Curil-T is the only approved compound for use in the assembly of the bearings on this motor. Other products may harden and impede the operation.**
- (2) During the re-assembly of the bearing parts, a thin layer of Curil-T should be applied to all gaskets and machined interface surfaces. This suggestion does not apply to the machined surfaces of the bearing liner halves.**
- (3) When seating the bearing shell, apply a thin layer of lube oil at the spherical surface of the liner. Slowly roll the lower bearing liner into the bearing housing making sure that the splinted surface of the liner and the housing are flush. Gradually lower the shaft onto the bearing. The weight of the shaft will help rotate the bearing liner so that the babbitt surface of the liner will match the slope of the journal. Sometimes it is required to use a rubber mallet to tap lightly on the bearing housing while slowly rolling the shaft to help this seating operation.**

## 5.7 Maintenance of slip ring (For Wound Rotor Motors only)



**Ensure motor is disconnected from power supplies and there are no accessible moving parts before maintenance operation.**

### 5.7.1 Adjustment of carbon brush

- (a) Brush pressure for normal operation:
  - Electro-graphite brush.....0.2~0.25 kg/cm<sup>2</sup>  
When frequent vibrations are evident or the brush is small (area below 0.5 cm<sup>2</sup>), the pressure should be greater than as shown.
- (b) Adjustment of brush pressure:  
The brush pressure should be adjusted to keep normal operation as it wears.
  - The brush pressure may be reduced after use, so it is necessary to re-adjust. For adjustment, please turn adjusting screw, pressure adjusting pin or pressure adjusting plate as shown in Fig. 14 to obtain the correct tension (=0.23 x brush cross sectional area in cm<sup>2</sup>) ±10% kg.
- (c) Brush pressure need not be adjusted if constant force spring is used as shown in Fig. 15 and Fig. 16.

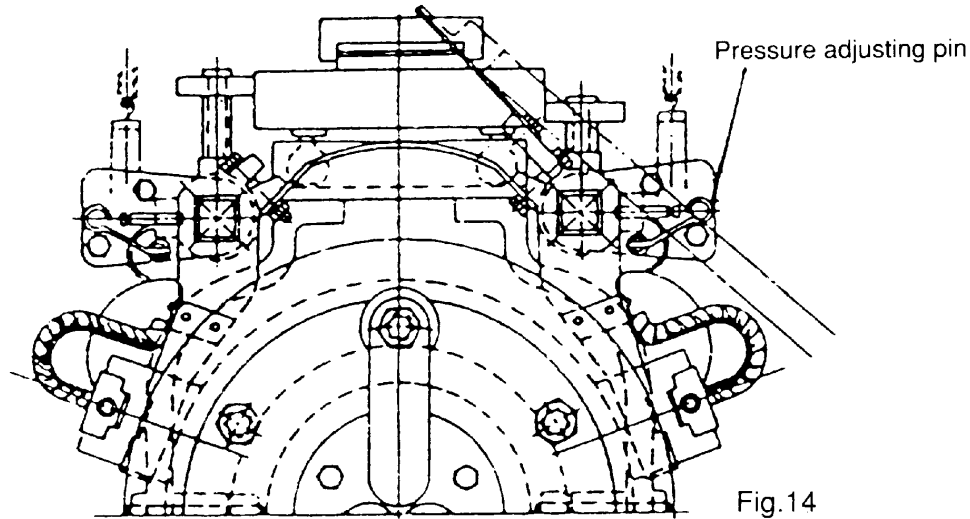


Fig.14

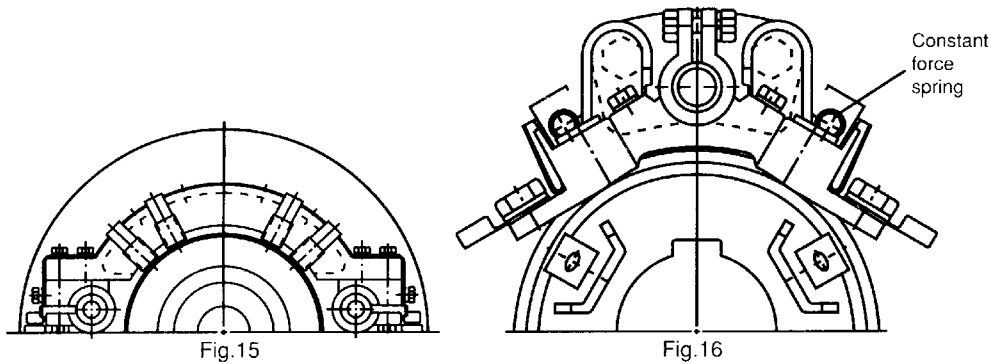


Fig.15

Fig.16

### 5.7.2 Brush replacement

The carbon brush is a part of the equipment which is easily worn away, replace it after it is worn to  $\frac{1}{2} \sim \frac{3}{4}$  of original size.

(a) Brush material

The brush material is important to the performance of the motor. Only the most appropriate materials are chosen by TWMC, and are listed on the nameplate of the motor. It is important to know this when you replace the brush, so a recommended type is used.

(b) Dimensions

Brush, holder and gap between them, please refer to CNS 2322 C4051 or JIS C2802.

**ATTENTION!**

**The gap between a brush and it holder is important for good performance and safety of the motor.**

(c) Adjustment of new brushes (Shown in Fig. 17)

- (1) Polish the new brush with a file until it assumes the appropriate contour of the slip ring which it touches.

- (2) Place sand-paper (JIS R6252 No. 40...50) on the slip ring with the abrasive face of the paper against the brush to induce a closer contact by rubbing against each other.
- (3) Repeat item 2 with fine sand –paper (JIS R6252 No. 100 to 200) until the contact surface between brush and slip ring exceeds 80%.
- (4) Finally, clean the contaminated slip ring and brush with clean cloth or compressed air.

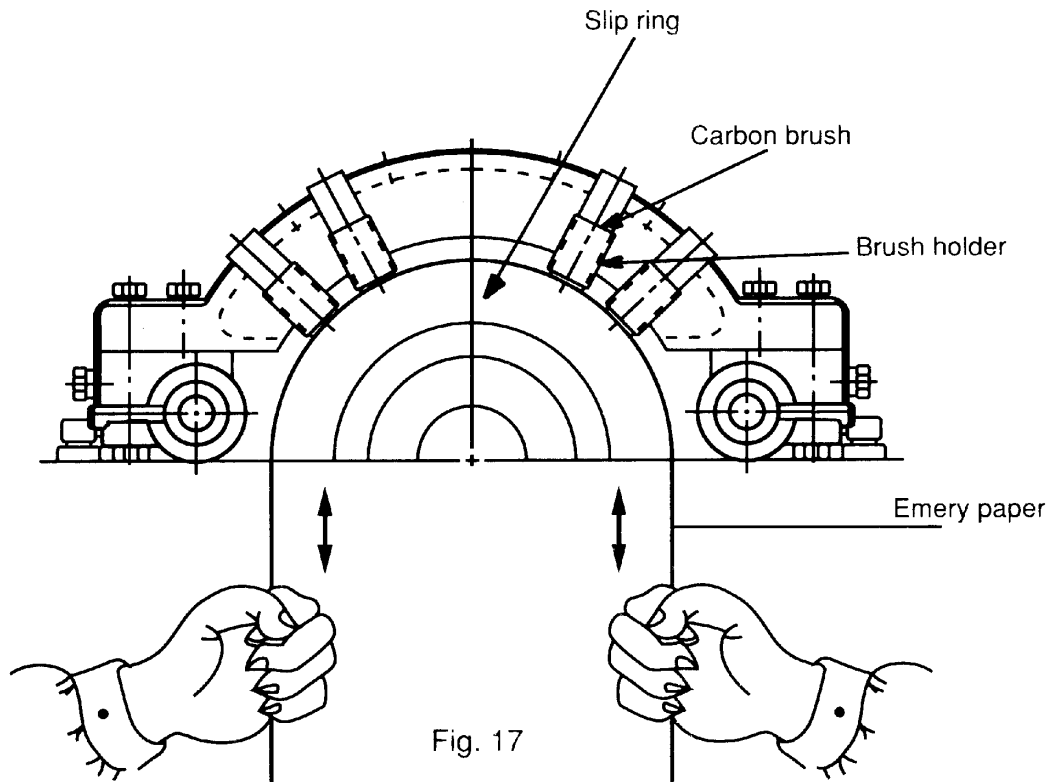


Fig. 17

## 5.8 Maintenance of non-reverse ratchet mechanism (For Vertical high Thrust Motor only)

### 5.8.1

In the pump piping system, a check valve and a stop valve should be installed in the discharge line. The check valve, placed between the pump and the stop valve, is to protect the pump from reverse flow and excessive backpressure. The stop valve is used in priming, starting and when shutting down the pump. It is advisable to close the stop valve before stopping the pump. This is especially important when the pump is operated against a high static head.

TWMC vertical high thrust motors are equipped with non-reverse ratchet (N.R.R.) mechanism only when requested by the pump manufacturer. Typical construction of the N.R.R. mechanism is shown as Fig 18 below.

The N.R.R. mechanism keeps the pump and motor from rotating in the reverse direction. Thus prevents damage from over-speeding and damage to water-lubricated pump shaft bearings

when, on shutdown, the falling water column tends to drive the pump in the reverse direction. In normal operation, the ratchet pins are lifted by the ratchet teeth and are held clear by centrifugal force and friction as the motor comes up to speed. When power is removed, the speed decreases and the pins fall. At the instant of reversal, a pin will catch in a ratchet tooth and prevent backward rotation.

### 5.8.2

The service life of ratchet pins depends not only on the reverse shock load between the pin and ratchet tooth when pump stopped but also the frequency of pump starting and stopping while in service. Provided that the pins are deformed due to this reverse shock load, then the up and down motion of the ratchet pins could be sluggish or jammed and that unusual noises shall arise.

The recommended replacement period for these ratchet pins is every three (3) years. If the reverse shock load is greater than 30% of motor rated torque or the starting frequency is more than twice per day, then the replacement period should be halved.

#### **ATTENTION!**

**The check valve and stop valve in the discharge line should be regularly inspected and maintained to assure the normal function of these valves. This is important to protect the pump and motor from damage and increase the service life of the N.R.R. mechanism.**

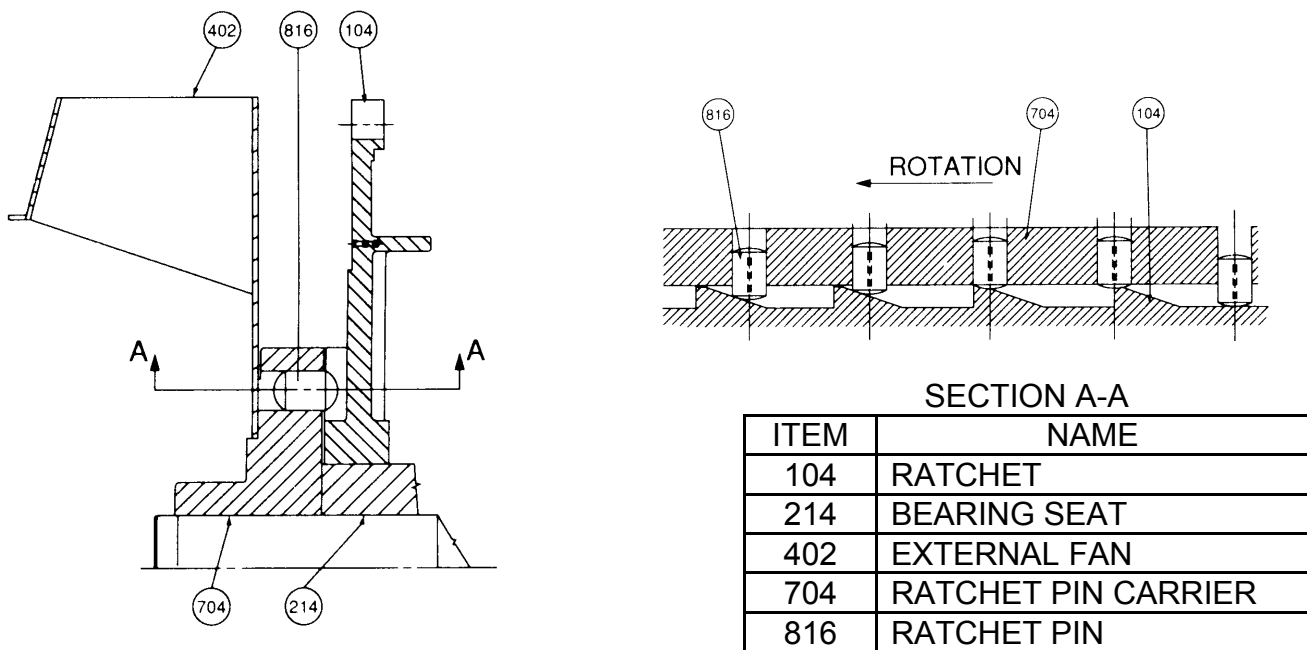


Fig. 18

## 6. FAULT FINDING AND RECOGNITION

Kinds of Breakdown	Symptoms	Possible Causes	Remedies
Fail to start without load	Motionless and soundless	Power-off	Consult power company
		Switch-off	Switch-on
		No fuse	Install fuse
		Broken wiring	Check wiring and repair
		Broken lead	Check wiring and repair
		Broken windings	Check windings and repair
	Fuse blowing. (Automatic switch trips off, slow start with electromagnetic noise)	Short circuit of circuit switches	Check circuit switches and replace
		Incorrect wiring	Check wiring according to nameplate
		Poor contact at terminal	Lock tightly
		Windings grounded	Factory repair
		Broken windings	Factory repair
		Poor contact of circuit switches	Check and repair
		Broken wiring	Check and repair
		Poor contact of starting switches	Check and repair
Short circuit of starting switches	Check and repair		
Incorrect connections of starting switches	Connect according to nameplate		
Loading after start	Fuse blowing. Fail to restart due to trip-off of automatic switch	Insufficient capacity of fuse	Replace fuse if wiring permits
		Overload	Lighten load
		High load at low voltage	Check circuit capacity and reduce load
	Overheating motor	Overload or intermittent overload	Lighten load
		Under-voltage	Check circuit capacity and power source
		Over-voltage	Check power source
		Ventilation duct clogged	Remove the foreign matter in the duct
		Ambient temperature exceeds 40°C	Correct insulation class to B or F, or lower ambient temperature
		Friction between rotor and stator	Factory repair
		Fuse blown (Single-phase rotating)	Install the specified fuse
		Poor contact of circuit switches	Check and repair
		Poor contact of circuit starting switches	Check and repair
		Unbalance three-phase voltage	Check circuit or consult power company

Kinds of Breakdown	Symptoms	Possible Causes	Remedies
Loading after start	Speed falls sharply	Voltage drop	Check circuit and powers source
		Sudden overload	Check machine
		Single-phase rotating	Check circuit and repair
	Switch overheating	Insufficient capacity of switch	Replace switch
		High load	Lighten load
	Bearing over-heating	High belt tension	Adjust belt tension
		Slack belt tension	Adjust belt tension
		Misalignment between motor and machine shafts	Re-align
		Over speed of bearing outer-ring	Adjust bracket
		High bearing noise	Replace the damaged bearing
Noise	Electromagnetic noise induced by electricity	Occurrence from its first operation	May be normal
		Sudden sharp noise and smoking	Short circuit of windings should be repaired at the factory
	Bearing noise	Noise of low shishi or Thru-Thru	May be normal
		Kala-Kala as a result of poor lubrication	Grease
		Kulo-Kulo as a result of poor lubrication	Clean bearing and grease
		Sa-Sa or larger noise	Replace the damaged bearing
	Mechanical noise caused by machinery	Loose belt sheave	Adjust key and lock the screw
		Loose coupling or skip	Adjust the position of couplings, lock key and screw
		Loose screw on fan cover	Lock fan cover screw tightly
		Fan rubbing	Adjust fan position
		Rubbing as a result of ingress of foreign matter	Clean motor interior and ventilation ducts
		Wind noise	Noise induced by air flowing through ventilation ducts
		Induced by conveyance machine	Repair machine
	Vibration	Electromagnetic vibration	Short circuit of winding
Open circuit of rotor			Factory repair
Mechanical vibration		Unbalanced rotor	Factory repair
		Unbalanced fan	Factory repair
		Broken fan blade	Replace fan
		Unsymmetric centers between belt sheaves	Align central points
		Central points of couplings do not lie on the same level	Adjust the central points of couplings to the same level
		Improper mounting installation	Lock the mounting screws
		Motor mounting bed is not strong enough	Reinforce mounting bed
Remarks:			
(1) Circuit switches: These include knife switches, electromagnetic switches, fuse and other connection switches etc.			
(2) Starting switches: These include Delta-Star starters, compensate starters, reactance starters, resistor starters, starting controller's etc.			

DATE  
APRIL 16, 2004  
CATALOG NO.  
E0058

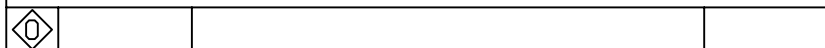
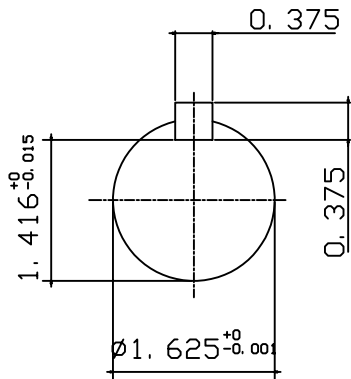
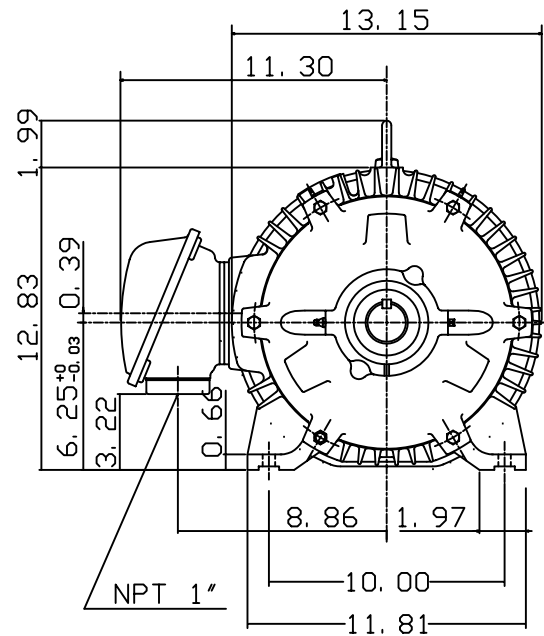
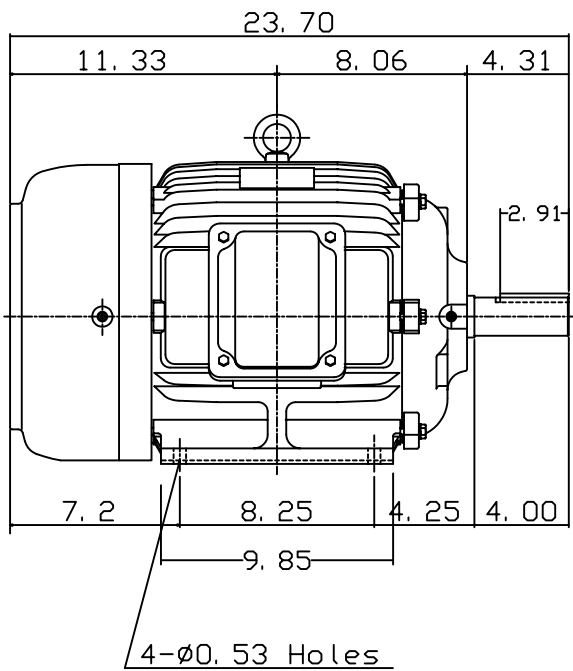
OUTLINE DIMENSIONS  
3-PHASE INDUCTION MOTOR

MOTOR TYPE:  
AEHE  
FRAME NO. 254T

Pole	HP	KW	Hz	VOLT	Syn. Speed RPM
8	5	3.73	60	230/460	900

Ins	Rating	Dimension in	Approx Weight	Bearings
F	CONT.	inches	288 lbs.	DE: 6309ZZ NDE: 6307ZZ

Totally Enclosed Fan-Cooled Type. Squirrel-cage Rotor.



DWN.	J. H. LIANG	11-30-98
CHKD.	C. H. KAO	12-26-98
APPD.	Y. B. HUANG	12-26-98

TECO Westinghouse

DWG NO.  
31057H357000

# TECO Westinghouse

ISSUED <b>March 11, 2005</b>	<b>PERFORMANCE DATA</b> <b>3-PHASE INDUCTION MOTOR</b>	ENCLOSURE <b>TEFC</b>
TYPE <b>AEHE</b>		CATALOG# <b>E0058</b>

### NAMEPLATE INFORMATION

OUTPUT		POLE	FRAME SIZE	VOLTAGE	HZ	RATED AMBIENT	INS. CLASS	NEMA DESIGN	TIME RATING	SERVICE FACTOR
HP	KW									
<b>5</b>	<b>3.7</b>	<b>8</b>	<b>254T</b>	<b>230/460</b>	<b>60</b>	<b>40°C</b>	<b>F</b>	<b>B</b>	<b>CONT.</b>	<b>1.15</b>

### TYPICAL PERFORMANCE

FULL LOAD RPM	EFFICIENCY				POWER FACTOR			MAXIMUM POWER FACTOR CORRECTION
	FULL LOAD		3/4 LOAD %	1/2 LOAD %	F. L. %	3/4 LOAD %	1/2 LOAD %	
	MIN. %	NOM. %						
<b>870</b>	<b>84</b>	<b>86.5</b>	<b>86.5</b>	<b>85.5</b>	<b>72</b>	<b>64</b>	<b>51.5</b>	<b>4 KVAR</b>

### CURRENTS

NO LOAD			FULL LOAD			LOCKED ROTOR			NEMA KVA CODE LETTER
AT	AT	AT	AT	AT	AT	AT	AT	AT	
208 VOLT	230 VOLT	460 VOLT	208 VOLT	230 VOLT	460 VOLT	208 VOLT	230 VOLT	460 VOLT	
<b>10.26</b>	<b>9.28</b>	<b>4.64</b>	<b>16.63</b>	<b>15.04</b>	<b>7.52</b>	<b>101.73</b>	<b>92.00</b>	<b>46.00</b>	<b>J</b>

### TORQUE

### INERTIA

### ACCEL TIME

FULL LOAD lb-ft	LOCKED ROTOR %FLT	PULL UP %FLT	BREAK DOWN %FLT	ROTOR WR <sup>2</sup> lb-ft <sup>2</sup>	NEMA LOAD WK <sup>2</sup> lb-ft <sup>2</sup>	MAX ALLOWABLE WK <sup>2</sup> lb-ft <sup>2</sup>	NEMA LOAD WK <sup>2</sup> Sec	MAX ALLOWABLE WK <sup>2</sup> Sec
<b>30.17</b>	<b>190</b>	<b>185</b>	<b>240</b>	<b>1.66</b>	<b>142</b>	<b>353</b>	<b>6.73</b>	<b>16.60</b>

SAFE STALL TIME IN SECONDS

ALLOWABLE STARTS PER HOUR

SOUND PRESSURE LEVEL @ 3 FT dB(A)

COLD	HOT	COLD	HOT	54
<b>47</b>	<b>33</b>	<b>2</b>	<b>1</b>	

APPROVED:	<b>M. PRATER</b>	DRAWING NO.	<b>31057E0058</b>	REVISION <b>0</b>
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# Shock/Vibration Control Switches Installation Instructions

**Models: VS2, VS2C, VS2N, VS2EX, VS2EXR, VS2EXRB and VS94**

VS-7037N  
Revised 06-96  
Replaces VS-7037NS and VIB-95108N  
Section 20  
(00-02-0185)



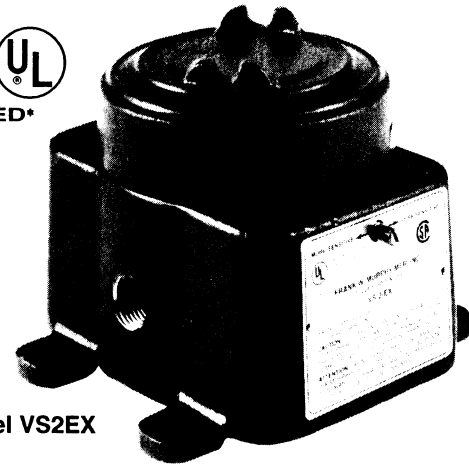
Please read the following instructions before installing. A visual inspection of this product for damage during shipping is recommended before mounting. It is your responsibility to have a qualified person install the unit, and make sure installation conforms with NEC and local codes.

## 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.



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.

**VS2N:** Pneumatic signal—no electrical contacts.

**VS94:** Base mount; non hazardous locations, NEMA 4.

\* See *Specifications* section, on page 3, for listed models.

### Remote Reset Option (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 6-1/2 minutes with a 20-turn potentiometer (15 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

-H23: Space heater for 230 VAC

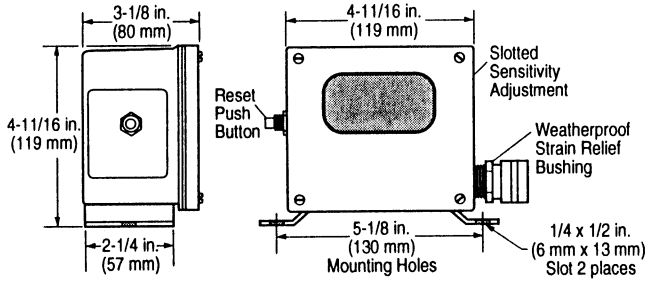
-H24: Space heater for 24 VDC

### Warranty

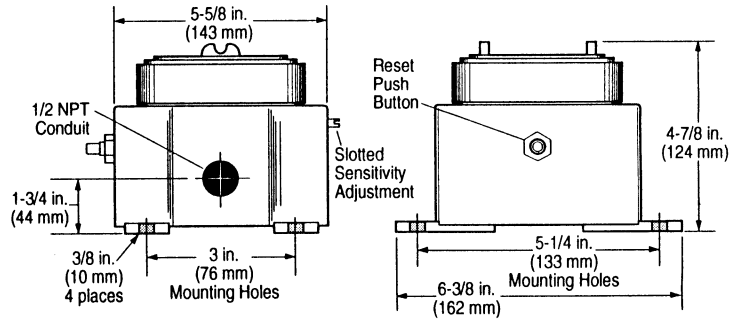
A two-year limited warranty on materials and workmanship is provided with this Murphy product. Details are available on request and are packed with each unit.

# DIMENSIONS

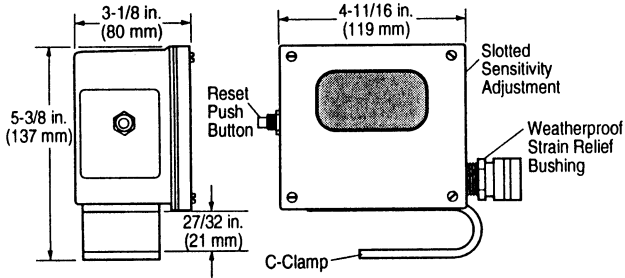
## VS2



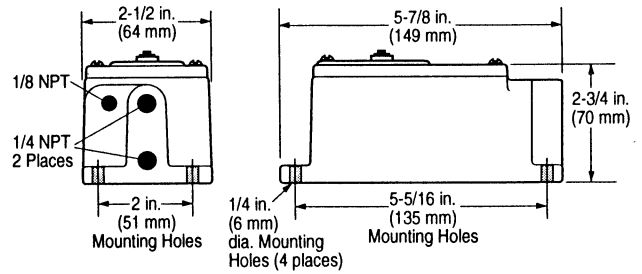
## VS2EX and VS2EXR



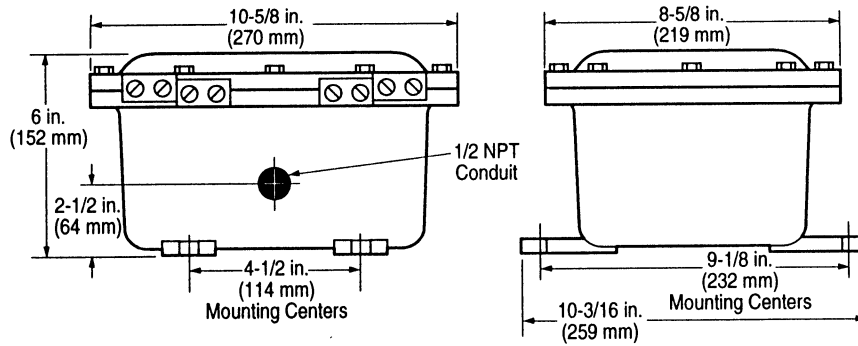
## VS2C



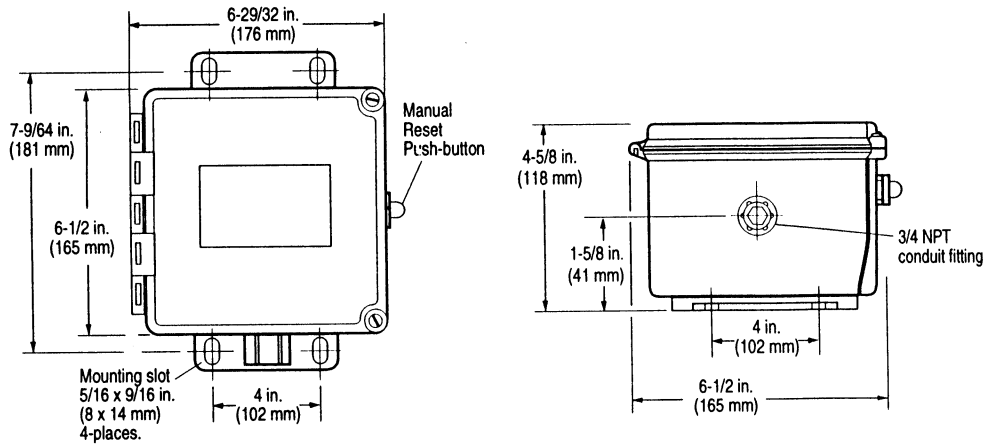
## VS2N



## VS2EXRB



## VS94



## SPECIFICATIONS

### VS2 and VS2C

- **Case:** Weatherproof (equal to NEMA 3R) housing suitable for open mounting. Rated 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 mm<sup>2</sup>) cable, and five cable hold down clamps.*

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

### VS2EX

- **Case:** Explosion-proof and weatherproof aluminum alloy housing; meets NEMA 7 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.

### 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 additional SPDT switch); 5A @ 480 VAC; 2A resistive, 1A inductive, up to 30 VDC.

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

\*CSA and UL listed with 480 VAC rating.

### VS2N (Pneumatic Model)

- **Case:** Aluminum alloy housing.
- **Operating Pressure:** 20 to 80 psi (138 to 552 kPa) [1.38 to 5.52 bar]. 60 psi (414 kPa) [4.14 bar] recommended.

### 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
H23	.011 A @ 230 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 6-1/2 minutes (15 seconds per turn approximately).

## INSTALLATION

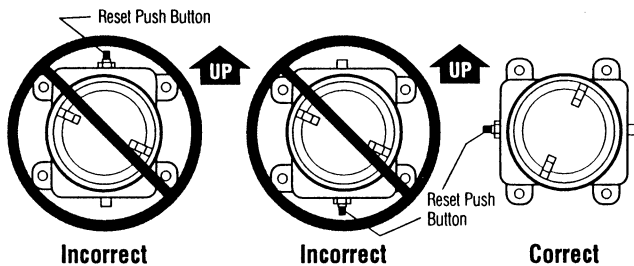


**WARNING: STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING INSTALLATION.**

The VS2 and VS94 Series are sensitive to shock and vibration in all three planes of motion—up/down, front/back and side/side. Front/back is most sensitive. (See Dimensions on page 2 for sensitivity adjustment location.)



**CAUTION:** Mounting for all VS2 and VS94 Series shock and vibration switches must be with the reset push button on a horizontal plane. **DO NOT MOUNT** with reset push-button **UP** or **DOWN**.



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 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 and VS94 Series. Typically 1/2 in. (13 mm) thick plate is sufficient. See illustrations on page 5 for typical mounting locations.

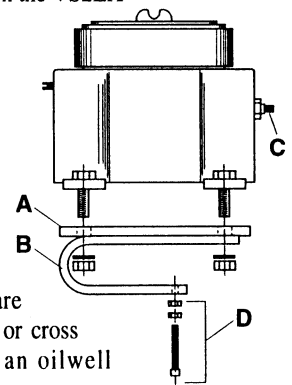
### C-Clamp Installation (VS2C model only)

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.*

## Electric 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 Installation* 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.*

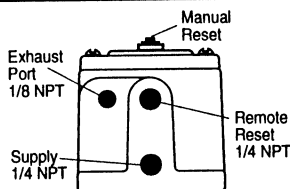
If conduit is not used for the entire length of wiring, conduit should be used from the electrical supply box to a height above ground level that prevents damage to the exposed cable from the elements, rodents, etc. or as otherwise required by applicable electrical codes. If conduit is not attached directly 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.

## Pneumatic Models (VS2N)



**WARNING: IF USED IN A HAZARDOUS AREA, EXPLOSIVE GASES MUST NOT BE VENTED INTO THE AREA.**

1. Mount the VS2N according to the same instructions as the electric models. However, note that although the VS2N is sensitive to shock/vibration in all three planes of motion, its most sensitive plane is perpendicular to its base.
2. Attach a pressure source of 20-80 psi (138-552 kPa) [1.37-5.51 bar] to the "Supply" port. Best operation is obtained with 60 psi (414 kPa) [4.13 bar]. Pressure medium must be clean, dry air or gas. Use a filter and pressure regulator as necessary.
3. Connect an exhaust line to the "Exhaust" port and to the equipment shutdown device to be operated.



## Sensitivity Adjustment

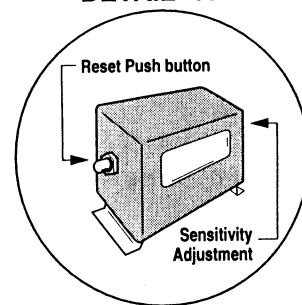


**WARNING: REMOVE ALL POWER BEFORE OPENING THE ENCLOSURE. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON PERFORM ADJUSTMENTS, AND MAKE SURE IT CONFORMS WITH NEC AND LOCAL CODES. DO NOT ADJUST SENSITIVITY WHILE THE MACHINE IS RUNNING. STAND CLEAR OF THE MACHINE AT ALL TIMES WHEN IT IS OPERATING.**

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, VS2N, VS94 series the reset button will remain depressed meaning the magnetic latch has engaged.
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").

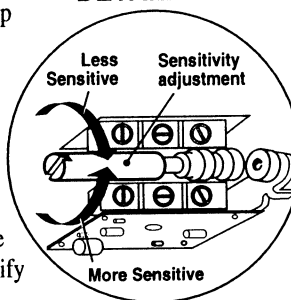
### DETAIL "A"



**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.

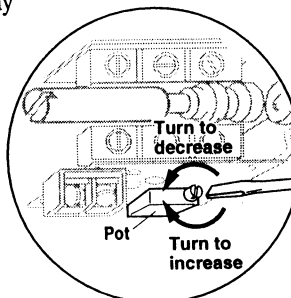
## VS94 Time Delay Adjustment



**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.**

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

### DETAIL "C"



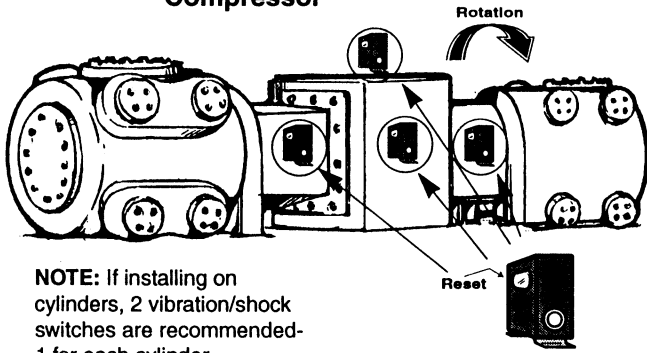
*NOTE: Allow 30 seconds bleed-time between turning the power "OFF" and "ON!"*

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 (15 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.*

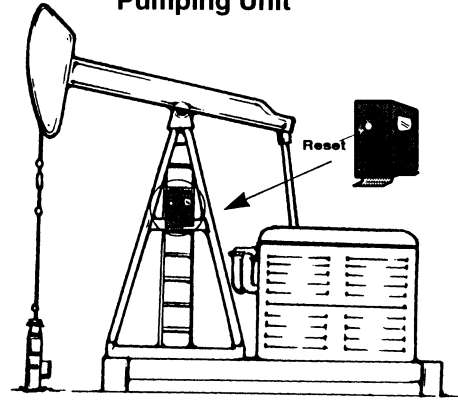
# TYPICAL MOUNTING LOCATIONS

## 2-Throw Balance-Opposed Compressor

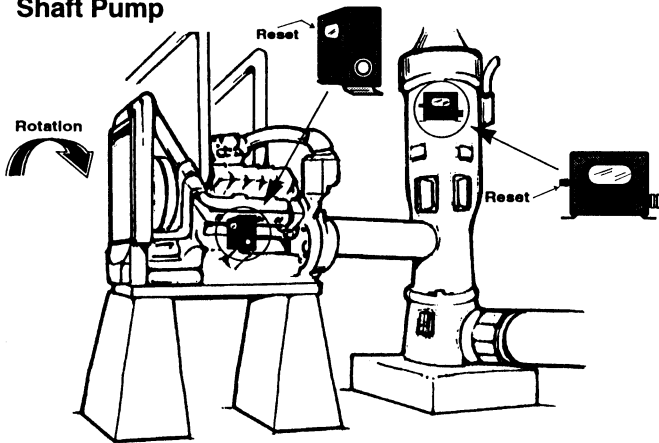


**NOTE:** If installing on cylinders, 2 vibration/shock switches are recommended- 1 for each cylinder.

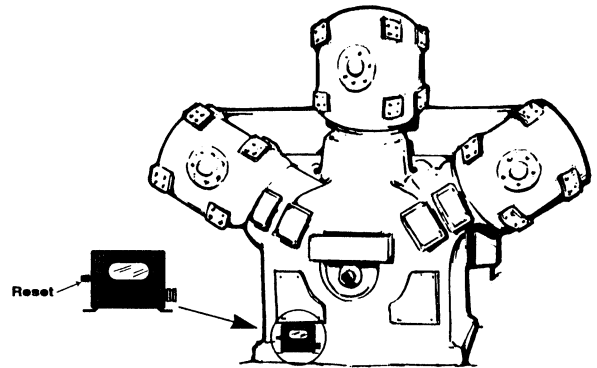
## Pumping Unit



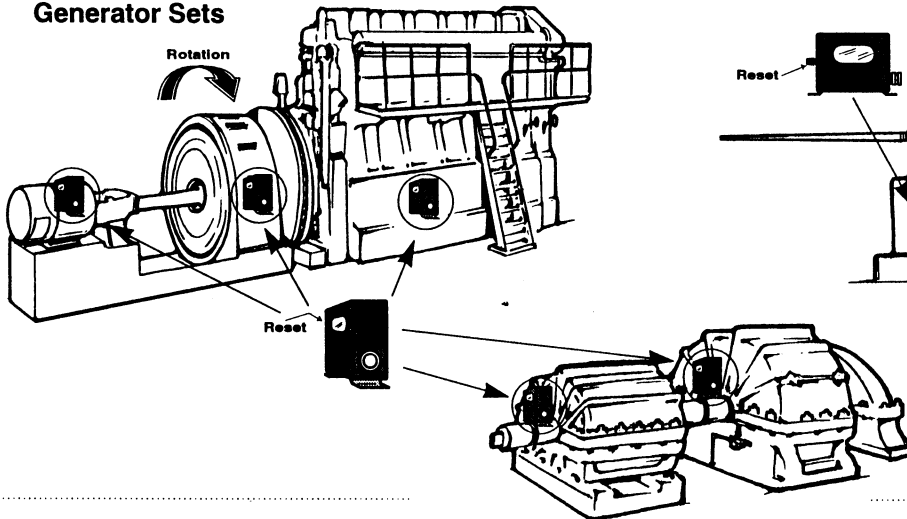
## Engine and Vertical Shaft Pump



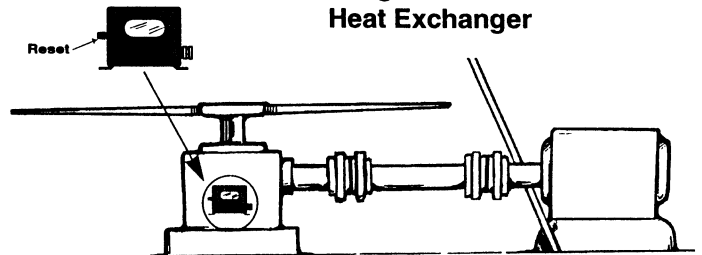
## "Y" Type Reciprocating Compressor



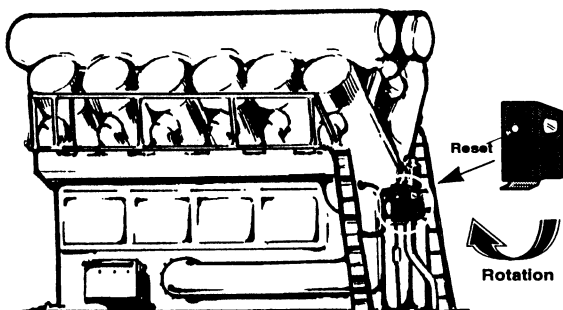
## Generator Sets



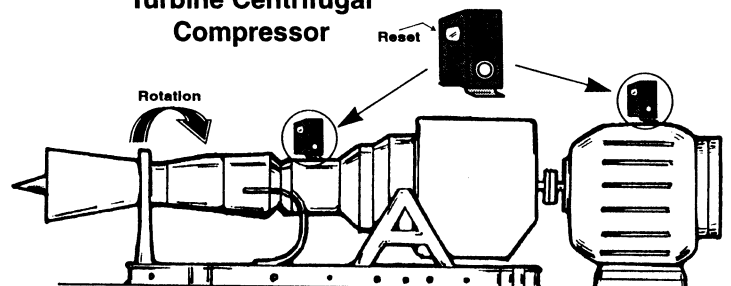
## Cooling Tower Fan or Heat Exchanger



## Engine Compressor

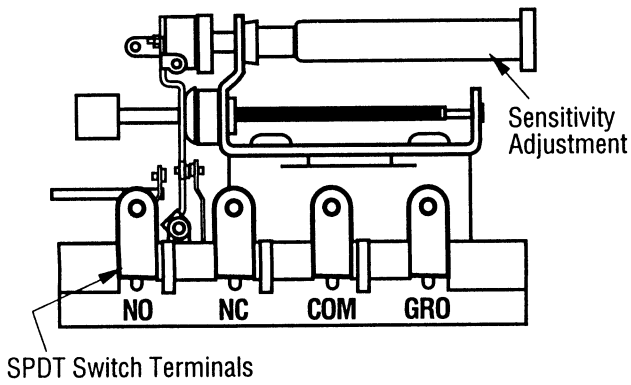


## Turbine Centrifugal Compressor

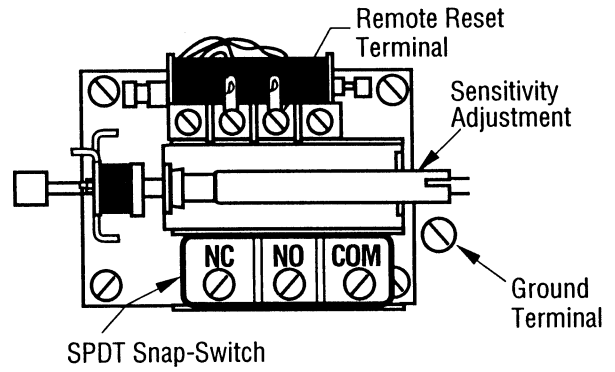


# INTERNAL SWITCHES

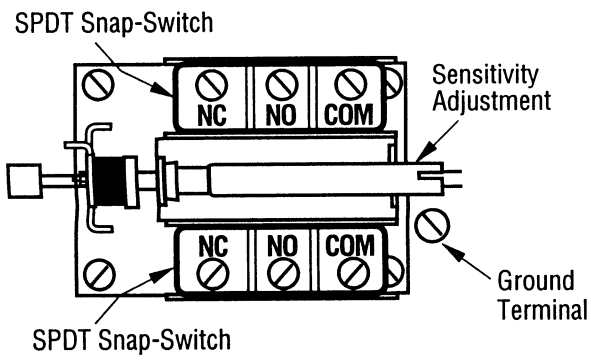
## VS2 and VS2C



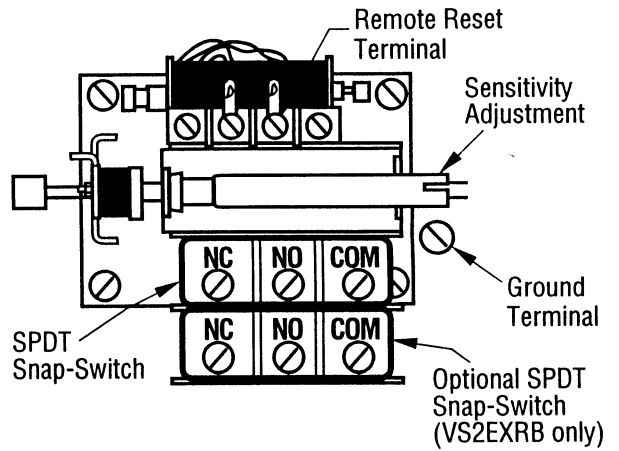
## VS2EXR



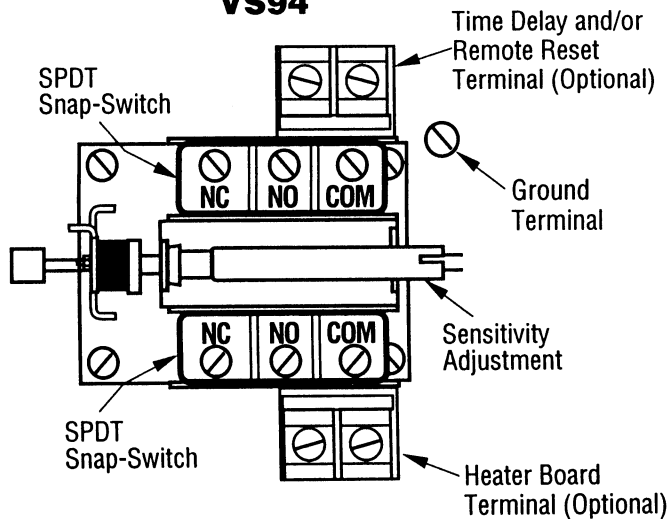
## VS2EX



## VS2EXB and VS2EXRB



## VS94

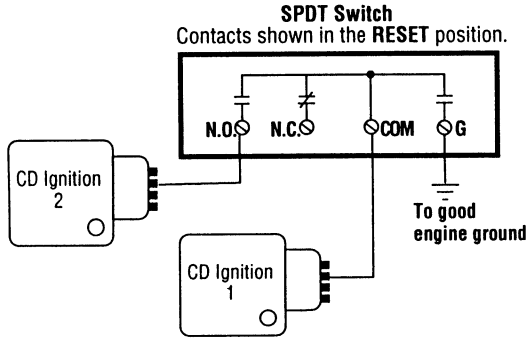


# ELECTRICAL

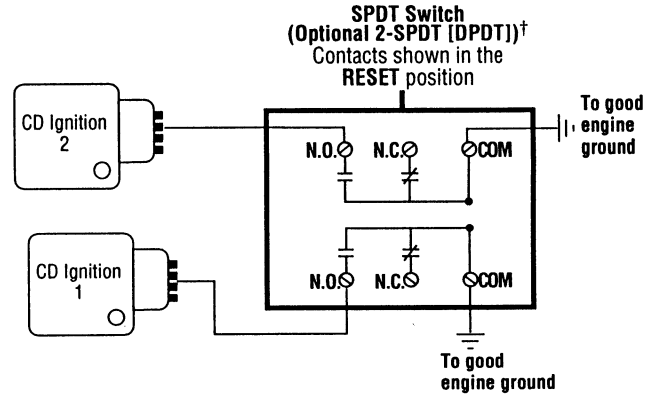


**WARNING:** REMOVE POWER BEFORE OPENING THE UNIT (ACCESS DOOR). STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING THE WIRING OPERATION. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON INSTALL AND WIRE THE UNIT, AND MAKE SURE IT CONFORMS WITH NEC AND APPLICABLE CODES.

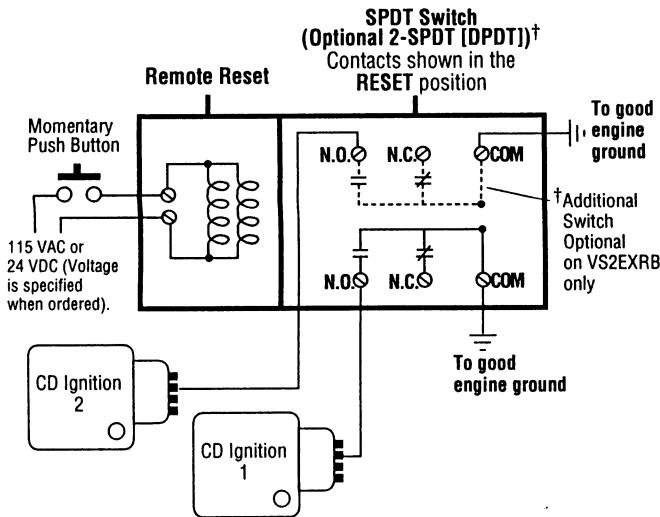
### VS2 and VS2C Typical Wiring Diagram for Single or Dual CD Ignition



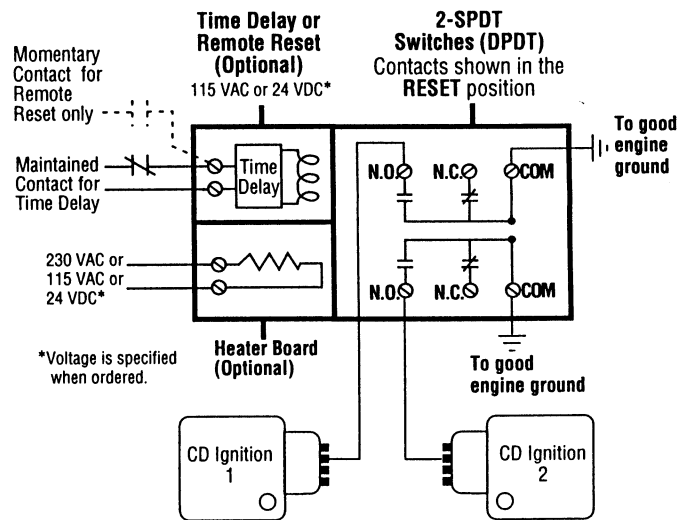
### VS2EX Typical Wiring Diagram for Single or Dual CD Ignitions



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

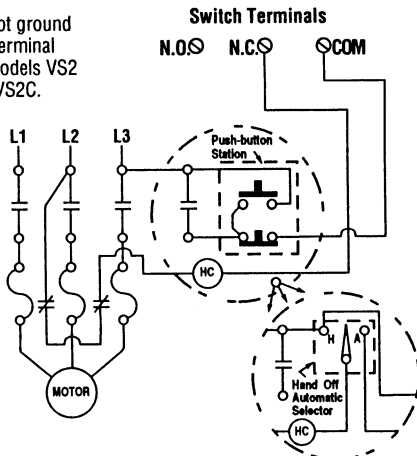


### VS94 Typical Wiring Diagram for Single or Dual CD Ignitions



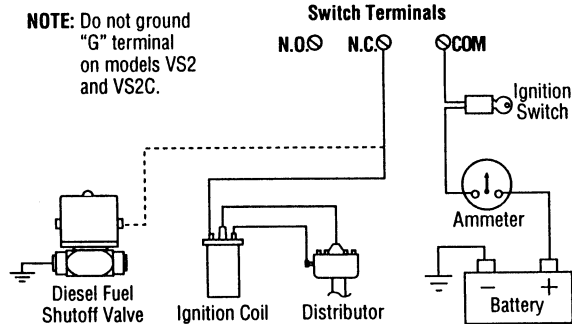
### VS2, VS2C, VS2EX, VS2EXR, VS2EXRB and VS94 Typical Wiring Diagram for Electric Motors

**NOTE:** Do not ground "G" terminal on models VS2 and VS2C.



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

**NOTE:** Do not ground "G" terminal on models VS2 and VS2C.



## SERVICE PARTS

**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
- 00-00-3292 Cable clamp assembly (1 each)
- 20-00-0465 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**

- 20-00-0046 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

**PART NO. DESCRIPTION**

**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
- 20-00-0046 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.*



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# INSTALLATION INSTRUCTIONS POLYESTER VINYL BUG SCREEN PANELS

## SERIES 1.2 – 0704

All “soft” bug screen panels are designed to provide ease of installation, quick removal, convenient storage, and optimum panel inter-changeability.

Panels are constructed of a woven, vinyl coated polyester 8 x 10 mesh, trimmed with polyester/vinyl binding, and attached using Velcro fastener material. They are designed for extended life and performance in all weather conditions for temperatures ranging from 120°F to minus 40°F.

### **CAUTION: READ ALL INSTRUCTIONS BEFORE PROCEEDING**

1. To avoid damage in shipping, shop handling, subsequent paintings, etc., each panel has been **pre-fitted** with a matching Velcro “hook” tape that must first be removed and bonded to the structural frame. This is done by using the special, pressure-sensitive adhesive back on the Velcro “hook” tape.
2. The perimeter, or 1” edge of the bug screen framework, is to be used to apply the Velcro “hook” tape. The painted or galvanized structural frame surface should be **clean, dry, and free of oil**. The best adhesive bonding results will be obtained when installed at or above 60°F.

**CAUTION:** A newly painted surface should have cured for at least 72 hours prior to application.

**NOTE:** In field retrofit, applications to the surface should be thoroughly cleaned to remove any “dead” paint. To clean, use 50/50 isopropanol/water, MEK or similar solution prior to applying the permanent Velcro “hook” tape.

3. The back of the Velcro “hook” is prepared with a special, pressure-sensitive adhesive. Peel the clear protective backing from the “hook”, being careful not to touch the adhesive, and install the Velcro tape immediately to the 1” metal framework surface area around the perimeter of the panel opening. In joining the two surfaces, use finger pressure to firmly smooth the tape in place (especially important at corners and along edges). Note: A hard rubber roller can be used to ensure a smooth, firm fit.

4. For best results, round off or trim the outside corners to prevent “snagging”
5. Insert the 1” square “studs” at each corner in the ¼ hole in the framework. The stud should cover the ends of the “hook” tape in order to secure it and prevent the corners from coming loose in the future. These normally will need to be tapped or driven into place, and will provide a positive attachment point at each corner of each panel.
6. Allow adhesive to dry for 48 to 72 hours before cycling (attaching and removing panels). If necessary, drying time can be speeded up by applying heat to 200°F (example: hair dryer or heat gun).

**OPERATION:** Individual panels should be kept clean to ensure adequate airflow and maximum cooling performance, especially in hot weather. As with any filtration medium, dirty or clogged screens or fin tubes will adversely affect the cooler operation.

### **GENERAL CHARACTERISTICS**

- Highly resistant to water, oil, ultraviolet rays (sun light), and chemicals
- Vibration or pressure increases closure and holding strength
- Quick panel placement by simply pressing panel edges to permanent Velcro “hook” material on the framework
- Quick panel removal by simply “peeling” perimeter edges from permanent “hook” material on the framework.
- Exceptionally strong and treated to meet State of California Fire Code Bulletin 117-Class 1 (most stringent in the U.S.)
- Flexible and light weight for ease of installation, handling, and storage



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BEFORE ENTERING

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# **Only the name is new... AXH air-coolers**

*...combines 40 years of leadership experience in the air-cooled heat exchanger industry that encompasses the entire spectrum of air-coolers from initial thermal application and mechanical engineering, through design drafting, project management and after market support. To meet the growing market demands and customer expectations Air-x-hemphill was merged into AXH air-coolers in early 2005 in conjunction with a major expansion of both physical facilities and personnel.*

## **Capabilities**

*AXH air-coolers' offers an unparalleled level of experience and technical expertise throughout the entire organization, coupled with the largest manufacturing facility in the industry. A complete range of air-cooler models, types and sizes can be provided to fit any standard or custom application. Importantly we have the capability to design, supply and duplicate virtually any replacement cooler or section as well as support the reapplication of existing coolers.*

## **Reliability**

*We have manufactured thousands of air-coolers for the natural gas compression and process industries and have an established reputation for meeting delivery requirements. Foremost we are committed to quality assurance and on time shipment.*

## **Integrity**

*AXH air-coolers' objective and commitment is to consistently provide customers with the highest quality air-coolers and support at a competitive price.*



Corporate and sales office



# Facilities



A new 161,000 square feet plant is located on 12 acres outside Tulsa and adjacent to Route 66 in Claremore, Oklahoma.





# Capabilities



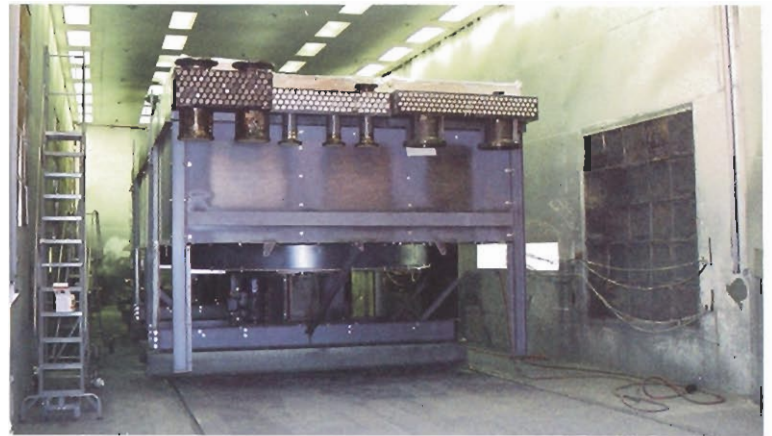
Finning area in 750 foot long East bay



5,000 sq. ft. parts warehouse



400 ton, 3/4" X 22' press brake



Larger of two paint booths - 1,900 sq. ft.

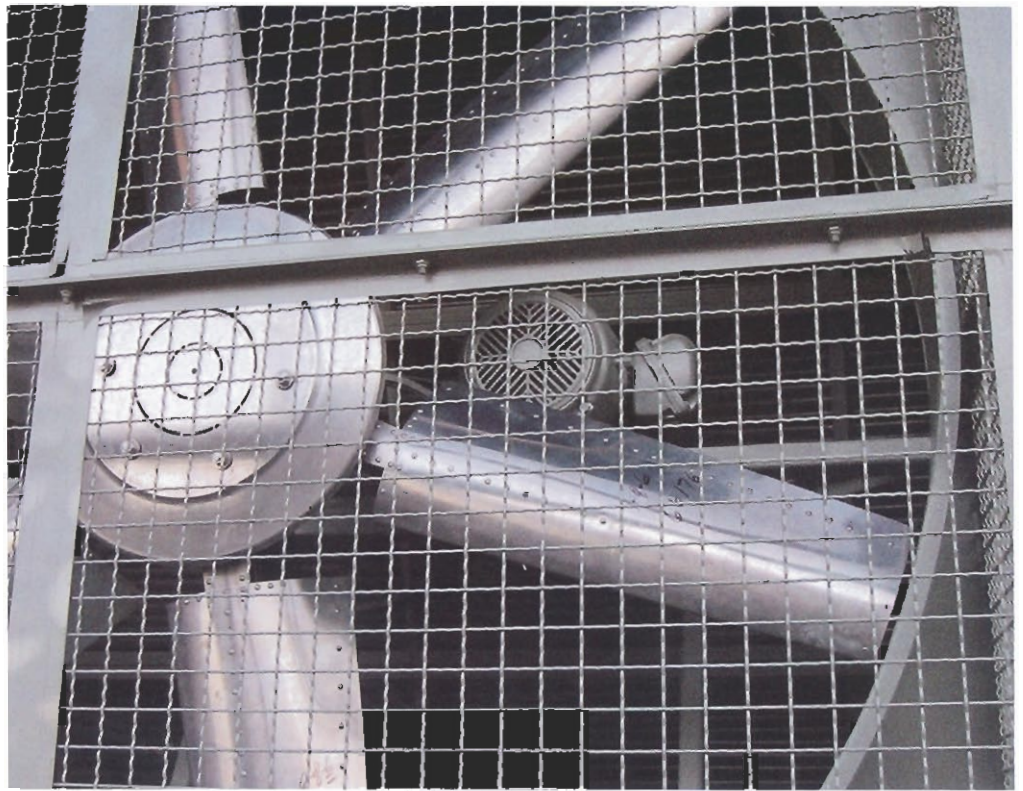


East bay final assembly area





(46) ASME code welding stations providing Stick, MIG, TIG & sub-arc procedures



Model 120EF with internal electric motor drive



Type HF incorporating evaporative inlet cooling



EF Models departing with warm air recirculation



# Reliability



EF coolers ready for shipment



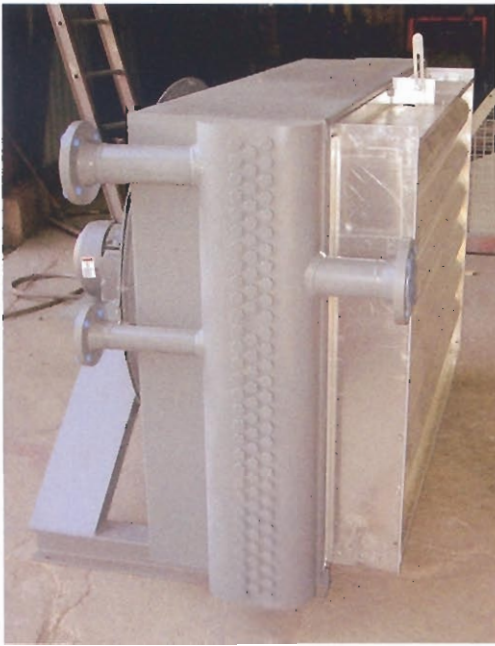
Type EF fan guard and "soft" bug screen frame



Induced Draft - Type VI's







Model VV with Obround headers



Model 180-2ZF destined for overseas



Direct Drive Model 36VF's



Model 60HF



Packaged two-fan, Model 120FF2



Galvanized Model 108FF2



**Integrity**



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