Air-X-Changers

Harsco

Plant Address
5215 Arkansas Rd.
Catoosa, OK 74015

Telephone 918.619.8000
Fax 918.619.5000

TO:	**ENERFLEX LTD.,C&P- BARLOW**	**DATE:**	**8/1/2010**
	10121 BARLOW TRAIL NE	**AXC #**	**104078**
	CALGARY, AB CANADA T3J 3C6	**PO #**	**MP526449**
ATTN:	**Document Control**	**TAG #**	**12517**

Transmittal Sheet

Please find the attached Operating, Maintenance & Instruction Manual. Should you have questions regarding this manual, please contact me at (918) 619-8000, or send an email to AXCQC@harsco.com.

Engine Drive Operating, Installation & Maintenance Instructions.

The following supplemental parts information is included:

Maro Shutter EH/Small VV

Garzo Air Motor

Kimray Temperature Controller

Kimray Separable Socket

Fisher Filter Regulator 67CF Series

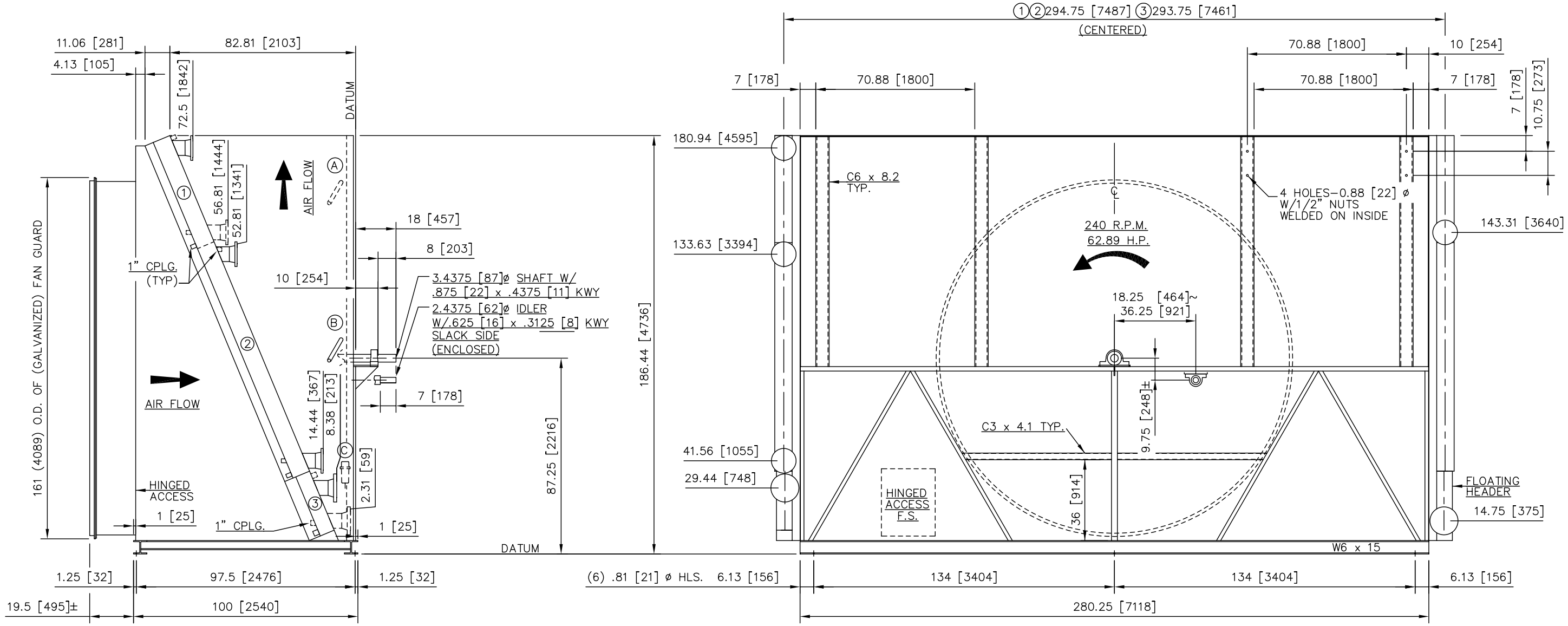
Moore Fan Class 10K

Dodge S-2000 Bearing

For Spare Parts
Call: 1-800-404-3904 or 01-918-619-8028

Patricia Kurth

cc: Eads - Canada



NOTE:
1. ESTIMATED DRY WEIGHT: 23,450#
2. PAINT: H–I–S 91L15 TINT–TO–MATCH DOFASCO QC315 TAN.
3. SPREADER BARS REQUIRED FOR LIFTING.
4. SHUTTER OPERATORS MAY BE LOCATED ON EITHER SIDE.
5. [ ] = METRIC DIMENSIONS
   AT GAS HEADERS:
6. P.W.H.T.
7. SPOT R.T. OF 1 LONG SEAM AND 1 END CLOSURE, PER HEADER.

COMBINED

① EJW/ELOW (54 GALS) D.P. 14 P.S.I. @ 300/–20 °F. NOZZLES 6"–150 RF	③ AC (ASME STAMP) D.P. 350 P.S.I. @ 300/–49 °F. NOZZLES 6"–300 RF
② TAW/CW (114 GALS) D.P. 14 P.S.I. @ 300/–20 °F. NOZZLES 6"–150 RF	

Ⓐ MANUAL SHUTTER EJW/ELOW W/ GROUND LEVEL OPERATOR

Ⓑ MANUAL SHUTTER TAW/CW W/ GROUND LEVEL OPERATOR

Ⓒ AUTO SHUTTER OPERATOR AC

AUTO BY (1) GARZO 501–6 AIR MOTOR (SHUTTERS FAIL CLOSED)

REV.	DESCRIPTION	BY	DATE	APP'D	DATE
1	CHANGED AC NOZZLE TO 6", SHAFT PROJECTION TO 18" AND PAINT COLOR TO TAN	MRAY	6/15/10	BB	6/16/10
2	REVISED TO REMOVE THE HAILGUARD & BUGSCREENS	GGH	7/26/10	IM	7/26/10

JOB STATUS:

RELEASED

FABRICATION OF THIS ORDER HAS BEGUN

CUSTOMER: ENERFLEX LTD
TAG: 12517
P.O. NO.: MP526449

HARSCO INDUSTRIAL Air-X-Changers

MODEL 156EH
AXC JOB NO.: 104078
DRAWN BY: AICS–MRAY DATE: 5/28/10
CHECKED BY: BB DATE: 6/1/10 REV.
DRAWING NO.: CRT SCALE: 1:1 2

PARTS LIST

air-x-changers
a harsco company

Post Office Box 1804
Tulsa, OK 74015
Phone: (918) 266-1850
Fax (918) 266-1322

JOB NUMBER: ***104078***
CUSTOMER: ***ENERFLEX***
ORDER COVERS: ***(1) Model 156EH-122-24***

REV.	BY	DATE	DESCRIPTION OF CHANGE
0	***SCARDWELL***	***6/7/2010***	***Initiated Parts List***
1	***SCARDWELL***	***7/20/10***	***Removed hail guard and bugscreens***

FINISH: ***Customer Tint***
SURFACE PREPARATION: ***Chemical Clean***
PRIMER: ***H-I-S 9267 or 92G08 Gray Primer***; ***1.5*** TO ***2.0*** MILS. DFT.
FINISH COAT: ***AXC Customer Tint: H-I-S 91L15 (Tint to Match Dofasco QC315 Tan)***; ***1.5*** TO ***2.0*** MILS. DFT.

P.O.	QTY.	DESCRIPTION OF COMPONENTS NOTE: AN ASTERIK (*) IN QUANTITY COLUMN INDICATES A RECOMMENDED SPARE PART
	2	SECTION(S) IN ACCORDANCE WITH SPECIFICATION SHEET.
	1	***156EH-122-24*** STRUCTURE(S), COMPLETE WITH: ~~***Hail Guards - Type: Standard; Flush Mount; ; Area(Sq.Ft.): 172.6***~~ ***Enerflex NEW Standard Pipe Supports with NEW surge tank mounts*** ***Fan Shaft Extension; Total Projection – 18"***
	1	SET SHUTTERS: TYPE ***Manual,*** FOR SERVICE(S) ***EJW/ELOW***, SQ. FT. = ***102,*** #LINKAGE SETS = ***1,*** MOUNTING TYPE: ***Standard,*** EXTRA FEATURES: ***None***
	1	SET SHUTTERS: TYPE ***Manual,*** FOR SERVICE(S) ***TAW/CW***, SQ. FT. = ***210,*** #LINKAGE SETS = ***1,*** MOUNTING TYPE: ***Standard,*** EXTRA FEATURES: ***None***
	1	SET SHUTTERS: TYPE ***Auto,*** FOR SERVICE(S) ***AC***, SQ. FT. = ***57,*** #LINKAGE SETS = ***1,*** MOUNTING TYPE: ***Standard,*** EXTRA FEATURES: ***None***
	1	AIR MOTOR: FOR SERVICE(S) ***AC, Garzo*** MAKE, ***501-6 w/Pivot Mount*** MODEL, ***6-30*** SPRING OPTION, ***Silicone*** DIAP MTRL., POSITIONER: ***None***
	1	TEMP CONTROLLER(S): ***Kimray*** MAKE, ***T12*** MODEL, ***-30/400°F*** TEMPERATURE RANGE, AXC P/N ***CT1080***
	1	SEPERABLE SOCKET(S): ***Kimray*** MAKE, ***SS-12SS*** MODEL, ***1" NPT*** THREADS, ***4,000psi MAWP***, AXC P/N ***CT1085***
	1	REGULATOR(S): ***Fisher*** MFG, ***67CFR-224*** MODEL, AXC P/N ***CT1195***
	**** 1***	FAN(S): ***156*** Inch DIAMETER, ***10*** BLADES, ***LH*** ROTATION, ***MOORE-CL10K*** MAKE, ***14.9°*** ANGLE ***@ Clevis***, ***3-7/16*** Inch BORE WITH ***7/8*** Inch X ***7/16*** Inch KEYWAY. MODEL/PITCH: ***60-HDVT/Manual***, HUB:***TAPER WELD VORTEX TIPS TO FAN BLADES!***
	**** 1***	FAN SHAFT(S): ***3-7/16*** Inch DIA. X ***125*** Inch LONG WITH ***7/8*** Inch SQ. KEYS ***each*** END, KEYWAY LENGTH(DRIVE END): ***7 Inch,*** KEYWAY LENGTH(FAN END): ***7 Inch,*** KEY LENGTH: ***5 Inch***
	**** 2***	***3-7/16*** Inch FAN SHAFT BEARINGS, MAKE/MODEL: ***Dodge-S2000/P2B-S2-307R,*** AXC P/N ***BR1124***
	**** 1***	IDLER SHAFT(S): ***2-7/16*** inch DIA. X ***20*** inch LONG WITH ***5/8*** inch SQ. KEY ***6*** inch LONG-ONE END
	1	SET(S): ***Adj. Block*** TYPE IDLER FRAME PARTS
	**** 2***	***2-7/16*** Inch IDLER BEARING(S), MAKE/MODEL: ***Dodge-S2000/P2B-S2-207R,*** AXC P/N ***BR1111***
		~~SET(S) BUGSCREEN FRAME/FANGUARD WITH SOFT BUGSCREEN PANELS ***PER AXC P/N BP0018***:~~ ~~ONE SET CONSISTS OF:~~ ~~***4*** PANELS ***28.5*** Inches X ***78.5*** Inches~~ ~~***8*** PANELS ***43*** Inches X ***81*** Inches~~ ~~COMPLETE WITH ONE(1) SOFTBUGSCREEN INSTALLATION KIT.~~

Air-X-Changers
Harsco
PO BOX 1804
TULSA, OK 74101-1804
PHONE: 918-619-8000
FAX: 918-384-5202

Job Number	104078
Initial Release Date	06/07/10
Page	1 of 1

Purchaser	ENERFLEX			Ultimate User	HUSKY OIL	
Inquiry / PO#	Q190393			Destination	ALBERTA	
Number of Units	1	Model	156EH-122-24	Reference	3516LE-RG357M 1340HP@1400RPM	
Assembly	PACKAGED	Draft	FORCED	Overall Size(WLH)	~10.04x25.00x15.54	Est. Weight 24650

PERFORMANCE

Service	EJW/ELOW	TAW/CW	AC		
Flow	344GPM	403GPM	4.34MMSCFD		
Fluid	50%GLY	50%GLY	AIR		
Temp. In / Out, f	190.0 / 166.9	150.0 / 130.0	230.0 / 120.0		
Pressure, psia			237.3		
Pressure Drop, psi	3.4	8.9	3		
Heat Load, btu/hr	3,717,237	3,659,127	992,848		
True LMTD, f	46.2	22.7	40.6		
Overall Rate, U, btu/hr sq ft f	156.6	154.0	91.5		
Fouling Factor, sq ft hr h / btu	0.0005	0.0005	0.0020		
Surface, Bare / Extended, sq. ft	521 / 8280	1065 / 16930	272 / 4325		
Sections, Number/Connected	(1) COMBINED w/2	(1) COMBINED w/1	(1) SINGLY		
Design Temp (Max / Min), f	300/-20	300/-20	300/-49		
Design / Test Pressure, psig	*14 / 65	*14 / 65	350 / 455		
Pass Arrangement	CROSSFLOW	CROSSFLOW	CROSSFLOW		
Number Tube Rows / Tube Passes	4 / 1	4 / 2	4 / 1		
Section Weight, lbs	8800	Combined w/1	2050		
Tubes, OD x BWG	5/8X16(.060MIN)	5/8X16(.060MIN)	5/8X16(.060MIN)		
Material	SA214	SA214	SA214		
Number per section / Length, ft	134 / 24	274 / 24	70 / 24		
Retarders					
Accelerators					
Fins, Type	L-TENSION/WHEEL	L-TENSION/WHEEL	L-TENSION/WHEEL		
Material	ALUMINUM	ALUMINUM	ALUMINUM		
Nozzles, Rating / Type	150 RF	150 RF	300 RF		
Material / Bore	SA105 / SCH-40	SA105 / SCH-40	SA350 LF2 / SCH-80		
(Number of Inlets) / Size, in	(1) / 6 Inch	(1) / 6 Inch	(1) / 6 Inch		
(Number of Outlets) / Size, in	(1) / 6 Inch	(1) / 6 Inch	(1) / 6 Inch		
Headers, Type	RECT. TUBE	RECT. TUBE	BOX W/PLUGS		
Material	SA500 GR.B	SA500 GR.B	SA516 70(N)		
Corrosion Allowance, in			0.0625		
Grooved Tubesheet			YES		
Plugs, Type	TAPER	TAPER	SHOULDER		
Material	SA105	SA105	SA350 LF2		
Industry Specifications	AXC-STD	AXC-STD	API-661		
ASME Code Stamp / National Board			YES		
Canadian Registration Number			YES		
PWHT			YES		
NACE					
Inspection / NDT			S		

F = 100% R.T. of all header seam & nozzle butt welds plus 100% U.T. of all attachment welds
S = Spot R.T. of one long seam and one end closure, per header
U = 100% U.T. of all header seam, attachment and nozzle butt welds
B = 100% R.T. of all nozzle butt welds
SB = ***S PLUS B*** as each are described above
UB = ***U PLUS B*** as each are described above

AIR SIDE PERFORMANCE		FAN DATA		DRIVER DATA		REDUCER DATA	
Ambient Air Temp., In, f	104	No. Fans / Make	1 / MOORE-CL10K	Type	ENGINE DRIVE	Type	REDUCER BY OTHERS
Elevation, ft	1890	Blade Material	ALUMINUM				
Air Flow, SCFM	239533.7	HP@RPM	62.89 @ 240				
Air Temp., Out, f	135.7	Dia., in / No. Blades	156 / 10				
Min. Ambient, f	0	Blade Angle, Deg	14.9 @ Clevis				
		Series/Blade Adj.	60-HDVT/Manual				
		Fan Hub Bushing	TAPER				

*** Actually built to standard 50# design. Designated 14# to eliminate necessity of Provincial registration.**

TOP MOUNTED HAIL GUARDS
INTAKE BUG SCREEN FRAME WITH REMOVABLE SOFT PANELS

9802 fpm fan tip speed: 87dBA@1m, 61dBA@15m

REV	DATE	BY	DESCRIPTION

104078-CRN-3
Additional Drawing No.

.517
Header Volume (cu.ft.)

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 Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by Harsco Industrial Air-X-Changers, 5215 Arkansas Road, Catoosa, Oklahoma, 74015, USA
(Name and address of manufacturer)

2. Manufactured for ENERFLEX LTD.,C&P- BARLOW, 10121 BARLOW TRAIL NE, CALGARY, T3J 3C6, CANADA
(Name and address of purchaser)

3. Location of Installation UNKNOWN
(Name and address)

4. Type Heat Exchanger (Horizontal or vertical, tank) | **104078.3** (Manufacturer's serial number) | V1683.213 (CRN) | HDR-3, REV0 (Drawing No.) | **68466** (National Board number) | 2010 (Year built)

5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE. The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 2007 (year) to A09 [Addenda (Date)]

N/A (Code Case numbers) | Low Temperature (Special Service per UG-120(d))

6. Shell: SA516 70(N) (Material spec. number, grade) | .75 in (Nominal thickness) | 0.0625 in (Corr. allow.) | N/A (Inner diameter) | N/A [Length (overall)]

7. Seams: Corner Joint [Long. (welded, dbl., sngl., lap, butt)] | N/A R.T.(Spot or Full) | C=.20 Eff.(%) | 1150 °F (H.T. temp) | 0.75 Time (hr) | N/A [Girth. (welded, dbl., sngl., lap, butt)] | N/A [R.T. (spot or full)] | N/A Eff(%) | N/A No. of Courses

8. Heads: (a) Material SA516 70(N) (Spec. no., grade) (b) Material SA516 70(N) (Spec. no., grade)

	Location (Top, Bottom, Ends)	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	TOP, BTM	.625"	0.0625	N/A	N/A	N/A	N/A	N/A	6" x 28.375"	N/A
(b)	ENDS	.5"	0.0625	N/A	N/A	N/A	N/A	N/A	6" x 5.4375"	N/A

If removable, bolts used (describe other fastenings) **N/A**
(Material spec. number, grade, size, number)

9. MAWP 350 psi (Internal) | N/A (External) at max. temp. 300 °F (Internal) | N/A (External)

Min. design metal temp. -49 °F at 350 psi . Hydro, pneu., or comb. test pressure HYDRO. at 455 psi

Proof test N/A

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain)	Number	Diameter or Size	Type	Material	Nominal Thickness	Reinforcement Material	How Attached	Location
IN/OUT	**2**	**6"**	**300# RFWN**	**SA350 LF2/SA333 GR.6**	**SCH-80**	**Weld**	**Welded**	**Header**
DRAIN	**1**	**1"**	**CPLG**	**SA350 LF2**	**6000#**	**Weld**	**Welded**	**Header**
DRAIN	**2**	**1"**	**CPLG**	**SA350 LF2**	**6000#**	**Weld**	**Welded**	**Header**

11. Supports: Skirt **NO** (Yes or no) | Lugs N/A (Number) | Legs N/A (Number) | Other **Structure** (Describe) | Attached Bolted (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:

N/A
(Name of part, item number, Manufacturer's name and identifying stamp)

Line 6 - -Tube and Plug Dimensions OR Header Dimensions: 6.6875" X 0.7500" X 2' 4.3750"
Straight length of tubes, OR, Distance between the headers: 24' 0.0"
(A)TUBES: 70 x .625" OD, Gauge: 16BWG, Material: SA214 Rolled Tube Sheet (B)INSP.OPENINGS:

Additional Remarks - See Attached U-4...

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 No. 4241 expires 12/31/2011

Date 07/28/2010 Co. name **Harsco Industrial Air-X-Changers** (Manufacturer) Signed Jon R. Messer (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by Harsco Industrial Air-X-Changers at 5215 Arkansas Road, Catoosa, Oklahoma, 74015, USA I, the undersigned, holding a valid commission issued by The National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province **OK** and employed by OneBeacon America Insurance Co. of Lynn, MA have inspected the component described in this Manufacturer's Data Report on July 19, 2010 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/her 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 07/29/2010 Signed (Authorized Inspector) Commissions 11672A, OK765 (National Board (incl. endorsements), State, Province and number)

FORM U-4 MANUFACTURER'S DATA REPORT SUPPLEMENTARY SHEET

As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII,

1. Manufactured and certified by Harsco Industrial Air-X-Changers, 5215 Arkansas Road, Catoosa, Oklahoma, 74015, USA
(Name and address of Manufacturer)

2. Manufactured for ENERFLEX LTD.,C&P- BARLOW, 10121 BARLOW TRAIL NE, CALGARY, T3J 3C6, CANADA
(Name and address of Purchaser)

3. Location of Installation UNKNOWN
(Name and address)

4. Type

Heat Exchanger	N/A	104078.3
(Horizontal, vertical, or sphere)	(Tank, separator, heat exh., etc.)	(Manufacturer's serial number)

V1683.213	HDR-3, REV0	68466	2010
(CRN)	(drawing no.)	(National Board number)	(Year built)

Additional nozzles, inspection and safety valve openings:

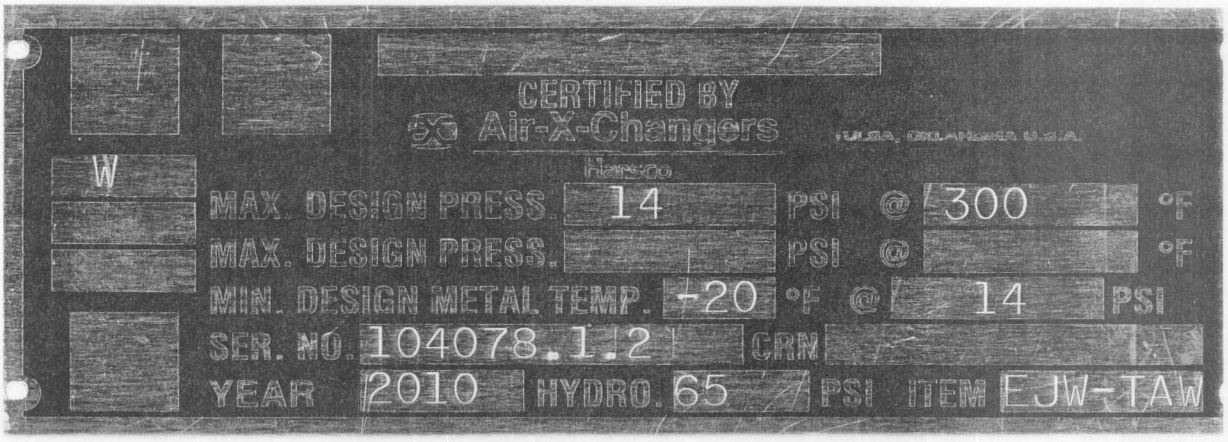
Additional Remarks:

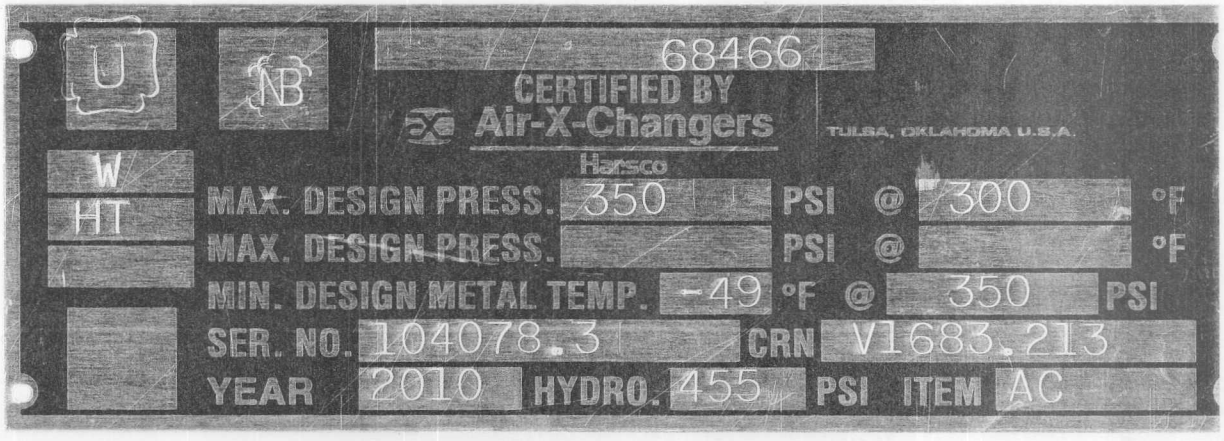
140, Type: 3/4X16UNF-Threaded, Material: SA350 LF2 (C)IMPACT REQUIREMENTS: PLATE IMPACT EXEMPT PER: UCS-66(A) & FIGURE UCS-66 CURVE D & UCS 68. PIPE AND FLANGE IMPACT EXEMPT PER: UCS-66(G). Constructed in conformance with Appendix 28.

Certificate of Authorization: Type "U" No. 4241 Expires 12/31/2011

Date 07/28/2010 Name **Harsco Industrial Air-X-Changers** (Manufacturer) Signed (Representative)

Date 07/29/2010 Name (Authorized Inspector) Commissions: 11672A, OK765
(National Board (incl. endorsements), State, Province and number)


CERTIFIED BY
Air-X-Changers
TULSA, OKLAHOMA U.S.A.
Harsco
W
MAX. DESIGN PRESS. 14 PSI @ 300 °F
MAX. DESIGN PRESS. PSI @ °F
MIN. DESIGN METAL TEMP. -20 °F @ 14 PSI
SER. NO. 104078.1.2 CRN
YEAR 2010 HYDRO. 65 PSI ITEM EJW-TAW


U
NB
68466
CERTIFIED BY
Air-X-Changers
TULSA, OKLAHOMA U.S.A.
Harsco
W
HT
MAX. DESIGN PRESS. 350 PSI @ 300 °F
MAX. DESIGN PRESS. PSI @ °F
MIN. DESIGN METAL TEMP. -49 °F @ 350 PSI
SER. NO. 104078.3 CRN V1683.213
YEAR 2010 HYDRO. 455 PSI ITEM AC

Air-X-Changers

Harsco

CERTIFICATE OF HYDROSTATIC TEST

AXC SERIAL NO.: 104078.1.2

ITEM DESCRIPTION: EJW/ELOW/TAW/CW

DESIGN PRESSURE: 14 ***psig***

DESIGN TEMPERATURE: 300/-20 ***ºF***

TEST PRESSURE: 65 ***psig***

This is to certify that above air-cooled heat exchanger section was hydrostatically tested at no less than 1.3 times the design pressure for a time no less than one (1) hour.

Patricia Kurth
AXC Quality Department Representative

8/1/2010
Date

TSI Heat Treating

Certification

Order No.: 150861 - 1
Date: 07/15/2010
Entry Date: 07/14/2010
Page: 1 of 1

To: 527
AIR - X - CHANGERS
P O BOX 1804

TULSA OK 74101

Purchase Order No.: 1078231
Packing List No.: 63938

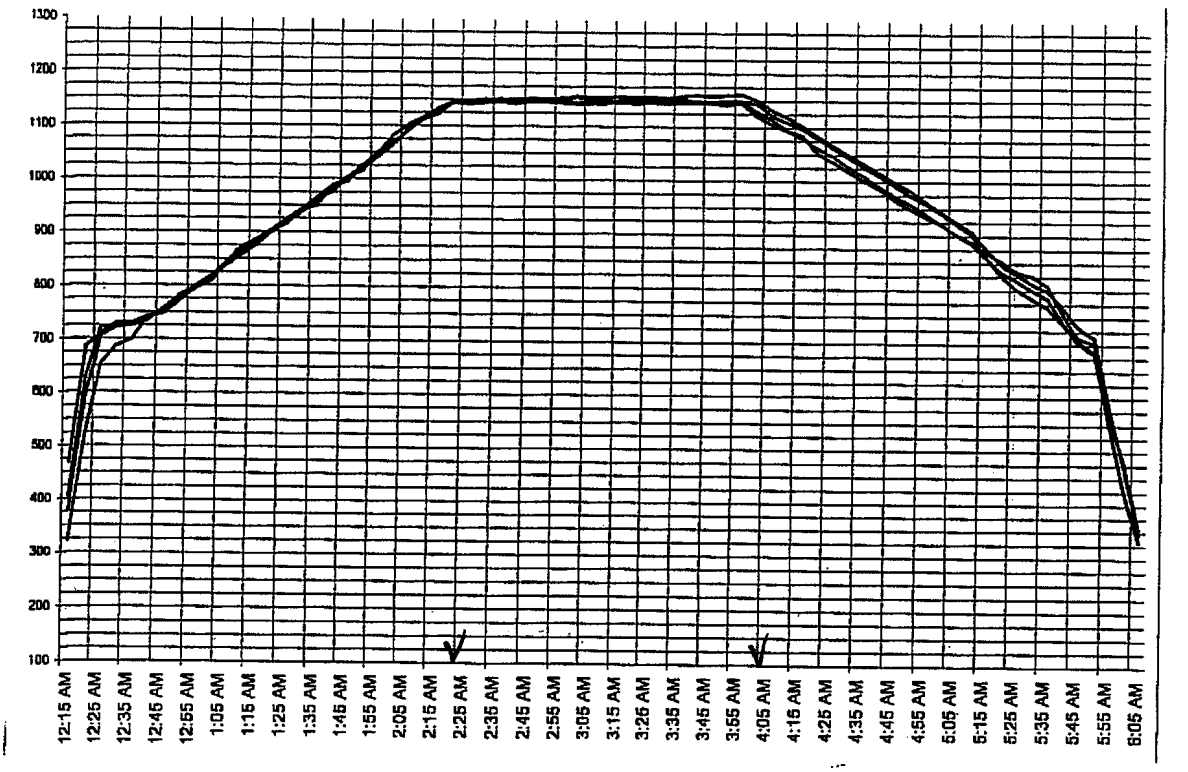
RECORDER: HONEYWELL CALIBRATION DATE: MAY. 14, 2010
TYPE K THERMOCOUPLE

Quantity	Part Number / Part Name / Part Description	Pounds
1	104078.3 FR	321
1	104078.3 BK	323

Process Steps

Step: 1 **Process: Stress** **Equipment #:** **25**

1150 degrees F. for 1 hrs



DATE: 7-15-10

CHART DIVISION: _____ MINUTES

MANAGEMENT REPRESENTATIVE

8181 S. 88th W. Ave. Tulsa, OK 74131 **Phone:** 918-227-4800 **Fax:** 918-227-4805

TULSA GAMMA RAY, INC.

1127 SOUTH LEWIS AVENUE
TULSA, OKLAHOMA 74104-3900
918 / 585-3228 • FAX 918 / 584-5598
1 - 800 - 625-9288
www.tulsagammaray.com

TECHNIQUE/INSPECTION REPORT

CUSTOMER DATA

NAME AXC
ADDRESS CATOOSA
PHONE _____ ATTN: _____
W.O. # 104078 P.O. # _____
JOB LOCATION AXC
DESCRIPTION SPOT X-RAY
MATERIAL TYPE: C/S

DATE 7-6-10 DAY TUESDAY

DEFECT CODE

AB – ARC BURN
AI – ALIGNED INDICATION
BT – BURN THROUGH
CON – CONCAVITY
CRACK – CRACK
HB – HOLLOW BEAD
IF – INADEQUATE FUSION
IP – INCOMPLETE PENETRATION
MA – MISALIGNMENT
POR – POROSITY
SLI – SLAG INCLUSION
SLL – SLAG LINE
SURF – SURFACE INDICATION
UCE – UNDERCUT EXTERNAL
UCI – UNDERCUT INTERNAL

ABBREVIATED TERMS

SOD = SOURCE TO OBJECT DISTANCE
OFD = SOURCE SIDE OF OBJECT TO FILM DISTANCE
OD = OUTER DIAMETER **REP** = REPAIR **RET** = RETAKE
WT = WELD THICKNESS **RES** = RESHOOT
WR = WELD REINFORCEMENT **BM** = BASE MATERIAL

WELD/FILM NUMBER	JOB NUMBER	OD	BM	WR	WT	WITHIN STD'S YES	WITHIN STD'S NO	# FILM	FILM SIZE / MFG / TYPE	SOD	OFD	IQI S-E	# EXP	DEFECT LOCATION
1 1-2 EB	104078	N/A	1/2"	1/8"	5/8"	✓		1	8 X 10 - 80	12"	5/8"	HB	1	
2 3-4	3-FR		5/8"	↓	3/4"	✓		↓	3 1/2 X 8 1/2 - 80	5 1/2"	3/4"	↓	↓	
3 4-5	↓		↓	↓	↓	✓		↓	↓	↓	↓	↓	↓	
4														
5 1-2 EB	3-BK		1/2"	↓	5/8"	✓		↓	8 X 10 - 80	12"	5/8"	↓	↓	
6 3-4	↓		5/8"	↓	3/4"	✓		↓	3 1/2 X 8 1/2 - 80	5 1/2"	3/4"	↓	↓	
7 4-5	↓		↓	↓	↓	✓		↓	↓	↓	↓	↓	↓	
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														

Larry Carter LEVEL II PIC

METHOD	SOURCE SIZE DIAG.	ISOTOPE	NO. CURIES	DEV. TIME	DEV. TEMP	DENSITY
RT	.150	IR-192	122	5 MIN	68°	2.0-4.0

NO. OF WELDS	FT. LONG SEAMS	STANDARDS	NO. OF FILM	FILM/ CASSETTE	EXPOSURE: DBL WALL	S. WALL	MR SCREENS
10	N/A		6	1/1	VIEWING: DBL WALL	S. WALL	3.0 Pb

TRUCK NO. / SHOP	REPORT NO.	PAGE NO.	TECH. HOURS	ASST. HOURS	TRAVEL HOURS	TOTAL HOURS	MILEAGE
AXC	1 OF 1	1 OF 1					

FILM INTERPRETER N. Weaver 7-6-10
ASST. NAME _____ ASNT LEVEL I
COMPANY REPRESENTATIVE
NDT TECHNICIAN _____ ASNT LEVEL II

SIGNATURE CERTIFIES TIME & MATERIALS CORRECT
SIGNATURE

FORM 88-1
Rev. 5/03

TULSA GAMMA RAY, INC. ASSUMES NO RESPONSIBILITY FOR LOSSES OF ANY KIND DUE TO INTERPRETATION

No. 59042

DRY MAGETIC PARTICLE INSPECTION
AC YOKE

REPORT

AC Yoke with Dry Visible particles with flash light. Refer to print for material and thickness.

Map of indication

Serial # 104078.3 FR 2BK Date 7/9/10

Technician Name John Ash

Parker B 100 Yoke ☐ Contour DA 200 Yoke ☐ Procedure # MT Rev.# D

MT Level I ☐ MT Level II ☒

☑ Acceptable

Location

☐ Rejectable ☐ Rounded

☐ Non-Rejectable ☐ Linear

Extent (length or diameter or aligned)_____

Post As Of Date: 06/28/10

Extend by Scrap Factor: No

Pick List by Stock Location: No

Job: 104078X-009
Status: R Released
Co-product Mix:
Item: .3 FRONT HEADER
.3 FRONT HEADER
Revision:

Job Date: 05/18/10
End: 07/06/10

Sched Method: BMQ
Released. 1.000

Oper	Seq	Item Description	U/M	Total Required Qty To Issue	Location Lot/Description	Quantity To Pull	Quantity Pulled/Exception
10	[1]	FL1625 FLNG,06.00,300-,RFW,080,SA350LF2**	EA	2.000 2.000	04	2.000	36230
	[2]	XHP-104078X .3	LOT	1.000 1.000			(No Item)
	[3]	CP1150 CPLG,1.000,06K,TOE,FULL,SA350LF2	EA	3.000 3.000	04	3.000	84U
	[4]	PI1220 PIPE,06.00,080,SA333GR6	IN	15.000 15.000	04	15.000	378836

TP253062

METALFAR
PRODOTTI INDUSTRIALI S.P.A.
STAMPAGGIO A CALDO DI ACCIAI COMUNI - LEGATI E INOSSIDABILI

SEDE AMMINISTRATIVA E STABILIMENTO:
23861 CESANA BRIANZA (LC) - Italy
Via G. Parini, 28
Tel. +39 031.655441
Fax +39 031.655149
quality.mff@farmas.com

COMPANY
WITH QUALITY MANAGEMENT
SYSTEM CERTIFIED BY DNV
= ISO 9001 : 2000 =

CERTIFICATO DI COLLAUDO SECONDO EN 10204 - 3.1 INSPECTION CERTIFICATE

Certif. N. 477	Del/Dated 05.02.2010
Fattura / Invoice N. 297	Del/Dated 03.02.2010
DDT / Del Note N. 590	Del/Dated 03.02.2010
Ns.Ord. / Our ref. N.	Del/Dated

SALA PROVE E ANALISI MATERIALI / MATERIAL TEST DEPARTMENT

Certificato generato da un sistema informatico secondo la norma EN10204, valido senza firma / This certificate has been generated by computer and need not to be signed for validity acc. to EN10204

COD. COL. / HEAT CODE	COLATA / HEAT	POS. / ITEM	VS.ORDINE / YOUR REFERENCE	Q.TA' / Q.TY	DESCRIZIONE / DESCRIPTION	DIM.IN ACC. A / DIM. ACCORDANCE TO	VISIVO E DIMENS. / VIS. & DIMENS.
-	08/32318	0031	60073/IP	30,00	W/N 300 RF 4" XS LF2CL1	ASME/ANSI B16.5	SATISFACTORY

MATERIALE / MATERIAL	C%	Si%	Mn%	S%	P%	Cr%	Ni%	Mo%	Ti%	Cu%	V%	Nb%	N%	Al%	C.E.%
ASTM A350 LF2 CL1/2	0,200	0,250	1,090	0,013	0,009	0,070	0,050	0,010	0,021	0,140	0,021	0,001	0,000	0,030	0,414

PROVETTA / TEST SPECIMEN SEZ. mm2 / SECT. mm2	LUNG. mm / LENGHT mm	FORMA / SHAPE 1=○ 2=□	SNERVAMENTO / YIELD POINT N/mm2 >=0,2%	ROTTURA / TENSILE STRENGHT N/mm2 >=	ALLUNGAMENTO / ELONGATION %>=	CONTRAZIONE / REDUCTION OF AREA %>=	DUREZZA / HARDNESS HB	RESILIENZA / IMPACT TEST - JOULE/cm2 TIPO / TYPE 10x10mm	°C	1	2	3	SNERVAMENTO / YIELD POINT N/mm2 >=1,0%	Ns.Rif. / OUR REF.
126,60	50,80	1	388,0	540,0	30,0	59,0	162,0 - 166,0	KV	-50	69	60	63	0,0	

MATERIALE IN ACCORDO A / MATERIAL IN ACC. TO	TRATTAMENTO TERMICO / HEAT TREATMENT	FORNO / FURNACE	ORIGINE / ORIGIN
ASTM/ASME A 350/SA 350 M - 07	NORMALIZED AT 930 C - COOLED IN STILL AIR	ELECTRIC FURNACE	EUROPE

COD. COL. / HEAT CODE	COLATA / HEAT	POS. / ITEM	VS.ORDINE / YOUR REFERENCE	Q.TA' / Q.TY	DESCRIZIONE / DESCRIPTION	DIM.IN ACC. A / DIM. ACCORDANCE TO	VISIVO E DIMENS. / VIS. & DIMENS.
-	09/36230	0032	60073/IP	30,00	W/N 300 RF 6" XS LF2CL1	ASME/ANSI B16.5	SATISFACTORY

MATERIALE / MATERIAL	C%	Si%	Mn%	S%	P%	Cr%	Ni%	Mo%	Ti%	Cu%	V%	Nb%	N%	Al%	C.E.%
ASTM A350 LF2 CL1/2	0,185	0,220	1,140	0,012	0,014	0,090	0,040	0,010	0,018	0,140	0,025	0,000	0,000	0,027	0,412

PROVETTA / TEST SPECIMEN SEZ. mm2 / SECT. mm2	LUNG. mm / LENGHT mm	FORMA / SHAPE 1=○ 2=□	SNERVAMENTO / YIELD POINT N/mm2 >=0,2%	ROTTURA / TENSILE STRENGHT N/mm2 >=	ALLUNGAMENTO / ELONGATION %>=	CONTRAZIONE / REDUCTION OF AREA %>=	DUREZZA / HARDNESS HB	RESILIENZA / IMPACT TEST - JOULE/cm2 TIPO / TYPE 10x10mm	°C	1	2	3	SNERVAMENTO / YIELD POINT N/mm2 >=1,0%	Ns.Rif. / OUR REF.
126,60	50,80	1	393,0	531,0	30,0	60,0	163,0 - 165,0	KV	-50	63	63	68	0,0	

MATERIALE IN ACCORDO A / MATERIAL IN ACC. TO	TRATTAMENTO TERMICO / HEAT TREATMENT	FORNO / FURNACE	ORIGINE / ORIGIN
ASTM/ASME A 350/SA 350 M - 07	NORMALIZED AT 930 C - COOLED IN STILL AIR	ELECTRIC FURNACE	EUROPE

COD. COL. / HEAT CODE	COLATA / HEAT	POS. / ITEM	VS.ORDINE / YOUR REFERENCE	Q.TA' / Q.TY	DESCRIZIONE / DESCRIPTION	DIM.IN ACC. A / DIM. ACCORDANCE TO	VISIVO E DIMENS. / VIS. & DIMENS.
-	697683	0034	60073/IP	20,00	W/N 300 RF 3" 160 LF2CL1	ASME/ANSI B16.5	SATISFACTORY

MATERIALE / MATERIAL	C%	Si%	Mn%	S%	P%	Cr%	Ni%	Mo%	Ti%	Cu%	V%	Nb%	N%	Al%	C.E.%
ASTM A350 LF2 CL1/2	0,184	0,236	1,110	0,013	0,012	0,053	0,026	0,008	0,001	0,028	0,001	0,001	0,000	0,031	0,384

PROVETTA / TEST SPECIMEN SEZ. mm2 / SECT. mm2	LUNG. mm / LENGHT mm	FORMA / SHAPE 1=○ 2=□	SNERVAMENTO / YIELD POINT N/mm2 >=0,2%	ROTTURA / TENSILE STRENGHT N/mm2 >=	ALLUNGAMENTO / ELONGATION %>=	CONTRAZIONE / REDUCTION OF AREA %>=	DUREZZA / HARDNESS HB	RESILIENZA / IMPACT TEST - JOULE/cm2 TIPO / TYPE 10x10mm	°C	1	2	3	SNERVAMENTO / YIELD POINT N/mm2 >=1,0%	Ns.Rif. / OUR REF.
126,60	50,80	1	318,0	525,0	32,0	60,0	156,0 - 159,0	KV	-50	64	62	62	0,0	

MATERIALE IN ACCORDO A / MATERIAL IN ACC. TO	TRATTAMENTO TERMICO / HEAT TREATMENT	FORNO / FURNACE	ORIGINE / ORIGIN
ASTM/ASME A 350/SA 350 M - 07	NORMALIZED AT 930 C - COOLED IN STILL AIR	ELECTRIC FURNACE	EUROPE

NOTE / NOTES	UFFICIO CONTROLLO QUALITA' / QUALITY CONTROL DEPARTEMENT	ENTE UFFICIALE DI COLLAUDO / INSPECTION AUTHORITY	MARCHIO PRODUZIONE / MANUFACTURER'S SYMBOL
MATERIAL IN ACCORDANCE WITH NACE MR-0175/2003 ISO 15156	S. Corti		MFF

voestalpine Tubulars GmbH & Co KG

Alpinestrasse 17
8652 Kindberg-Aumuehl
T. +43/50304/23-0
F. +43/50304/63-532
www.vatubulars.com

Legal Structure: Limited Partnership
Location: Kindberg/Austria,
Company Registry Number 165400k
Commercial Court of Leoben
DPR 0592684, VAT Nr. ATU 43630406

General Partner: voestalpine Tubulars GmbH
Legal Structure: Limited Liability Company
Location: Linz, Company Registry Number 106933 f
Commercial Court of Linz

Abnahmeprüfzeugnis 3.1 / Nr./No. Z47812
(gem. EN 10204)

Inspection - Certificate 3.1
(according to EN 10204)

FSVAT6XHGRL

Besteller: Purchaser:	VOEST-ALPINE TUBULAR CORPORATION USA-77042 HOUSTON TEXAS INDUSTRIAL PIPING SPEC., TULSA OK 74158-1270	Bestell-Nr.: Your order No.:	VATC P.O. 706500 PO# HR011750
Hersteller: Manufacturer:	voestalpine Tubulars GmbH & Co KG	Auftrags-Nr.: Our works order No.:	225703 / Item 02
Prüfgegenstand Object of tests:	SEAMLESS STEEL TUBES	Versandanzeige: Dispatch advice No.:	02253/94649 2007-10-04
Anforderungen: Requirements:	ASTM A 106-04b/ ASME SA 106 – Gr.B+C, ASTM/ASME A/SA 333-05 – Gr. 1+6 (ASME SECTION II, Part A, July 1, 2004 + Addenda 2006) NACE MR 0175 / ISO 15156-2004	Erschmelzungsart: Melting process:	Y
Werkstoff: Material:	GRADE B / GRADE C / GRADE 6 / GRADE 1	Zeichen des Lieferwerkes: Marking of producer	va

*) Grade C/Grade 1 without marking on tubes

Kennzeichnung: Marking:	PAINT STENCILLING: **va** A/SA 106 Grade B A/SA 333 GRADE 6 6.625" 0.432" 28,60 2800 PSI HOT FINISHED SEAMLESS LT -50°F length ft. weight Heat No, P.O. HR011750 MADE IN AUSTRIA tag: CIF PORT OF HOUSTON, TX + PO HR011750
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.: Poste n°	Stückzahl Number Of Numbre	kg	ft	Abmessung Dimension Dimension	Schmelze Nr. Heat No. N° Coulée	Probe-Nr.: Test-No. N° d' éprouvette
02	102	55086	4246.54	168.3x10.97mm 6 NPS 6.625 in OD 0.432 in w.th. SCHED 80	see attachment	see attachment

voestalpine Tubulars GmbH & Co KG
Qualitätsstelle / Quality Department
GFRERER
Der Werkssachverständige
Works Inspector / L'Expert d' usine

Kindberg, 06.08.2007

HR011750MTA$1/1

Material Test Report (MTR)

voestalpine
ONE STEP AHEAD.

voestalpine Tubulars GmbH & Co KG

Volume of delivery

Bundle No.	Heat	Lot
1-15	378836	107959 -- 01

Test Results

1 Visuelle Inspektion/ Visual Inspection: o.B./satisfactory

2 Dimensionskontrolle/ Dimensional Inspection: o.B./satisfactory

3 Wasserinnendruckversuch/Hydrostatic test: 2800 PSI o.B./satisfactory

4 Ringfaltversuch/Flattening test:o.B./satisfactory

5 Streuflusspruefung/Diverted flux: o.B./satisfactory

№ 47812

Kindberg, 09.10.2007

voestalpine Tubulars GmbH & Co KG
Qualitätsstelle / Quality Department
GFRERER
Der Werkssachverständige
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.6		35000		60000	26.5
						Gr.C		40000		70000	
						Gr.1		30000		55000	
to:											
107959	--	01	N	1	Streifen	25.40	11.60	51776		74546	37.70
107959	--	01	N	2	Streifen	25.20	11.80	49021		72081	37.30
107959	--	01	N	3	Streifen	25.30	11.30	50761		73096	35.90
107959	--	01	N	4	Streifen	25.20	11.10	49891		73241	37.30
107959	--	01	N	5	Streifen	25.30	10.90	51631		73386	36.30
107959	--	01	N	6	Streifen	25.30	11.50	50761		73821	37.40

Hardness testing HRB (HRC max. 22 o.k.)

Lot No					Hardness number	Mean hardness number	Variation
from :							-
to:					-	-	-
107959	--	01	N	1	79.90	79.10	.70

Impact test results Charpy-V -45°C specimen 55x10x10mm longitudinal

Lot No					Single	14J (18J)		Value
107959	--	01	N	1	57	107	63	76

№ 47812

Kindberg, 09.10.2007

voestalpine Tubulars GmbH & Co KG
Qualitätsstelle / Quality Department
GFRERER
Der Werkssachverständige
Works Inspector / L'Expert d' usine

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
378836	0.1822	0.2438	0.9542	0.0101	0.0048	0.0286	0.0212	0.0057	0.0039	0.0376	0.0025	0.0315	0.0027	0.0438	0.0002

C.E. 0.35%

№ 47812

Kindberg, 09.10.2007

voestalpine Tubulars GmbH & Co KG
Qualitätsstelle / Quality Department
GFRERER
Der Werkssachverständige
Works Inspector / L'Expert d' usine

voestalpine
ONE STEP AHEAD.

08/25/2008 From: U.S. ALLOYS INC. To: PRODUCTION MFG.
Item : LP-2 RND A350/A105 HR NORMALIZED, 2-1/4" X 20'1",20'0",19'1"P.O.#: 2137
S.O.#: 108197 Item #: 1 P/N #:

844

Republic ENGINEERED PRODUCTS

3049 LAKESHORE-GATE 6
PHONE: 330-438-5694

BUFFALO, NY 14219
FAX: 330-438-5695

CERTIFICATE OF TESTS — REPUBLIC ENGINEERED PRODUCTS — October 23, 2007
PAGE 1

OF 2

PURCHASE ORD: 14089
PART NUMBER:
ORDER NUMBER: 1348193 - 01
HEAT: 8995814

PURCHASE ORDER DATE: 8/30/2007
ACCOUNT NUMBER: 5625-1831-01
SCHEDULE: 0614-65
REVISION: 1

CHARGE ADDRESS

US ALLOY INC
P O BOX 262405
HOUSTON, TX 77207

SHIP TO

US ALLOYS INC
Chuck Redman
C/O T C INDUSTRIES INC
3703 SOUTH RT 31
CRYSTAL LAKE, IL 60012

MATERIAL DESCRIPTION

HOT ROLLED STEEL BARS CARBON DIN 50 049 AND EN10204 SECT 3.1B CAMERON SPEC MR-005 REVISION C1 FOR CHEM ONLY US ALLOYS SPEC USA-2 REVISION DTD 02/18/04 FOR CHEM ONLY US ALLOYS SPEC USA-4 REVISION DTD 03/20/06 FOR CHEM ONLY ASTM A105-05 FOR CHEM ONLY ASTM A350-04A GRADE LF2 CLASS 1 FOR CHEM ONLY ASTM A675-03 GRADE 70 FOR CHEM ONLY ASTM A420-06 GRADE WPL6 FOR CHEM ONLY ASME SA 350-04 GRADE LF2 CLASS 1 FOR CHEM ONLY ASTM A696-90A GRADE C FOR CHEM ONLY ASME SA 105-06 FOR CHEM ONLY ASME SA 675-04 GRADE 70 FOR CHEM ONLY ASME SA 696-04 GRADE C FOR CHEM ONLY NACE MR0175-92 FOR CHEM ONLY GRADE 1522 MOD FINE GRAIN VACUUM DEGASSED MULTIPLE RESTRICTIVE REQUIREMENT QUALITY RESTRICTED CHEMISTRY 3 TON MAXIMUM LIFT

SIZE: RDS 2.2500 DIAM X 18FT 0.0000IN MIN/20FT 0.0000IN MAX
RDS 57.1500MM DIAM X 5486.4000MM MIN/6095.0000MM MAX

LADLE CHEMISTRY %

C	MN	P	S	SI	CU	NI	CR
0.20	1.08	0.008	0.020	0.24	0.15	0.10	0.09
V	MO	SN	AL	CB	N		
0.000	0.04	0.008	0.025	0.000	0.0077		

CALCULATED TESTS

Carbon Equivalents
ASTM A707 (STANDARD CB)
EQUALS: 0.420
REDUCTION RATIO 32.7 TO 1
Standard Calculated Tests
CU+NI+CR+MO
EQUALS: 0.360
CR+MO
EQUALS: 0.130
CU+NI+CR+MO+V
EQUALS: 0.389

AUSTENITIC GRAIN SIZE 5 OR FINER BASED ON A TOTAL ALUMINUM CONTENT EQUAL TO OR GREATER THAN .020% PER ASTM A29.

SEMI - FINISHED RESULTS

FINISHED SIZE RESULTS

NOTES

REPUBLIC ENGINEERED PRODUCTS HEREBY CERTIFY THAT THE MATERIAL LISTED HEREIN HAS BEEN INSPECTED AND TESTED IN ACCORDANCE WITH THE METHODS PRESCRIBED IN THE GOVERNING SPECIFICATIONS AND BASED UPON THE RESULTS OF SUCH INSPECTION AND TESTING HAS BEEN APPROVED FOR CONFORMANCE TO THE SPECIFICATIONS.

CERTIFICATE OF TESTS SHALL NOT BE REPRODUCED EXCEPT IN FULL.

ALL TESTING HAS BEEN PERFORMED USING THE CURRENT REVISION OF THE TESTING SPECIFICATIONS.

RECORDING OF FALSE, FICTITIOUS OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHED AS A FELONY UNDER FED STATUES TITLE 18 CHAPTER 47.

R. A. [illegible] NICOLO
DIRECTOR [illegible] ASSURANCE
RR Nicolo

BY JANET K. [illegible]STLINE

MARCO INDUSTRIAL EXCHANGE
CUSTOMER
P.O. # 1080153
ITEM CP1150 L-6000# x 2 3/8" TOL COUPLIN
HEAT CODE 844

/08 From: U.S. ALLOYS, INC. To: PRODUCTION MFG.
LF-2 RND A350/A105 HR NORMALIZED, 2-1/4" X 20'1",20'0",19'1"P.O.#: 2137
108197 Item #: 1 P/N #:

Republic ENGINEERED PRODUCTS
3049 LAKESHORE-GATE 6 BUFFALO, NY 14219
PHONE: 330-638-5694 FAX: 330-638-5695

CERTIFICATE OF TESTS REPUBLIC ENGINEERED PRODUCTS October 23, 2007

OF 2

PURCHASE ORD:	14089	PURCHASE ORDER DATE:	8/30/2007
PART NUMBER:		ACCOUNT NUMBER:	5625-1831-01
ORDER NUMBER:	1348193 - 01	SCHEDULE:	0614-6S
HEAT:	8996814	REVISION:	1

THE MATERIAL WAS NOT EXPOSED TO MERCURY OR ANY METAL ALLOY THAT IS LIQUID AT AMBIENT TEMPERATURE

---------- NOTES (CONTINUED) ----------
DURING PROCESSING OR WHILE IN OUR POSSESSION.

NO WELD OR WELD REPAIR WAS PERFORMED ON THIS MATERIAL.

THE RESULTS REPORTED RELATE ONLY TO THE ITEMS TESTED

TO THE BEST OF OUR KNOWLEDGE THERE ARE NO SOURCES IN THE PRODUCTION OR PROCESSING OF STEEL PRODUCTS WHICH COULD CREATE A CONDITION WHEREBY THAT PRODUCT WOULD CONTAIN A DETECTABLE QUANTITY OF MERCURY OF MERCURY RADIUM OR OTHER ALPHA SOURCES.

---------- SOURCE INFORMATION ----------
MELT SOURCE: CANTON CAST ROLL MELT COUNTRY: U.S.A HOT ROLL SOURCE: LACKAWANNA 13in, U.S.A
MELT METHOD: EF BLOOM RED. RATIO: 32.7

---------- END OF DATA ---------- CC ---------- END OF DATA ----------
WITH SHIPMENT 1 COPY PRINTED AT SHIPPING AREA
FAX SHIP TO 1 COPY ATTENTION CHUCK REDMAN 1-713-644-9889
FILE 1 COPY

TEST REPORT FURNISHED
BY U. S. ALLOYS, INC.
ITEM LF-2 2 1/4"
HT. CODE WHM CLR CODE Green
DATE _____ APP. BY _____

R. J. [illegible]
DIRECTOR [illegible] ASSURANCE

BY JANET [illegible]

K.E. Nebel

MATERIAL TRACEABILITY RECORD

Job No. 104078

PIPE ☐ PLATE ☑ TUBES ☐ BY AAM DATE 6-29-10 CUST. Enerflex

MTL. P.O. NO. SECTION NO.	MATERIAL DESCRIPTION	HEAT OR CERTIFICATION NO.
.3	1. SA516-70N .75 SSAB	E0C138 ✓
	2. SA516-70 .625 Arcelor	823260180 ✓
	3. SA516-70 .5 SSAB	W0D512 ✓
	1.	
	2.	
	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.

AXC-119 (7/95)

E0C138 B18 ID#1254

SSAB

Test Certificate

Form TC1: Revision 1: Date 31 Oct 2000

12400 Highway 43 North, Axis, Alabama 36505

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

Customer P.O. No.: MUS-230885 | Mill Order No.: 41-263382-03 | Shipping Manifest : AR889870

Product Description: 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

Ship Date: 13 Apr 10
Cert Date: 13 Apr 10

Cert No: 081216425
(Page 1 of 1)

Size: 0.750 X 96.00 X 480.0 (IN)

Tested Pieces				Tensiles					Average Hardness	Charpy Impact Tests							
Heat Id	Piece Id	Piece Dimensions	Tst Loc	YS (PSI)	UTS (PSI)	%RA	Elong % 2in	8in Tst Dir		Abs. Energy(FTLB) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
E0B039	B11	0.751 X 120.0 (DISCRT)	L	57000	78000		26	T		124 108 138 123.3		-60F	L	10.	
E0B040	B14	0.751 X 120.0 (DISCRT)	L	55000	76000		25	T		69 81 129 93.0		-60F	L	10.	
E0C138	B18	0.752 X 96.00 (DISCRT)	L	51000	73000		27	T		66 52 64 60.7		-60F	L	10.	

Chemical Analysis

Heat Id	C	Mn	P	S	Si	Tot Al	Sol Al	Ca	Ni	Cr	Mo	Cb	V	Ti	CEV	ORGN
E0B039	.15	1.33	.011	.001	.22	.028	.020	.20	.11	.09	.06	.018	.006	.009	.42	USA
E0B040	.15	1.35	.011	.002	.22	.023	.020	.20	.10	.08	.06	.016	.006	.007	.43	USA
E0C138	.17	1.12	.011	.003	.19	.026	.024	.24	.14	.12	.06	.002	.004	.013	.42	USA

MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED
DURING THE MANUFACTURE OF THIS PRODUCT
CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15
100% MELTED AND MANUFACTURED IN THE USA. MTR DIN EN10204 TYPE 3.1 COMPLIANT.
NORMALIZED PLATES. HEATED AT 1650F FOR 32 MINUTES.
E0C138 B18 6159050 PCES: 1, WGT: 9955
E0B040 B14 6158944 PCES: 1, WGT: 9822

E0B039 B11 6159009 PCES: 1, WGT: 9835

AIRX HT#E0C138
PO#1079968 SL#B18
SO#173432 ITEM#SEE CUT LIST

Q.A. APPROVED
By MLC Date 5-24-10

(*) 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

CB 6-30-10

GLOBE X-RAY SERVICES, INC.

8441 South Union Tulsa, Ok. 74132

Certification # 44648

Report of Ultrasonic Examination

Customer: PORT CITY P.O. 73931 Job#

Address;

Test Instrument: KBI USN 52 S/N 620507

Search Unit 1" x 2.25 MHZ S/N 011237

Surface Condition: SMOOTH Procedure NO: GXSTT-D & B Rev. 1-10

Couplant: Exosen 30 Search unit cable: RG-174 Co-Axial, 6 ft. long with BNC to BNC Connectors

Technique: Contact, Manual Scan Calibration Reference: Back wall Reference Level: 56 Db

Scanning Pattern: 100% Scanning Surface: One major surface Beam Angle: 0 Degrees

The plates listed below have been ultrasonically examined and comply with the acceptance criteria of the indicated specifications. Unless otherwise noted by an * following the plate number, there were no recordable indications Observed.

✓ ASTM/ASME A-578/SA-578 Level A(1)
✓ ASTM/ASME A-578/SA-578 Level B(2)
✓ ASTM/ASME A-578/SA-578 Level C(3)
✓ ASTM/ASME A-435/SA-435
____ Wheatley-Gasso Sep 6.6.2 Rev. C
Other: AM 203.2

____ In addition to the above ultrasonic examination, the material has been hardness tested and meet the requirements of ANSI/NACE Standard MR0175. Hardness value does not exceed ____ HRC.

Plate No.	Mat'l Spec.	Thickness	Dimensions	Heat No.	Slab No.	Hardness
	516-70 MT	7/8"	96x480	EDE020	A58	
	516-70 MT	3/4"	96x60	EOC138	B18	
	516-70 MT	5/8"	23x44	EOC058	A60	
	516-70 MT	5/8"	23x39	E8C143	A18	
	516-70 MT	1/4"	120x35	W7B743	A51	
	516-70 MT	1"	120x150	W9H754	B04	

Examination By: COLTER MOYER Qualification Level: II

Date: 6-18-10 Time: N/A AM/PM

Q.A. APPROVED

By MLE Date 6-23-10

GLOBE X-RAY ASSUMES NO RESPONSIBILITY FOR THE INTEGRITY OF THE STRUCTURE OR FOR ANY LOSSES OF ANY KIND DUE TO ANY KIND OF INTERPRETATION

PortCity
METAL SERVICES

CERTIFICATE OF COMPLIANCE

DATE: 24 JUNE, 2010
SUBJECT: NACE

GENTLEMEN:

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

PLATE: ASTM A516-70N AND ASME SA516-70N LATEST EDITION.
SIZE: 3/4" NOMINAL
MILL CERTIFIED: SSAB
HEAT: E0C138
SLAB: B18

Specification: NACE MR 01-75

Hardness, HRC	Results	Hardness, BHN	Results
			152, 155, 152

WE HEREBY CERTIFY THE ABOVE INFORMATION IS CORRECT.

Marty L Eubanks

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

823Z60180 W031918 ID#1093

ArcelorMittal Burns Harbor Plate

QUALITY ASSURANCE
REPORT OF TEST AND ANAYLESIS

SHIPMENT NO.	DATE SHIPPED	CAR OR VEHICLE NO.		PAGE
803-17049	11-30-07	IHB-DOLTN-UP	LMIC 406546	5

SOLD TO
METALS USA PLATES & SHAPES S CTL
PLATES & SHAPES - MUSKOGEE
PO BOX 917
MUSKOGEE OK 74402

SHIP TO
METALS USA PLATES & SHAPES S CTL IN
TRACK 747
PORT OF MUSKOGEE
MUSKOGEE OK

NOTE	SERIAL NUMBER	PAT NO.	HEAT NUMBER	NO. PCS.	SIZE AND QUANTITY: THICKNESS	WIDTH OR DIA.	LENGTH	WEIGHT	YIELD POINT	TENSILE STRENGTH	ELONG.	RED.
					INCHES	INCHES	INCHES	POUNDS	PSI	PSI	IN %	%

QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A.
PLATES - ASTM A516-90 GR 70 PVQ, ASME SA516 GR 70 PVQ 2004 EDITION, CH-V A20S5 PLT L 15/12 FTLBS AT -50F --- PLT NORMALIZED & COOLED IN STILL AIR --- TEST CERTS ARE PREPARED IN ACCORD WITH PROCEDURES OUTLINED IN EN 10204:2004 PARA 3.1
NO WELD REPAIR WAS PERFORMED ON BELOW PLATE(S)
MFST - MFST MILL SERIAL# MFST TEST CERTS ARE PREPARED IN ACCORD WITH PROCEDURES OUTLINED IN MFST EN 10204:2004 PARA 3.1
- LIFT MAX 25 TON UNLDG
OH-CHAIN-SLING LOAD MAX 185000 #
CO# MUS-226108 GH 816-2149B

AIRX HT#823Z60180
PO#1079968 SL#W031918
SO#173432 ITEM#SEE CUT LIST

PLATES HEAT TREATED - TEST SPECIMENS ATTACHED & YIELD STRENGTH @ .5% EUL

W031918 823Z60180 2 5/8 120 480 20420 51400 74100 8 26
N 1650 DEG F - 32 MIN

(M55)MFST REF#:003

Q-QUENCH TEMPERATURE T-TEMPER TEMPERATURE N-NORMALIZE TEMPERATURE

SERIAL NUMBER	PAT NO.	HEAT NUMBER	HARD BHN	BEND	THICKNESS INCHES	TYPE	SIZE	DIR	TEST TEMP °F	CHARPY IMPACT ENERGY FT LBS 1	2	3	SHEAR(%) 1	2	3	LAT. EXP MILS 1	2	3
W031918		823Z60180			.625	V	FULL	L	-50	138	128	117						

HEAT NUMBER	CHEMICAL ANALYSES C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Cb	N	Sn	MOLIAD GRAIN SIZE
823Z60180	.17	1.01	.010	.004	.308	.233	.16	.03	.009	.001	.002	.024	.0002		.002	.006	.003

Q.A. APPROVED
By MLE Date 5-11-10

I certify that the above results are a true and correct copy of actual results contained in records maintained by ArcelorMittal Burns Harbor and are in full compliance with the requirements of the specification cited above. This test report cannot be altered and must be transmitted intact with any subsequent third party test reports, if required.
PRODCUCED UNDER A CERTIFIED QMS COMPLYING WITH ISO 9002 ABS-QE CERT. #30477

D. W. ELWOOD PER WNK

BHPLTRPT.TIF

SUPV. QUALITY ASSURANCE

CB030-00

PortCity
METAL SERVICES

CERTIFICATE OF COMPLIANCE

DATE: 1 JUNE, 2010
SUBJECT: NACE

GENTLEMEN:

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

PLATE: ASTM A516-70N AND ASME SA516-70N LATEST EDITION.
SIZE: 5/8" NOMINAL
MILL CERTIFIED: MITTAL
HEAT: 823Z60180
SLAB: W031918

Specification: NACE MR 01-75

Hardness, HRC	Results	Hardness, BHN	Results
			176, 172, 174

WE HEREBY CERTIFY THE ABOVE INFORMATION IS CORRECT.

Marty L Eubanks

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

W0D512 D15 ID#0826

SSAB

Test Certificate

Form TC1: Revision 1: Date 31 Oct 2000

12400 Highway 43 North, Axis, Alabama 36505

Customer:	Customer P.O. No.: MUS-296811	Mill Order No.: 41-261805-01	Shipping Manifest : AR896521
METALS USA PLATES & SHAPES SOU P.O. BOX 3528 101 EAST ILLINOIS ENID OK 73702	Product Description: ASME SA516-70/SA516-65/SA516-60(99A) ASTM A516-70/A516-65/A516-60(06) LCVN 15/12 FT.LBS @ -60F/A673-P NORMALIZED	Ship Date: 22 Apr 10 Cert Date: 22 Apr 10	Cert No: 081217846 (Page 1 of 1)
	Size: 0.500 X 96.00 X 480.0 (IN)		

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) 1 2 3 Avg	% Shear 1 2 3 Avg	Tst Tmp	Tst Dir	Tst Siz (mm)	BDWTT Tmp %Shr
W0D512	D15	0.501 X 96.00 (DISCRT)	L	55000	76000		39	T		118 95 83 98.7		-60F	L	10.	

Heat Id	Chemical Analysis C	Mn	P	S	Si	Tot Al	Sol Al	Cu	Ni	Cr	Mo	Cb	V	Ti	CEV	ORGN
W0D512	.17	1.11	.012	.006	.21	.031	.029	.27	.20	.11	.06	.003	.005	.014	.42	USA

MERCURY IS NOT A METALLURGICAL COMPONENT OF THE STEEL AND NO MERCURY WAS INTENTIONALLY ADDED
DURING THE MANUFACTURE OF THIS PRODUCT
CEV (IIW) = C + MN/6 + (CR+MO+V)/5 + (NI+CU)/15
100% MELTED AND MANUFACTURED IN THE USA. MTR DIN EN10204 TYPE 3.1 COMPLIANT.
NORMALIZED PLATES. HEATED AT 1650F FOR 23 MINUTES.
W0D512 D15 6163367 PCES: 1, WGT: 6628
W0D512 D15 6163365 PCES: 1, WGT: 6628
W0D512 D15 6163366 PCES: 1, WGT: 6628

AIRX HT#W0D512
PO#1079968 SL#D15
SO#173432 ITEM#SEE CUT LIST

Q.A. APPROVED
By ALE Date 5-13-10

(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

CB 10-30-10

PortCity
METAL SERVICES

CERTIFICATE OF COMPLIANCE

DATE: 1 JUNE, 2010
SUBJECT: NACE

GENTLEMEN:

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

PLATE: ASTM A516-70N AND ASME SA516-70N LATEST EDITION.
SIZE: 1/2" NOMINAL
MILL CERTIFIED: SSAB
HEAT: W0D512
SLAB: D15

Specification: NACE MR 01-75

Hardness, HRC	Results	Hardness, BHN	Results
			174, 175, 170

WE HEREBY CERTIFY THE ABOVE INFORMATION IS CORRECT.

Marty L. Eubanks

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

ERP 6.01.10 activ

JOB15-R

AIR-X-CHANGERS

J O B P I C K L I S T

damos 06/25/10 14:10:02

Extend by Scrap Factor: No

Pick List by Stock Location: No

Job: 104078X-006 Job Date: 05/18/10 Status: R Released End: 07/08/10 Sched Method: BMQ

Co-product Mix:

Item: .1/.2 FINTUBES Released: 1.000 Revision: Warehouse: MAIN

.1/.2 FINTUBES

OPER	WC	DESCRIPTION	START	END
15	FIN20	Finning	06/29/10	07/07/10

ITEM / DESCRIPTION	U/M	TOTAL REQ / QTY ISSUED	QTY AVAIL / QTY TO PICK	LOCATION / LOT/DESCRIPTION	QUANTITY PICKED
REPRINT					
BT1074	EA	408.000	3,499.000	09J	
BRTB,0.625x.060Mx24.000,SA214		0.000	408.000	BARE TUBES	_____
REPRINT					
FS1000	LB	1,831.000	23,919.000	09Z	
FINS,.015,.500,1100-0,AL		0.000	1,831.000	FinStrip	_____

1066195

LA. 817698

ERP 8.01.10 activ | AIR-X-CHANGERS | damos 06/25/10 14:09:57
JOB15-R | J O B P I C K L I S T | Page: 1

Extend by Scrap Factor: No | Pick List by Stock Location: No

Job: 104078X-011 Job Date: 05/18/10 Status: R Released End: 07/12/10 Sched Method: BMQ
Co-product Mix:
Item: .3 FINTUBES Released: 1.000 Revision: Warehouse: MAIN
.3 FINTUBES

OPER	WC	DESCRIPTION	START	END
15	FIN20	Finning	07/08/10	07/08/10

ITEM / DESCRIPTION	U/M	TOTAL REQ / QTY ISSUED	QTY AVAIL / QTY TO PICK	LOCATION / LOT/DESCRIPTION	QUANTITY PICKED
REPRINT					
BT1074	EA	70.000	3,499.000	09J	
BRTB,0.625x.060Mx24.000,SA214		0.000	70.000	BARE TUBES	
REPRINT					
FS1000	LB	314.000	23,919.000	09Z	
FINS,.015,.500,1100-0,AL		0.000	314.000	FinStrip	

PO# 106195

Heat 187227

Do not document any information other than Purchase Order and Heat Number above this Line)

~~60~~ 64

(USE S.S. Staples)

Operator # 6005		Bands	48 Centers.
Date Completed 7/10/10		Stripback	1.25
Tube Exceptions (Document any variances to quantity, material grade, length, etc.)			

FinStrip Usage

1st Coil	2nd Coil	3rd Coil	4th Coil	5th Coil	6th Coil	Unused Weight	Total Weight Used
						490	234

SGC /ISO 9001:2000
ABS QUALITY EVALUATIONS
CERTIFICADO No. 32110

PRECITUBO S.A. DE C.V.
DEPTO. DE ASEGURAMIENTO DE CALIDAD

CERTIFICADO DE CALIDAD
MILL TEST REPORT

PRECITUBO S.A. DE C.V. Km 11.4 carretera a el Castillo, El Salto Jal. México. C.P 45680 Tel (52) 33 3688-0002 /3688-0530. Fax (52) 33 3688-06-31

Pag: 1
DATE: 05/14/2009

PO 1066195

No. 44587

CUSTOMER: CONDUMEX INC CUSTOMER REFERENCE: 24533 Ship No.: 24309 S.O.: OV10225

SPECIFICATION : ASME-SA-214/SA-214M-EDITION-2007

DESCRIPTION: ELECTRIC-RESISTANCE-WELDED CARBON STEEL HEAT-EXCHANGER AND CONDENSER TUBES.

ITEM	SIZE	QUANTITY (Pces.)	LENGTH (Ft.)	WEIGHT (Lb.)	HEAT No.	# P.O.
2	5/8" X 0.060"MN	1,950	20.000	14941.92	LA817698	10225/2

MECHANICAL TESTING RESULTS

# P.O.	# Heat		Tensile Str(PSI)	Yield Str(PSI)	Elongation 2"	Hardness(HRB)	Flattening	Fla-Rev	Flaring	Flange	Bending
SPECIFIED		MIN:	0.00	0.00	0.00	0.00					
		MAX:				72.00					
10225/2	LA817698		0.00	0.00	0.00	54.00	O.K.	O.K.	N.A.	O.K.	N.A.

CHEMICAL ANALYSIS

		% C	% S	% Si	% Mn	% P	% Mo	% Cr	% Ni	% Cu	% V	% Co	% Al
Std :													
SPECIFIED	MIN:	0.000	0.000	0.000	0.270	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	MAX:	0.180	0.035		0.630	0.035							
P.O	Heat												
10225/2	LA817698	0.080	0.005	0.009	0.355	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.037

NONDESTRUCTIVE TEST

El documento certifica que los productos descritos fueron manufacturados, probados y/o inspeccionados de acuerdo con la especificación de referencia y cumple satisfactoriamente con los requerimientos correspondientes. Este documento fue elaborado y validado por un representante autorizado del staff independiente al departamento de manufactura.

This document certify that the products described here in were manufactured, sampled, tested and /or inspected in accordance with the referenced specification and meets the requirements in all respects. This certificate was issued and validated by an authorized representative of the staff independent of the manufacturing department.

GAC-06 000.3

PRECITUBO

SGC /ISO 9001:2000
ABS QUALITY EVALUATIONS
CERTIFICADO No. 32110

PRECITUBO S.A. DE C.V.
DEPTO. DE ASEGURAMIENTO DE CALIDAD

CERTIFICADO DE CALIDAD
MILL TEST REPORT

OCICSA

PRECITUBO S.A. DE C.V. Km 11.4 carretera a el Castillo. El Salto Jal. México. C.P 45680 Tel (52) 33 3688-0002 /3688-0530. Fax (52) 33 3688-06-31

DATE: 05/26/2009

1066196

No. 44635

CUSTOMER: CONDUMEX INC CUSTOMER REFERENCE: 24462 Ship No.: 24362 S.O.: OV10219

SPECIFICATION : ASME-SA-214/SA-214M-EDITION-2007

DESCRIPTION: ELECTRIC-RESISTANCE-WELDED CARBON STEEL HEAT-EXCHANGER AND CONDENSER TUBES.

ITEM	SIZE	QUANTITY (Pces.)	LENGTH (Ft.)	WEIGHT (Lb.)	HEAT No.	# F.O.
1	5/8" X 0.060"MW	4,800	23.999	44133.60	187227	1021912

MECHANICAL TESTING RESULTS

# F.O.	# Heat		Tensile Str(PSI)	Yield Str(PSI)	Elongation 2"	Hardness(HRB)	Flattening	Fla-Rev	Flaring	Flange	Bending
SPECIFIED		MIN:	0.00	0.00	0.00	0.00					
		MAX:				72.00					
1021912	187227		0.00	0.00	0.00	53.00	O.K.	O.K.	N.A.	O.K.	N.A.

CHEMICAL ANALYSIS

		% C	% S	% Si	% Mn	% P	% Mo	% Cr	% Ni	% Cu	% V	% Co	% Al
Std :													
SPECIFIED	MIN:	0.000	0.000	0.000	0.270	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	MAX:	0.180	0.035		0.630	0.035							
F.O.	Heat												
1021912	187227	0.093	0.017	0.020	0.300	0.009	0.003	0.010	0.020	0.020	0.001	0.000	0.037

NONDESTRUCTIVE TEST

Iskdro Juárez Meléndez
Inspector Aseg. de Calidad /
Quality Assurance Inspector

- *Este documento certifica que los productos descritos fueron manufacturados, probados y/o inspeccionados de acuerdo con la especificación de referencia y cumple satisfactoriamente con los requerimientos correspondientes. Este documento fue elaborado y validado por un representante autorizado del staff independiente al departamento de manufactura.*
- *This document certify that the products described here in were manufactured, sampled, tested and /or inspected in accordance with the referenced specification and meets the requirements in all respects. This certificate was issued and validated by an authorized representative of the staff independent of the manufacturing department*

Air-X-Changers
Harsco

Plant Address
5215 Arkansas Rd
Catoosa, OK 74015

P.O Box 1804
Tulsa, OK 74101
Telephone 918. 619. 8000
Fax 918. 619. 5000

LIQUID PENETRANT TESTING REPORT

MANUFACTURED FOR: ***ENERFLEX LTD, C&P-BARLOW***

AIR-X-CHANGERS SERIAL #: ***104078.3***

THIS REPORT IS TO CERTIFY THAT THE AFOREMENTIONED SECTION(S) WAS/WERE LIQUID PENETRANT EXAMINED PER THE LATEST EDITION OF SECTION VIII, DIVISION 1, APPENDIX 8.

LOCATION OF TESTS

- ☒ PLATE EDGES PER UG-93(d)
- ☒ NOZZLE & COUPLING OPENINGS
- ☐ HEADER & NOZZLE ROOT PASSES
- ☒ NOZZLE & COUPLING ATTACHMENT ROOT PASSES
- ☒ ALL COMPLETED WELDS

DATE: ***07/08/2010*** BY: *Trish Kurth*

Harsco Industrial
Air-X-Changers
5215 Arkansas Rd.
Catoosa, OK 74015 USA

Phone: 918.619.8000
Fax: 918.384.5000
www.harscoaxc.com

HARSCO INDUSTRIAL
Air-X-Changers

HARDNESS TEST RECORD

(Readings Taken with Equo Tip)

Brinnell _____ **Rockwell C** ___X___ **Vickers** _____ **Other** _____

Serial No: 104078.3 **Date:** 7/15/2010

LOCATION	BASE METAL	WELD	HAZ
FRONT HEADER			
LONG SEAM	N/A	9.6	8.0
END BLOCK	N/A	11.5	7.2
NOZZLE	N/A	8.6	6.5
BACK HEADER			
LONG SEAM	N/A	8.8	6.5
END BLOCK	N/A	12.0	6.5
NOZZLE	N/A	9.6	5.5

FRONT HEADER VIEWED FROM PLUG SHEET.
BACK HEADER VIEWED FROM TUBE SHEET.

TEST CONDUCTED BY:	CUSTOMER INSPECTOR:
MIKE DARY	

N/A = Not Applicable

Harsco Industrial Air-X-Changers

FINAL - IN PROCESS INSPECTION CHECKLIST

Customer:	Enerflex	Job No.:	104078x	Date:	07/15/10
Model:	156 EH	Tag No.:	12517		

FINAL ASSEMBLY INSPECTION POINTS	Production Check By	Production Check Lead	Hold Points Q.C.	Hold Points Cust.	FINAL ASSEMBLY INSPECTION POINTS	Production Check By	Production Check Lead	Hold Points Q.C.	Hold Points Cust.
Dimensional Inspection of Sub Columns -	✓	✓	✓		Manual and/or Air Motors	JR-FR 07-22-10	FR 7-22-10	AL 7-23-10	✓
Dimensional Inspection of Base Holes -	FR 07-22-10	JR 07-22-10	AL 7-23-10		Final Paint of Unit	Jmdhl 7-23-10	TP 7/23/10	AL 7-23-10	
Fan Blade Clearance	MB 7-22-10	JR 07-22-10	AL 7-23-10		All Shutter Rods Pinned with #14 x 3/4" Tapping Screws -				
Fan Blade Pitch	MB 7-22-10	JR 07-22-10	AL 7-23-10		Clean Galvanizing	✓	✓	✓	
Fan Shaft Clearance -	MB 7-22-10	JR 07-22-10	AL 7-23-10		All Bearings and/or Universals Greased -	FR 07-22-10	JR 07-22-10	AL 7-23-10	
Idler Alignment -	RN 7-21-10	JR 07-21-10	AL 7-23-10		Vibration Switches	✓	✓	✓	
Electric Motor	✓	✓	✓		Unit Name Plate -	VR 7-22-10	Am 7-23-10	AL 7-23-10	
Gear Box	✓	✓	✓		Lifting Lug Attachment -	A.C 7-22-10	Am 7-23-10	AL 7-23-10	
Bearing Set Screws Torque -	RN 7-21-10	JR 07-21-10	AL 7-23-10		All Loose Parts Tagged -	Am 7-23-10	TP 7/23/10	AL 7-23-10	
Prevention of Rust -	FR 07-22-10	JR 07-22-10	AL 7-23-10		Section Name Plate Attachment	AL RN 07-21-10	JR 07-21-10	AL 7-23-10	
Flange Arrangement and Facing	AL RN 07-21-10	JR 07-21-10	AL 7-23-10		Run Test and Vibration Check				AC 7-26-10
Hail, Core, Fan Guards, Bug Screens -		N/A			Megger Test on Motors				
Shutters Operate Correctly	JR 07-22-10	FR 7-21-10	AL 7-23-10						

Prepared By: Tony Deckard

Q.C. Release for Shipment (signature and date): [signature] 7-23-10

Comments:

Initialing on this form indicates acknowledgment that you have visually inspected the item listed and to the best of your knowledge, the item meets the required specification issued to this job.

FORM NO.: FINAL REV. A

N/A = Not Applicable

Harsco Industrial Air-X-Changers

ADDITIONAL ENERFLEX REQUIREMENTS, FINAL - IN PROCESS INSPECTION CHECKLIST

Customer:	*Enerflex*	Job No.:	*104078x*	Date:	*07/15/10*
Model:	*156 EH*	Tag No.:	*12517*		

FINAL ASSEMBLY INSPECTION POINTS	Production Check		Hold Points		FINAL ASSEMBLY INSPECTION POINTS	Production Check		Hold Points	
	By	Lead	Q.C.	Cust.		By	Lead	Q.C.	Cust.
Bugscreens Test Mounted		N/A							
Nozzle Levelness Chart			AL 7-23-10						
Customer Tag Number on Cooler Nameplate	Am 7-23-10	TD 7/23	AL 7-23-10						
Access Doore on Cooler			A.L 7-23-10						
Close Shutters prior to Shipment, as applicable	Am 7-23-10	TD 7/23	AL 7-23-10						

Prepared By:	*Tony Deckard*
Comments:	

Q.C. - 'AS-BUILT' DRAWING IS REQUIRED

Customer Documentation Packet shall include: WARRANTY, SPEC. SHEET, U-1A & NAMEPLATE RUBBINGS, FINAL W / 'AS-BUILT'

Initialing on this form indicates acknowledgment that you have visually inspected the item listed, and to the best of your knowledge, the item meets the required specification issued to this job.

FORM NO.: FINAL REV. A

HARSCO
INDUSTRIAL
Air-X-Changers

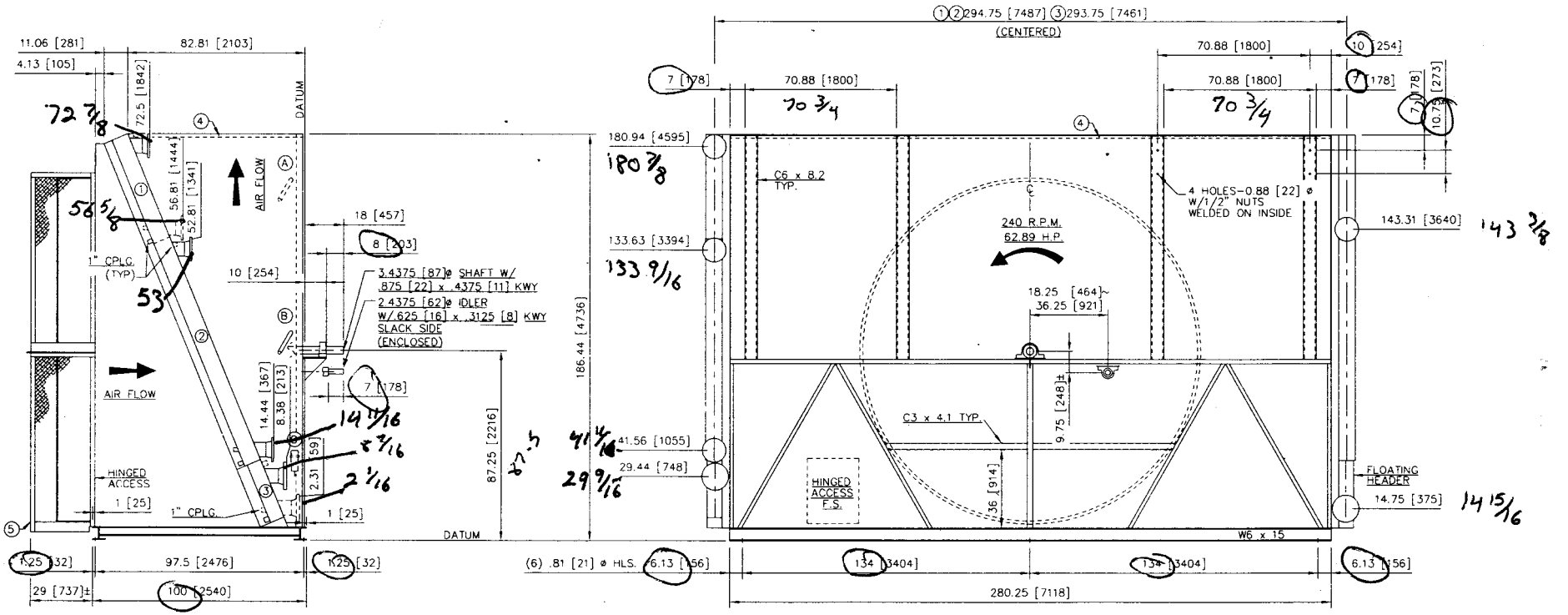
PAINT - IN PROCESS INSPECTION CHECKLIST

MODEL:	156 EH	JOB NO.:	104078x	DATE:	7/15/10

INITIAL AND DATE ALL CHECKPOINTS	OPERATIONS	QUALITY CONTROL, AS APPLICABLE	
		REJECTED	ACCEPTED
Surface Cleaning Before Primer	CB		
Surface Preparation Before Final Paint	LL JM DM		
Final Paint Accepted	TD		AL 7-23-10
Type of Primer:	92 G08		
Dry Mills Requirements:	1.5 - 2.0		
Type of Intermediate:			
Dry Mills Requirements:			
Type of Top Coat:	91 L 15		
Dry Mills Requirements:	3.0 - 4.0		

Comments:

As Built. 104078



NOTE:
1. ESTIMATED DRY WEIGHT: 25,000#
2. PAINT: H-I-S 91L15 TINT-TO-MATCH DOFASCO QC315 TAN.
3. SPREADER BARS REQUIRED FOR LIFTING.
4. SHUTTER OPERATORS MAY BE LOCATED ON EITHER SIDE.
5. [ ] = METRIC DIMENSIONS AT GAS HEADERS.
6. P.W.H.T.
7. SPOT R.T. OF 1 LONG SEAM AND 1 END CLOSURE, PER HEADER.

COMBINED

(1) EJW/FLOW (54 GALS)
D.P. 14 P.S.I. @ 300/-20 °F.
NOZZLES 6"-150 RF

(2) TAW/CW (114 GALS)
D.P. 14 P.S.I. @ 300/-20 °F.
NOZZLES 6"-150 RF

(3) AC (ASME STAMP)
D.P. 350 P.S.I. @ 300/-49 °F.
NOZZLES 6"-300 RF

(4) GALVANIZED HAIL GUARD (FLUSH MOUNT)

(5) BUGSCREEN FRAME / FAN GUARD W/ SOFT BUGSCREENS (FRAME SHIPS LOOSE) (SOFT BUGSCREEN PANELS SHIP LOOSE)

(A) MANUAL SHUTTER EJW/FLOW W/ GROUND LEVEL OPERATOR

(B) MANUAL SHUTTER TAW/CW W/ GROUND LEVEL OPERATOR

(C) AUTO SHUTTER OPERATOR AC
AUTO BY (1) GARZO 501-6 AIR MOTOR (SHUTTERS FAIL CLOSED)

REV.	DESCRIPTION	BY	DATE	APP'D	DATE
1	CHANGED AC NOZZLE TO 6", SHAFT PROJECTION TO 18" AND PAINT COLOR TO TAN	MRAY	6/15/10	BB	6/16/10

JOB STATUS:
RELEASED
FABRICATION OF THIS ORDER HAS BEGUN

CUSTOMER: ENERFLEX LTD
TAG: 12517
P.O. NO.: MP526449

HARSCO INDUSTRIAL
Air-X-Changers

MODEL 156EH
AXC JOB NO.: 104078
DRAWN BY: AICS-MRAY DATE: 5/28/10
CHECKED BY: BB DATE: 6/1/10 REV. 1
DRAWING NO.: CRT SCALE: 1:1

Air-X-Changers
Harsco

Installation, Maintenance, and Operating Instructions

for

Engine Drive Units

Air-x-changers has prepared this manual for the care and up keep of your cooler. With these simple instructions and a few tools, the owner can perform many maintenance and light repair procedures such as tightening the V-belts, checking fan blade angle, greasing bearings, setting the vibration switch, and cleaning fins and tubes. If more information is needed about a specific component we recommend that you refer to the attached specific manufactures maintenance instructions i.e. (motors, fans, and bearings).

Because this manual covers several cooler styles and sizes, the instructions outlined are general in nature. This should be noted when looking at any illustration or parts of the manual that may not apply to your cooler.

Good judgement should be used when purchasing either replacement parts or products to be used in your repair or maintenance work. Some products may cause a decrease in performance. All replacement parts should be equivalent to the manufacture's original parts. Replacement parts ordered from the factory always carry our required high level of quality. DO NOT take a chance with products that might not do the job.

EQUIPMENT SITING AND INSTALLATION

Setting of cooler(s) is the responsibility of the purchaser who must insure that cooler intake areas are free from obstruction to airflow and sources of hot air (including other air coolers). Spacing of air coolers should be adequate to avoid hot air recirculation. Raising and or separating units should compensate for the effects of grouping coolers together.

ON ARRIVAL AT SITE SHIPPING DAMAGE

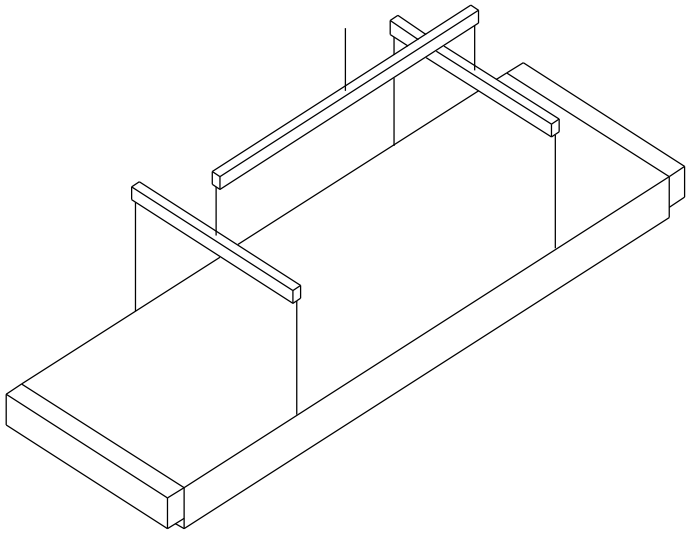
The cooler should be thoroughly inspected for damage by receiving personnel. Damage in transit can be result of dropping or being struck by heavy objects, any damage should be described on receiving documents presented by carrier. Prompt claim filing will expedite early compensation from the offending carrier.

Loose Parts

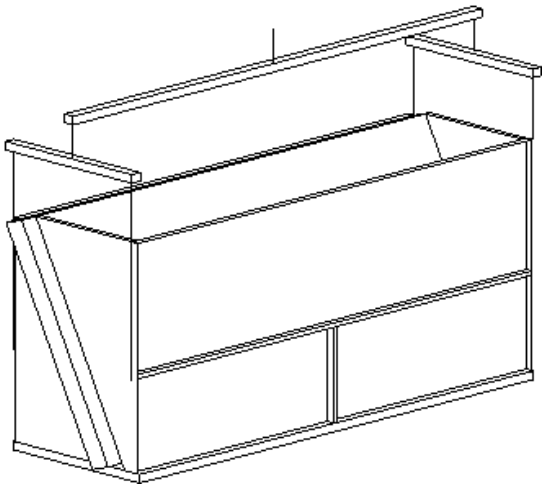
The parts list should be checked to see that all parts shipped with the cooler are present. These parts may be secured to the skid base (if so designed) or inside the plenum area. Basically this cooler is completely shop assembled and no assembly at the job-site is required, but occasionally special accessory devices will be required which must be shipped disassembled to meet height or width limitations.

UNLOADING COOLER

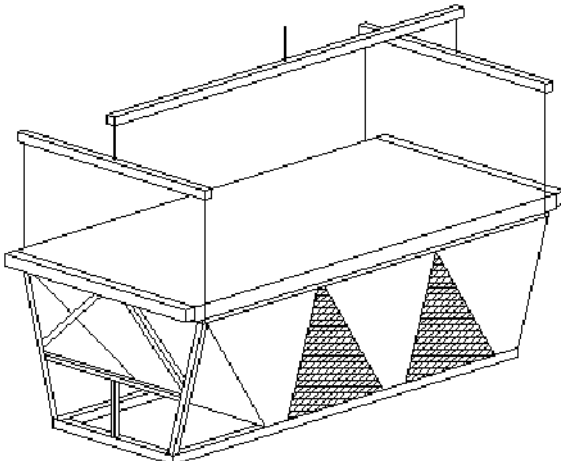
Spreader bars are to be used for lifting when the cooler is eight (8) feet. The cooler is supplied with lifting points to be used for off loading from carrier. Lifting by any other point may cause damage to the cooler. Following are some suggested ways of lifting. Locate the picture which resembles the type of unit you have and use as a guide on how to unload and handle the cooler properly. (See unit name plate for unit type i.e. EH, H, FI, etc.)



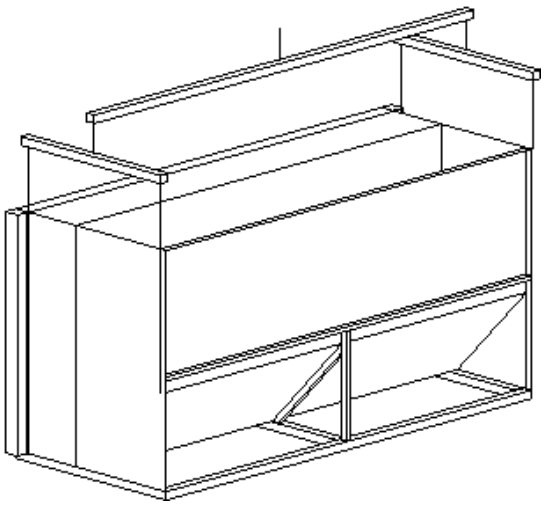
TUBE BUNDLES



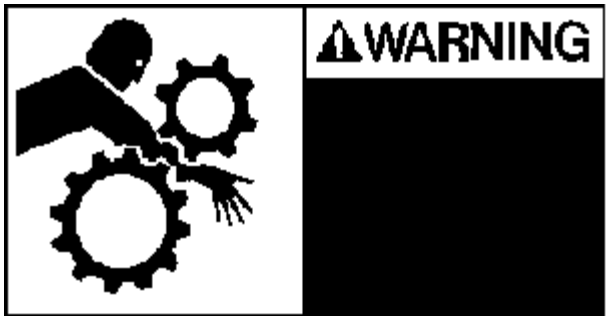
EH-UNITS



F-UNITS



VI-UNITS



TURN OFF AND LOCK OUT DRIVER BEFORE ENTERING COOLER

PRIOR TO RUN-IN

NOTE: Check all nuts and bolts for tightness, bolting will loosen during shipment.

Fans

Check fan blade bolts and hub set screws for tightness. Rotate fan by hand to insure that shaft, speed reducer, and driver turn freely. The fan should be checked for adequate tip clearance and blade pitch angle. 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 ring. To check the fan blade angle, use a level bubble protractor (this can be obtained from the factory). 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). 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. Some coolers are equipped with an automatic fan. These fans have blade angles controlled by varying the air supply pressure. Air pressure should be applied by to the fan before starting to check for proper operation. Before starting, the motor should be bumped to check for proper direction of fan rotation.

Bearings

Bearing mounting bolts and set screws should be checked for tightness. The manufacturer lubricates the bearings and no additional grease is necessary to start. When remote lube lines are provided check to insure they are full by loosening at the bearing end, then fill with grease from fitting end. This will insure that the grease lines are full of grease. During high-speed operation too much grease will cause over heating. To protect bearings against entrance of foreign material when dust and water are present the bearings should contain as much grease as speed will allow. Daily lubrication may be required to maintain a slight leakage at the seals. Under normal conditions use the following table as a guide. However, certain conditions may require a change of lubrication periods such as the ones described above.

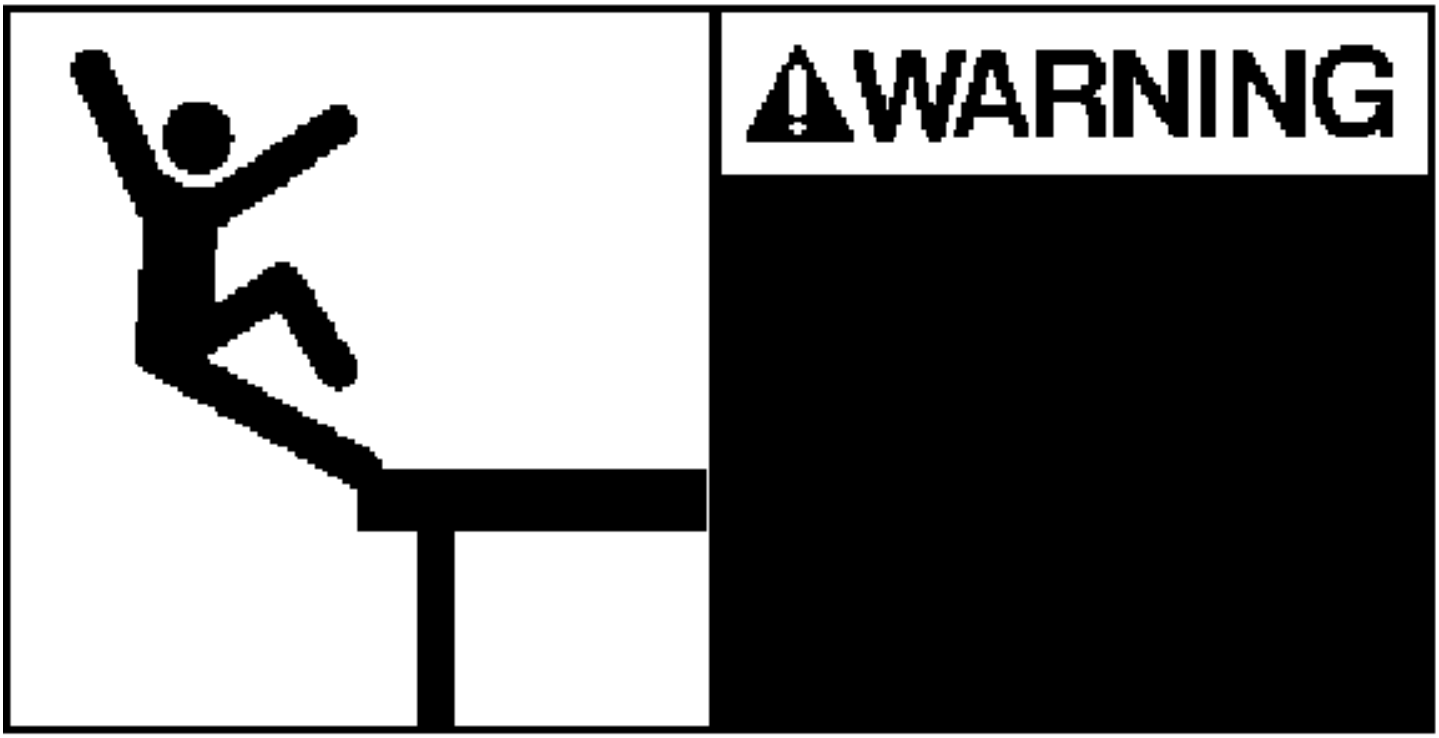
Read preceding page before establishing lubrication schedule

LUBRICATION GUIDE

	Suggested Lubrication Period in Weeks							
HOURS PER DAY	1 TO 250 RPM	251 TO 500 RPM	501 TO 750 RPM	751 TO 1000 RPM	1001 TO 1500 RPM	1501 TO 2000 RPM	2001 TO 2500 RPM	2501 TO 3000 RPM
8	12	12	10	7	5	4	3	2
16	12	7	5	4	2	2	1	1
24	10	5	3	2	1	1	1	1

Louvers

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



DO NOT WALK ON LOUVERS
OR USE AS A LADDER!!

U-Joints

Relubrication cycles vary depending on the service requirements and operating conditions of the drive. Under normal conditions, a maximum relubrication cycle of 30 to 60 days is recommended. Consult the manufacturer service manual for specific grease and lubrication requirements.

RUN-IN

Vibration Switch (optional) (Murphy & Nelson)

After the switch has been installed, adjust by turning the adjustment screw in a clockwise direction until the starting torque does not trip the vibration switch. For other brands see manufactures 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 low heat loads should also be avoided during start up.

Plugs

Header plugs are installed at room temperature in our plant. 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 the bundle is under pressure. If any plugs are removed, the gasket (for shoulder plugs only) should always be replaced. Replacement gaskets should be ordered from the factory. When installing the plugs, a thread lubricant and antigalling compound should be used.

LONG TERM

Fin Cleaning

Fins should be kept free of dirt and lint, which can be removed by directing compressed air perpendicular to the tubes in a direction opposite to the normal airflow. Do not use steam or chemicals to clean fins.

Tube Cleaning

The internal cleaning of tubes can be done three different ways:

1. Mechanical Cleaning

   This consists of using drills, (or wire brushes), on long rods. And rotating them with air or electric motors. This is normally followed by a water wash or air purge.

2. Chemical Cleaning

   This consists of circulating hot chemical solution through the tubes. The solution contains 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 the hollow rods and pushing through the individual tubes.

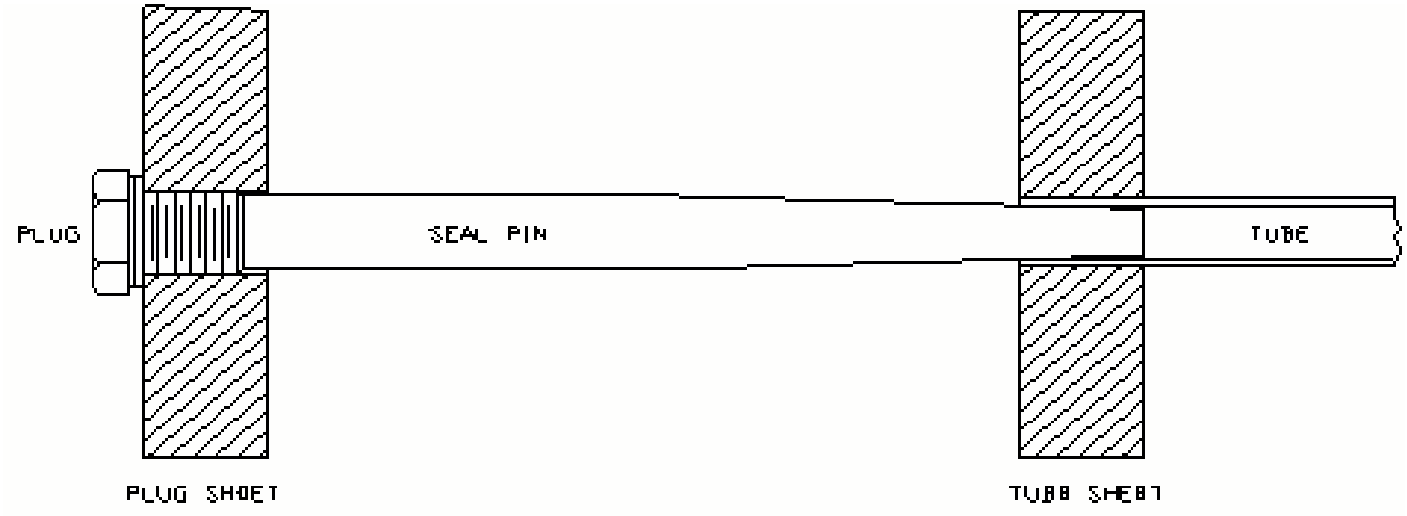
NOTE: The last two processes will not work on tubes that are plugged, they must be drilled out mechanically.

Leaking Tubes

Tube leaks can be two types: (1) leaks through the tube wall and (2) leaks in the tube attachment. In the first case it is most practical to plug both ends of the tube. Only a limited number of tubes can be sealed off in this manner before performance is affected. When performance drops below acceptable limits, tube bundle must be retubed. If leaks develop in the tube end attachment, rerolling of the tube will be necessary. Care must be taken in selecting the proper tube expander for the size and gauge of tube to be rolled. When rolling a tube, over-rolling must be avoided. Consult the factory for information on taper pins to plug the tubes and roller tube sizes.

INSTRUCTIONS FOR USING TAPER PINS FOR SEALING LEAKING TUBES

1. Remove plug from one end of leaking tube (do not switch plugs in holes).
2. Insert taper pin through plug hole into tube and tap lightly with hammer until seated firmly, but not too tight to be removed.
3. Measure plug for depth it was originally screwed into the plug sheet.
4. Measure the distance that the tape pin protrudes from the plug sheet in seated position.
5. Add the distance measured in Steps 3 and 4 then subtract 1/8". This will be the length which should be cut off the large end of the taper pin



6. Remove the taper pin from the end of the tube.
7. Saw a piece off the large end of the taper pin, the length figured in Step 5. Be careful not to cut the pin too short.
8. Re-insert the taper pin in the tube and drive well into place.
9. Lubricate plug (see PLUGS page 12) and replace in plug sheet. Run up tightly. The plug should now seat and help hold the taper pin in place.
10. Repeat operation on opposite end of tube.

NOTE: If the plug removed does not seal replace it and the gasket if so equipped.

Recommended Spare Parts

We suggest that one each of the parts, which are designated by an asterisk (*) on the parts list be carried in your stock of spare parts. The down time caused by waiting for delivery of a spare part usually cost more in lost production or service than the cost of the part itself.

Spare parts orders should be specified in accordance with the parts list description and the Job number of the unit.

P.O.	QTY.	DESCRIPTION OF COMPONENTS
	__	SECTIONS IN ACCORDANCE WITH SPECIFICATION SHEET DATED: _____
	__	____ STRUCTURE(S): _____
	__	SET(S) SHUTTERS: _____
	__	SET(S) TURNING VANES: _____
	*__	FAN (S) __" *DIA.* __ BLADES _____ HAND _____ MAKE ___° ANGLE AT ___ _____ " BORE WITH ___"X___" KEYWAY. _____
	*__	FAN SHAFT(S): ____" DIA. X __" LONG WITH ___" SQ. KEYS ____ END, KEYWAY LENGTH __"
	*__	____" FAN BEARING(S): _____
	*__	____" IDLER BEARING(S): _____
	*__	IDLER SHAFT(S) ___" DIA. X ___" LONG WITH ___" SQ. KEY _____" LONG ONE END.
	*__	IDLER PIVOT SHAFT(S) ___" DIA. X ___" LONG, CRS, WITH ONE HOLE DRILLED FOR ¼" COTTER PIN ¼" FROM THE END.
	__	SET(S) _____ TYPE IDLER FRAME PARTS; PULLROD LENGTH ____", MINIMUM THREAD LENGTH_____
	__	VIBRATION SWICHES ____ MAKE _____ MODEL
	*__	V-BELTS: _____ TYPE, ___" CENTER DISTANCE, ___ HP EACH, MATCHED SETS OF __
	__	SHEAVE SET(S):_____ __ GROOVES, FAN SHEAVE: ___" OD, _____" BORE WITH ___" X ___" KEYWAY __ PITCH, MOTOR SHEAVE: ____" OD, ____" BORE WITH ___" X ___" KEYWAY
	*__	MOTOR (S): _____ HP, ___ RPM, __ PHASE, __ HZ, __ VOLTS, ___ ENCL., VARIABLE TORQUE, SINGLE WINDING, _____ SHAFT, ___ MOUNTING, ____ FRAME, ____ SLIDEBASE, CUST. SPECIFICATIONS __ , MOTOR DATA REQUIRED __ , WIRING DIAGRAMS ___

*** RECOMMENDED SPARE PARTS**

INSPECTION

Tubes

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

Fans

Fans should be inspected for wear (pitting, cracks and corrosion) on all surfaces. These inspections should be preformed every six months. In addition to surface inspections, all bolts and nuts must be checked for proper torque.

Bearings

In addition to bearing checks 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 (6) months.

Structure

A general inspection of the structure should be performed every six (6) months. This inspection should include checks for corrosion, damaged members and sheeting, and for loose bolting.

Headers

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

WARRANTY

Air-x –changers warrants that the apparatus 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 months from shipment. Such warranty shall not apply to any equipment, which 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 judgement 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 it's 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, AIR-X-CHANGERS 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. AIR-X-CHANGERS 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 ARRISING 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 REPLACEMENTPARTS, 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.

AIR-X-CHANGERS
P.O. BOX 1804
Tulsa, OK 74101
(918) 266-1850

SPARE PARTS

ITEM	DESCRIPTION	PRICE	AMOUNT
SEAL PINS	USED TO SEAL LEAKING TUBES		$24.00 ea.
HAND TUBE ROLLER	USED TO ROLL TUBE IN BOX		$134 ea.
V-BELT TENSIONER	USED TO SET BELT TENSION		$15.00 ea.
SOCKETS FOR PLUGS			
TOOL KIT			
PROTRACTOR	USED TO CHECK FAN BLADE ANGLE		
PROTRACTOR BASE	USED ON	VERTICAL FANS	
FIN COMB			$20.00 ea.
PLUG GASKETS			$0.20 ea.
TAPER PLUGS (BR)	TAPERED BRASS		$1.50 ea.
TAPER PLUGS (STL)	TAPERED STEEL		
SHOULDER PLUGS			$2.00 ea.
THEAD LUBE	LOK-CEASE COMPOUND		
THEAD LUBE (SS)	LIQUID-O-RING #404		

NOTE: PRICE INCLUDES ALL SHIPPING AND HANDLING

TOTAL FROM ABOVE

TAX

TOTAL ENCLOSED

PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE AND WITHOUT INCURRING OBLIGATION.

WHEN ORDERING PROVIDE FOLLOWING INFORMATION.

JOB NUMBER _____

MODEL TYPE _____

ORIGINAL CUSTOMER _____

AIR-X-CHANGERS STANDARD CONDITIONS OF SALE

1. PRICES…Unless otherwise specifically provided, all prices are F.O.B. the Company's plant at the Port of Catossa, Oklahoma and are subject to withdrawal or change without notice at any time prior to the Company's acceptance of a purchase order, as provided in Paragraph 3 of these Standard Conditions of Sale. After the Company's acceptance of a purchase order, prices are subject to the timely receipt of all required information and material from the Purchaser and to the timely approval of prints by the Purchaser.

2. TAXES…Prices do not sales, use, excise or similar taxes. Consequently, in addition to the price, the amount of any present or future sales, use, excise or other tax applicable to the sale or use of the Company's product or equipment shall be paid by the Purchaser unless the Purchaser shall have provided the company with a tax exemption certificate acceptable to the taxing authorities.

3. ACCEPTANCE…Acceptance of all purchase orders will be by authorized personnel at our general offices, subject to review of purchase order documents and credit approval.

4. DELIVERY…All delivery terms and dates are subject to: (i) the prior sale of the product or equipmentof any part thereof: (ii) causes beyond the Company's reasonable control: (iii) acts of God, fires, floods, epidemics, riots, wars, priorities and acts of civil or military authority: (iv) strikes, labor difficulties and shortages of labor: (v) delays in trasportation, car shortages and shortages in fuel, power, materials and supplies: (vi) acts of the Purchaser and reciept of all required information and materials from the Purchaser.

5. TERMS OF PAYMENT…The Terms of Payment shall be those set forth in the Company's quotation.

6. The Company warrants that the apparatus covered by this quotation is free of defects in material and workmanship, when operated in accordance with the conditions stated in this proposal, for a period of one year after start-up not to exceed fifteen (15) months from shipment. Such warranty shall not apply to any equipment, which 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 judgement 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. AIR-X-CHANGERS HEREBY DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OTHERWISE.

7. LIMTATION OF LIABILITY…THE REMEDIES SET FORTH HEREIN ARE EXCLUSIVE. AIR-X-CHANGERS 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 TO THE EQUIPMENT.

8. CHANGES…The Purchaser may change the specification of their order only upon written notice. Any additional charges accrued as a result, will be for Purchaser's account.

9. CANCELLATION…Should the order require cancellation, written notice should be forwarded to Air-X-Changers main office immediately. A review of all costs incurred on the Purchaser's behalf, will be made, to establish cancellation charges.

10. WAIVER AND MODIFICATION…No waiver or modification of any of the companies terms shall be effective unless acknowledged in writing and signed by an authorized Air-x-changers' employee.

11. SITING/INSTALLATION...Siting of cooler(s) is the responsibility of the purchaser. Purchaser must insure that cooler air intake areas are free from obstruction to airflow, and sources of hot air (including other coolers). Spacing of air coolers should be adequate to avoid hot air recirculation. Raising units should compensate for effects of grouping coolers together.

Air-X-Changers Field Services

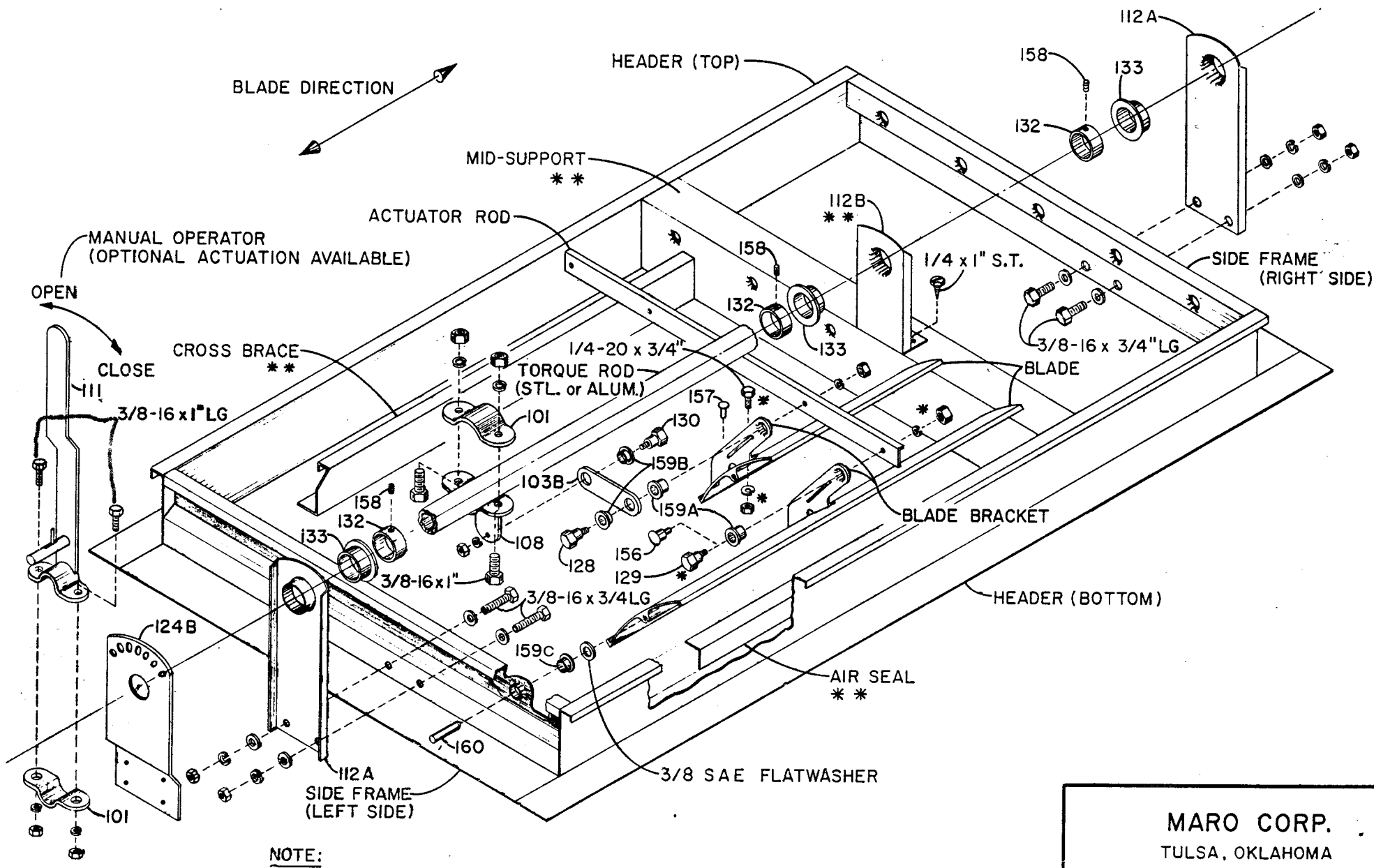
Air-X-Changers (AXC) prides itself on world-wide customer service, providing timely and optimal technical solutions. AXC recently launched a new Field Service department staffed with experts to provide a variety of services to accommodate our customers' cooling equipment needs. This newly assembled team of specialists not only supports AXC products, but can provide customized field solutions for any type of cooling equipment. From parts replacement to periodic maintenance inspections, the on-site services will enhance the productivity and longevity of the equipment.

It is AXC's mission to support our deployed equipment and partner with our customers to provide the necessary services to keep your business running efficiently and economically. Whether your needs are replacements parts, technical advice, replacement sections or a new cooler, we are available for our customers 24 hours a day, 7 days a week. Field Service agreements are individually structured based on the types of services you require. Let us put AXC's years of industry experience and leadership to work for you! Below are some of the current services offered.

- Fan replacement
- Fan balancing and adjustment
- Tube bundle repair/replacement
- Tube bundle/fin cleaning
- Tube leak detection
- Bearing replacement/alignment and inspection of lube lines
- Structural repair
- Inspection and installation of drive components
- Periodic inspections
- Measure and adjust fan pitch
- Verify fan RPM, air flow performance and other air cooler variables
- Verify and process data
- Trouble-shoot
- Re-Rate or repair pressure vessels (via National board "R" Certification)
- On-site painting of coolers
- On-site supervision for field erection
- 24 hour emergency parts replacement

For additional information about AXC Field Services or to develop a service agreement, please contact following.

Emergency Parts and Field Service:
Phone: 1-800-404-3904
Phone: 01-918-619-8028
E-mail: axcparts@harsco.com



NOTE:

1. * INDICATES REPLACEMENT PARTS ONLY.
2. * * INDICATES ITEMS USED ACCORDING TO SHUTTER SIZE OR CUSTOMER SPEC'S.
3. PART NUMBERS 128, 129, 130 USE 1/4-20 NUT AND LOCKWASHER.

MARO CORP.
TULSA, OKLAHOMA

500 SERIES SHUTTER

DWG NO. 162

GARZO spring opposed linear diaphragm operators

Your solution for friction-free cylinders.

GARZO

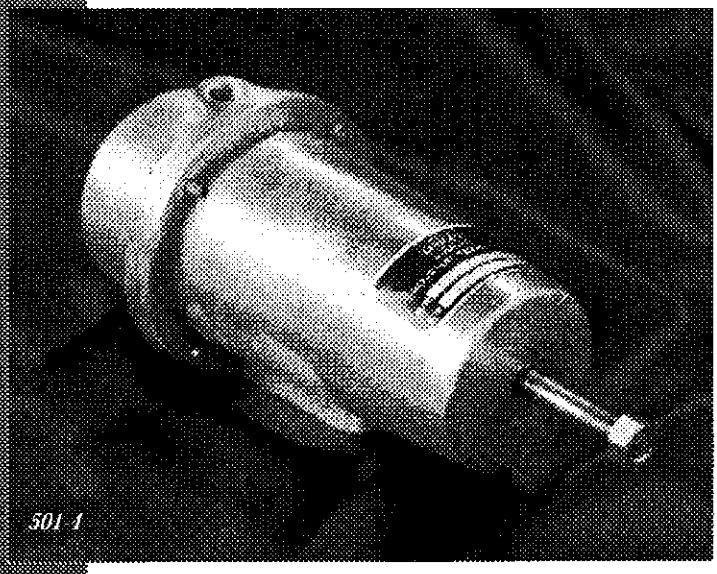
spring opposed linear diaphragm operators

Quality at every level.

GARZO Linear Diaphragm Operators are small diameter spring opposed rolling diaphragm operators suitable for gas compressor applications. The series 501operators are designed specifically to be used in various industrial applications. The rolling diaphragm creates the perfect seal for friction free cylinders. It is a durable, flexible membrane shaped like a top hat with the peak of the hat resting against the end of the piston and the brim clamped between the forward and rear cylinders. Inside the cylinder this forms a long-lasting frictionless sealed cushion of air between the piston head and the cylinder wall. The fabric reinforced elastomer rolling diaphragms are produced exclusively for GARZO to our exacting standards. Standard diaphragm material design allows for operation of the cylinders in temperatures from -31°F to 248°F. Custom diaphragm material design allows for operation of the cylinders in temperatures from -121°F to 500°F.

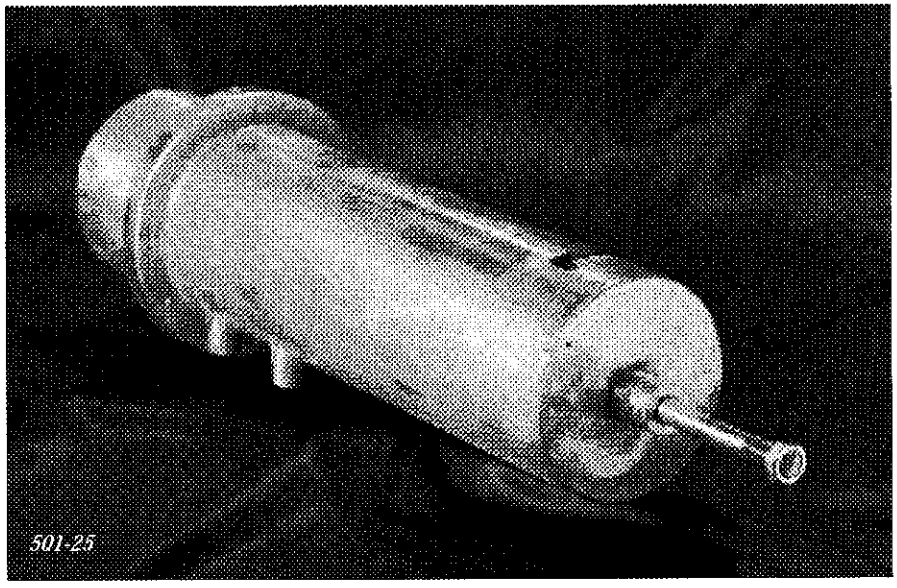
GARZO spring opposed linear diaphragm operators

Dependability every time.



The operators are designed to withstand many corrosive elements. The piston and body of the operators are made from 100% aluminum castings which resist galvanic corrosion and eliminate the need for painting. The diaphragm is a Dacron fabric, Buna-N impregnated, molded rolling diaphragm. The diaphragms are designed and manufactured to withstand repeated use in industrial applications, and the fabric prevents the elastomer from stretching in over pressure conditions. The spring has been electro zinc plated. The piston rod is a large diameter 300 series stainless steel. All other parts are either plated or stainless steel, making the operator suitable for offshore salt water, natural gas, and sour gas service.

GARZO linear diaphragm operators are designed using INSTRUMENT SOCIETY of AMERICA recognized spring rates. The GARZO operators have strokes that follow a true linear progression. A properly sized GARZO spring opposed diaphragm operator has as much force on the forward stroke as it does on the return stroke.



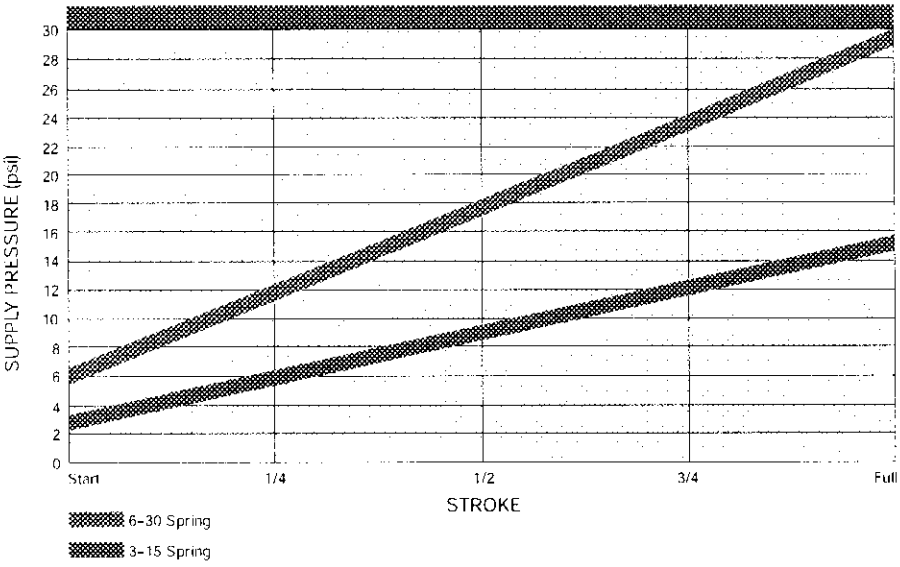
Features

- Super Sensitivity
- Absolutely No Lubrication Required
- Low Hysteresis
- No Blow-By Leakage-- 100% Leak Testing
- Solid Aluminum Construction
- Ease of Maintenance
- Wide Temperature Variations
- Designed For Use With Air or Sour Gas

Specifications

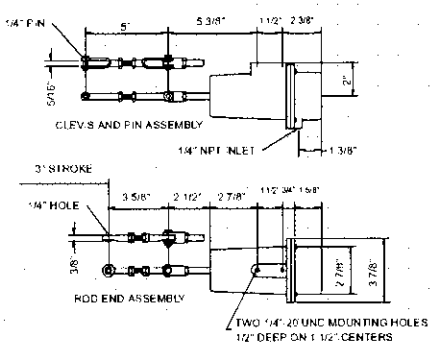
- Cylinders
  100% Cast Aluminum
- Piston
  100% Cast Aluminum
- Rod
  303 Stainless Steel
- Diaphragm
  Buna-N with Dacron Fabric
- Spring
  Zink Plated

MODEL NUMBER	EFFECTIVE AREA (IN^2)	STROKE (IN)	FORCE AVAILABLE (LB)	NOMINAL SUPPLY PRESSURE	MAXIMUM SUPPLY PRESSURE
501-4-315	4	3	12	20	100
501-4-630	4	3	24	40	100
501-6-315	6	4	18	20	100
501-6-630	6	4	36	40	100
501-12-315	12	6	36	20	100
501-12-630	12	6	72	40	100
501-25-315	25	10	75	20	100
501-25-630	25	10	150	40	100

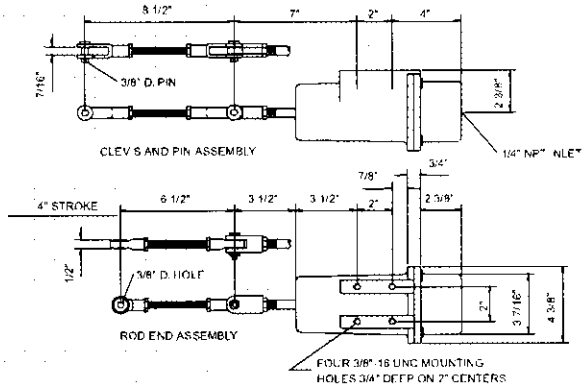


GARZO spring opposed linear diaphragm operators

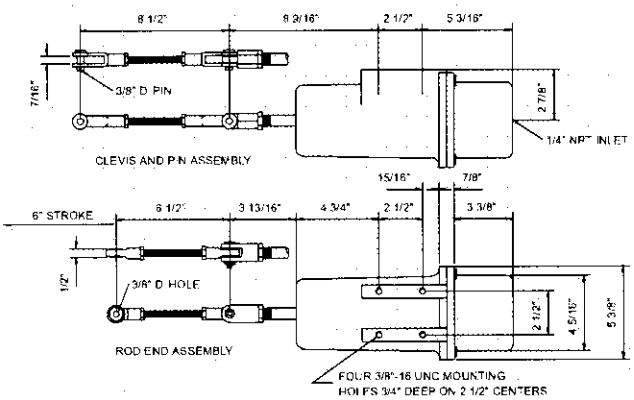
SDL-1



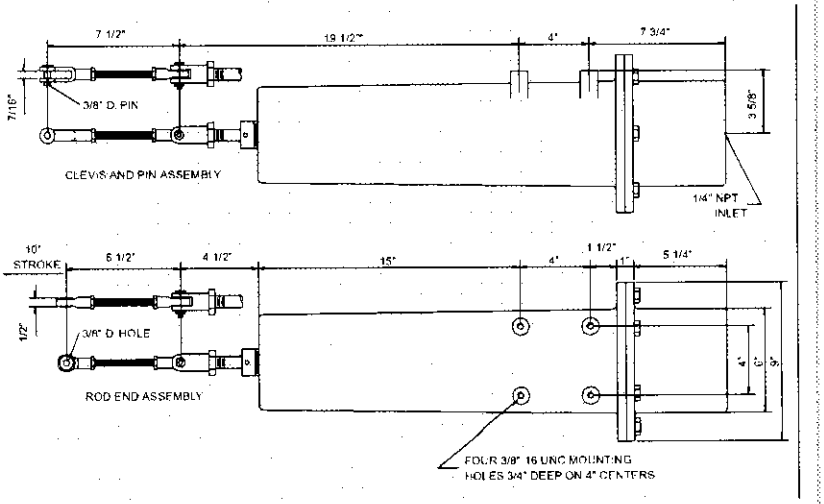
SDL-3

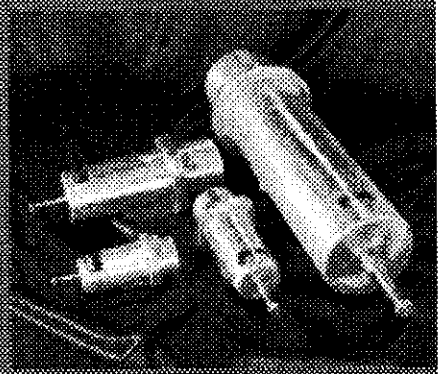


SDL-12



SDL-25





How to order.

Series 501- 4 - 315 - SUR - P - SIL

Model

Spring Range
- 315-3 to 15 psig
- 630-6 to 30 psig

Mounting
- SUR-Surface Mounting Bracket
- PVT-Pivot Mounting Bracket

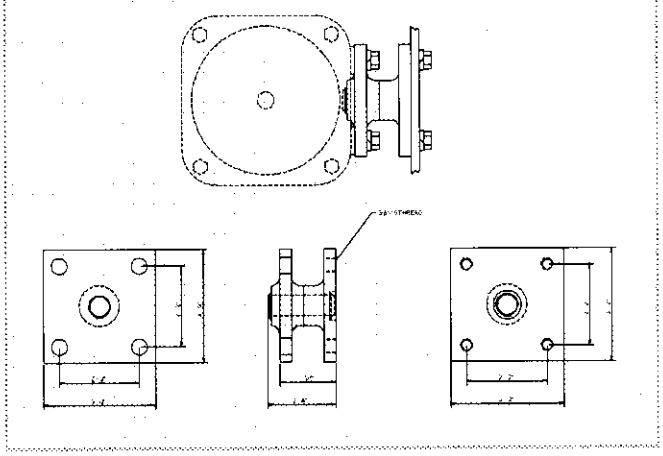
Positioner
- O-Without Positioner
- P-With Top Mounted Positioner

Diaphragm Temerature Range

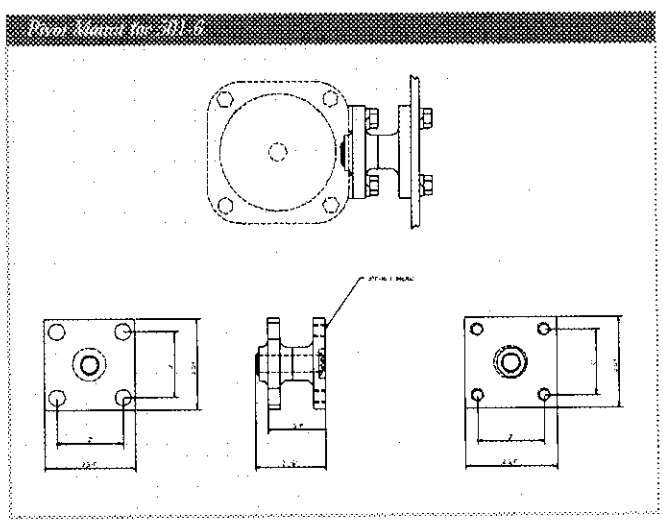
Buna-N Diaphragm (Standard)	-35°C to 120°C (-31°F to 248°F)
Silicone Diaphragm	-85°C to 260°C (-121°F to 500°F)

Connector Assembly
- Clevis & Pin Assembly (Standard)
- Rod End Assembly

Panel mount for 327-13



Panel Mount for 503-5

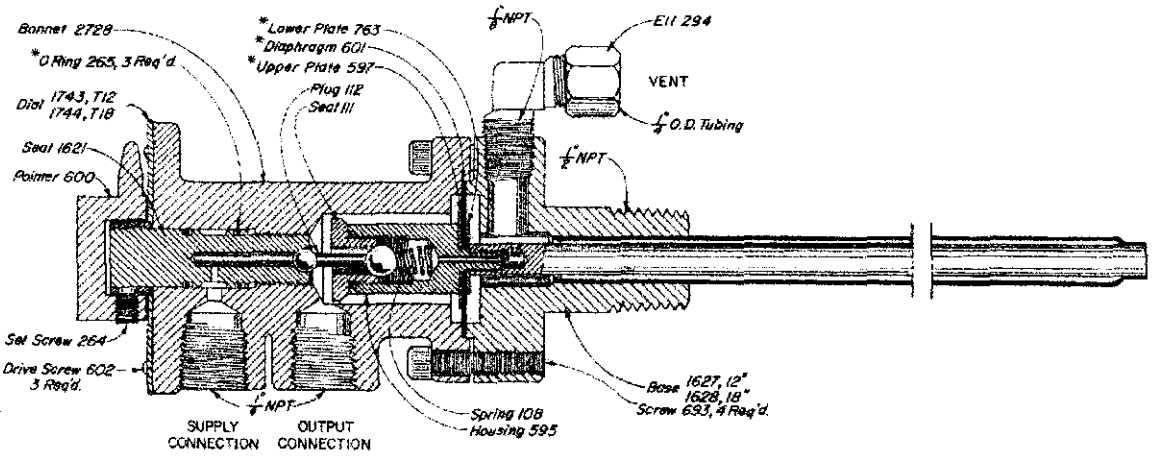


GARZO
INCORPORATED
4430 Steffani • Houston, TX 77041
Phone: (713) 466-8679 • Fax: (713) 466-8686 • Toll Free: (800) 729-8807
E-MAIL: pafford@phoenix.net

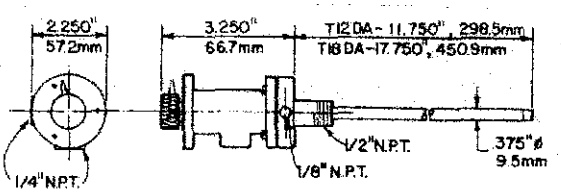
7-01

Printed in U.S.A

T 12/18DA
CAST IRON
500 lbs. W.P.
-30°F to 400°F, -34°C to 204°C



THERMOSTAT DIMENSIONS



DIRECT BASE ASSEMBLIES AVAILABLE:
CAST IRON

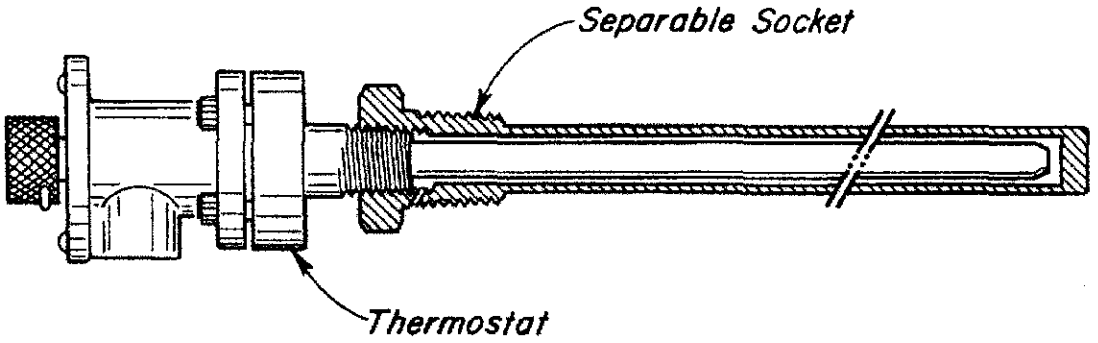
CAT. NO.	BASE ASSEMBLY	MAX. TEMP. °F	MAX. TEMP. °C
HAP	T 12 DA	400	204
HAR	T 18 DA	400	204

*These are recommended spare parts and are stocked as repair kits. To order repair kit, specify; "T12DA Repair Kit, RLK."

Separable Sockets are available at extra cost, refer to Table of Contents for ordering.

APPLICATION:

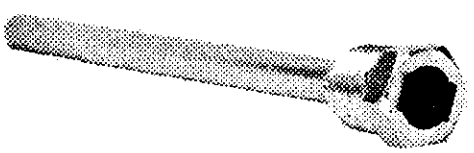
Increases working pressure of Thermostat Sensing Element.
All Separable Sockets are filled with high temperature grease.
Allows Thermostat removal without losing vessel pressure.



SEPARABLE SOCKETS AVAILABLE: STEEL & 316 SS

CAT. NO.	MALE THD. SIZE,NPT	MODEL NUMBER	MATERIAL	W.P. psig	W.P. kg/cm²
HCA	1"	SS-4	STL	4,000	281.23
HCB	1"	SS-6	STL	4,000	281.23
HCC	1"	SS-12	STL	4,000	281.23
HCD	1"	SS-18	STL	4,000	281.23
HCE	1"	SS-12SS	SS6	4,000	281.23
HCF	1"	SS-18SS	SS6	4,000	281.23
HCG[a]	1"	S-SS-12SS	SS6	7,000	492.15
HCH	3/4"	3/4SS-12	STL	4,000	281.23
HCI	3/4"	3/4SS-18	STL	4,000	281.23
HCJ	3/4"	3/4SS-12SS	SS6	4,000	281.23
HCK	3/4"	3/4SS-18SS	SS6	4,000	281.23
HCL	3/4"	3/4SS-4	STL	4,000	281.23
HCM	3/4"	3/4SS-6	STL	4,000	281.23
HCMSS6	3/4"	3/4SS-6	SS6	4,000	281.23
HCN	1"	SS-6SS	SS6	4,000	281.23
HCP	3/4"	SS-4SS	SS6	4,000	281.23
HCR[a]	3/4"	S-SS-12SS	SS6	5,000	351.53
HCS[a]	1"	S-SS-6SS	SS6	7,000	492.15
HCX	1"	SS-18	STL	4,000	281.23

[a]One piece construction



H:100.1
Issued 5/99 Rev. 1

ACTION:

Direct semi-throttle; Pilot Output Pressure (Yellow) increases with temperature rise.

APPLICATION:

Low temperature shut down, direct action temperature controller requiring semi-throttling direct action.

For piped vent in Direct or Indirect mode.

WORKING PRESSURE (sensing element):

psig	kg/cm²
500	35.15 max. without Separable Socket
4000	281.23 max. with Separable Socket
7000	492.15 max. with Special Separable Socket

Separable Socket is an extra price item and must be ordered separately, if desired. To order Separable Sockets refer to Table of Contents

TEMPERATURE RANGE:

-30°F minimum To 400°F maximum
-34°C minimum to 204°C maximum

SUPPLY PRESSURE:

5 to 30 psig
.35 to 2.11 kg/cm²

OPERATION:

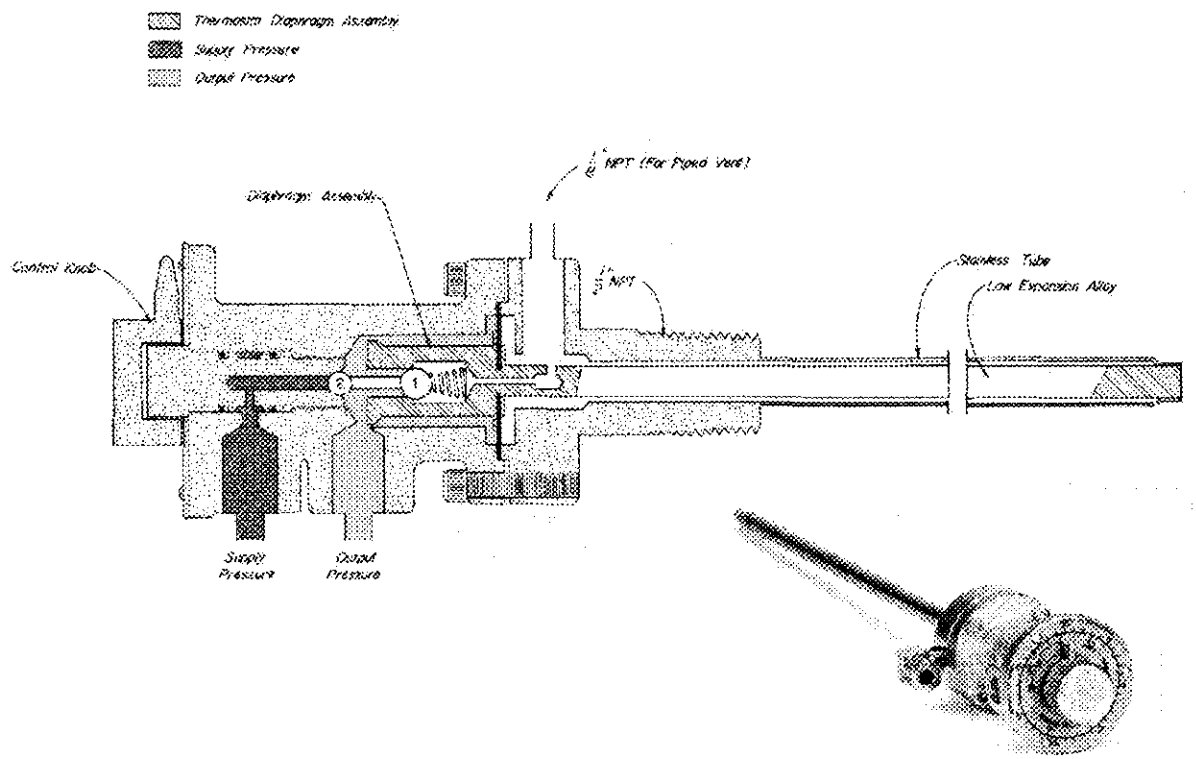
This Thermostat Base Assembly consists of a STAINLESS TUBE for monitoring the changing temperature, which is connected by a Low Expansion Alloy Rod to a DIAPHRAGM ASSEMBLY. The differential pressure across the Diaphragm combined with the changes in the length of the STAINLESS TUBE semi-throttle a PILOT PLUG valve. The PILOT PLUG consists of two stainless balls rigidly connected together. The seat at BALL 1 is the pressure vent (Yellow to Atmosphere).The seat at BALL 2 is the Supply Pressure inlet (Violet to Yellow).

Assume the set temperature of the Thermostat is above that of the system. The Inlet at BALL 2 is closed and the vent at BALL 1 is open. Output Pressure (Yellow) is vented away so that no signal is being sent to the Pilot or Motor Valve.

As the temperature rises in the system, the STAINLESS TUBE increases in length to move the Thermostat Diaphragm Assembly in a direction to first close the seat at BALL 1 (Yellow to Atmosphere) and open the seat at BALL 2 (Violet to Yellow). Output Pressure (Yellow) increases and acts on the DIAPHRAGM accounts for the semi-throttle action of the Thermostat. Output Pressure (Yellow) increases to cause the desired Pilot or Motor Valve action.

As the temperature decreases, the action is reversed to decrease or vent Output Pressure(Yellow).

By reversing the Vent and Supply lines, the Thermostat can be made to act in an indirect throttle mode, Pilot Output Pressure decreases with temperature rise. In this mode the "DA" Thermostat acts identical to the standard T 12 Thermostat with the exception of being able to pipe the vent line away from the thermostat.



67CF Series Filter Regulators

Introduction

Scope of Manual

This manual provides instructions and parts lists for 67CF Series filter regulators. Instructions and parts lists for other equipment mentioned in this instruction manual, as well as for other 67 Series regulators, are found in separate manuals.

Product Description

The 67CF Series direct-operated regulators are equipped with a filter for removing particles from the supply gas. They are typically used to provide constantly controlled, reduced pressures to pneumatic and electropneumatic controllers and other instruments. These are suitable for most air or gas applications. Other applications include providing reduced pressures to air chucks, air jets, and spray guns.

The Type 67CFR regulator has an integral low-capacity internal relief valve. A downstream pressure increase above the outlet pressure setting moves the diaphragm assembly off the soft seat, venting the excess pressure through a hole or vent in the spring case.

W7412

Figure 1. Typical Type 67CF Filter Regulator with Optional Gauge

Specifications

Some general 67CF Series ratings and other specifications are given on page 2. A label on the spring case gives the control spring range for a given regulator as it comes from the factory.

Installation

Note

If the regulator is shipped mounted on another unit, install that unit according to the appropriate instruction manual.

WARNING

Personal injury, property damage, equipment damage, or leakage due to escaping gas or bursting of pressure-containing parts may result if this regulator is overpressured or is installed where service conditions could exceed the limits given in the specifications, or where conditions exceed any ratings of the adjacent piping or piping connections. To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding those limits.

D102601X012

Specifications

Body Size, Inlet and Outlets Connection Style
1/4-inch NPT screwed

Maximum Inlet Pressure (Body Rating)(1)
250 psig (17,2 bar)

Outlet Pressure Ranges

OUTLET PRESSURE RANGES, PSIG (bar)	CONTROL SPRING DATA		
	Part Number	Color	Wire Diameter, Inch (mm)
0 to 20 (0 to 1,4)	T14130T0012	green stripe	0.135 (3,43)
0 to 35 (0 to 2,4)	T14059T0012	silver	0.156 (3,96)
0 to 60 (0 to 4,1)	T14058T0012	blue stripe	0.170 (4,32)
0 to 125 (0 to 8,6)	T14060T0012	red stripe	0.207 (5,26)

Maximum Emergency Outlet Pressure(1)
50 psi (3,4 bar) over outlet pressure setting

Wide-Open Flow Coefficients
Main Valve: C_g: 11.7; C_v: 0.36; C_1: 32.2
Internal Relief Valve: C_g: 1.45; C_v: 0.045; C_1: 32.8

Pressure Registration
Internal

Accuracy
Inlet Sensitivity: Less than 0.2 psig (0,014 bar) change in outlet pressure for every 25 psig (1,72 bar) change in inlet pressure
Repeatability: 0.1 psig (0,0069 bar)(2)
Air Consumption: testing repeatedly shows no discernible leakage

Regulator Temperature Capabilities
With Nitrile (NBR): -40° to 180°F (-40° to 82°C)
With Fluoroelastomer (FKM):
0° to 300°F (-18° to 149°C)
With Silicone (VMQ)(3): -60° to 180°F (-51° to 82°C)

Drain Valve and Spring Case Vent Location
Aligned with inlet, other positions optional

Type 67CFR Internal Relief Performance
Low capacity for minor seat leakage only; other overpressure protection must be provided if inlet pressure can exceed the maximum pressure rating of downstream equipment or exceeds maximum outlet pressure rating of the Type 67CFR

Filter Capabilities
Free Area: 12 times pipe area
Micron Rating:
Cellulose Element: 40 microns
Glass Fiber Element: 10 microns
Stainless Steel Element: 40 microns

Approximate Unit Weight
1 pound (0,5 kg)

Options
- Handwheel adjusting screw
- NACE (MR0175) compliant construction
- Ammonia service construction
- Panel mount (includes spring case with 1/4-inch vent, handwheel, and panel mounting nut)
- Closing cap (available on spring case with 1/4-inch NPT vent)
- Aluminum or stainless steel drain valve
- Fluoroelastomer (FKM) elastomers for high temperatures and/or corrosive chemicals
- Silicone (VMQ) elastomers for cold temperatures
- Triple scale oultet pressure gauge (brass or stainless steel)
- Stainless steel stem on the valve plug
- Fixed bleed restriction mounted in the side outlet
- Tire valve in second outlet
- Pipe plug in second outlet

1. The pressure/temperature limits in this bulletin and any applicable standard or code limitation should not be exceeded.
2. Repeatability is the measure of the regulator's ability to return to setpoint consistently when traveling from steady state to transient to steady state.
3. Silicone is not compatible with hydrocarbon gas.

WARNING

The internal relief valve of the Type 67CFR regulator does not provide full overpressure protection. The internal relief valve is designed for minor seat leakage only. If maximum inlet pressure to the Type 67CFR exceeds maximum pressure ratings of the downstream equipment or exceeds maximum allowable outlet pressure of the Type 67CFR, additional overpressure protection is required.

1. Regulator operation within ratings does not preclude the possibility of damage from debris in the lines or from external sources. Regulators should be inspected for damage periodically and after any overpressure condition.

2. Only personnel qualified through training and experience should install, operate, and maintain a regulator. Make sure that there is no damage to or foreign material in the regulator. Also ensure that all tubing and piping is free of debris.

3. Install the regulator so that flow is from the IN to the OUT connection as marked on the regulator body.

4. For best drainage, orient the drain valve (key 2) to the lowest possible point on the dripwell (key 5). This orientation may be improved by rotating the dripwell with respect to the body (key 1).

WARNING

A regulator may vent some gas to the atmosphere. In hazardous or flammable gas service, vented gas may accumulate and cause personal injury, death, or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air intakes or any hazardous area. The vent line or stack opening must be protected against condensation or clogging.

5. A clogged spring case vent hole may cause the regulator to function improperly. To keep this vent hole from being plugged (and to keep the spring case from collecting moisture, corrosive chemicals, or other foreign material) orient the vent to the lowest possible point on the spring case or otherwise protect it.

Inspect the vent hole regularly to make sure it is not plugged. Spring case vent hole orientation may be changed by rotating the spring case with respect to the body. A 1/4-inch NPT spring case vent may be remotely vented by installing obstruction-free tubing or piping into the vent. Protect the remote vent by installing a screened vent cap on the remote end of the vent pipe.

6. For use in regulator shutdown, install upstream block and vent valves and downstream block and vent valves (if required), or provide some other suitable means of properly venting the regulator inlet and outlet pressures. Install a pressure gauge to monitor instruments on startup.

7. Apply a good grade of pipe compound to the male pipe threads before making connections, making sure not to get the pipe compound inside the regulator.

8. Install tubing fitting or piping into the 1/4-inch NPT inlet connection on the body (key 1) and into the 1/4-inch NPT body outlet connection.

9. The second 1/4-inch NPT outlet can be used for a gauge or other use. If not used, it must be plugged.

Installing a 67CF Series Regulator in an Existing Installation

When installing a 67CF Series regulator in an existing installation, it may be necessary to use spacers (key 34, figure 6) to adapt the installation. If the mounting bolts are too long, place a spacer on the bolt (see figure 6). To be sure the regulator is secure, the bolts should have at least two full threads of engagement.

Startup and Adjustment

Key numbers are referenced in figure 2.

1. With proper installation completed and downstream equipment properly adjusted, slowly open the upstream and downstream shutoff valve (when used) while using pressure gauges to monitor pressure.

WARNING

To avoid personal injury, property damage, or equipment damage caused by bursting of pressure containing parts or explosion of accumulated gas, never adjust the control spring to produce an outlet pressure higher than the upper limit of the outlet pressure range for that particular spring. If the desired outlet pressure is not within the range of the control spring, install a spring of the proper range according to the diaphragm parts maintenance procedure.

2. If outlet pressure adjustment is necessary, monitor outlet pressure with a gauge during the adjustment procedure. The regulator is adjusted by loosening the locknut (key 19), if used, and turning the adjusting screw or handwheel (key 18) clockwise to increase or counterclockwise to decrease the outlet pressure setting. Retighten the locknut to maintain the adjustment position.

Shutdown

First, close the nearest upstream block valve and then close the nearest downstream block valve (when used). Next, open the downstream vent valve. Since the regulator remains open in response to the

decreasing downstream pressure, pressure between the closed block valves will be released through the open vent valve.

Maintenance

Regulator parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and replacement of parts depends on the severity of service conditions and upon applicable codes and government regulations. Open the drain valve (key 2) regularly to empty accumulated liquid from the dripwell (key 5).

Note

If sufficient clearance exists, the body (key 1) may remain mounted on other equipment or in a line or panel during maintenance unless the entire regulator will be replaced.

WARNING

To avoid personal injury, property damage, or equipment damage caused by sudden release of pressure or explosion of accumulated gas, do not attempt any maintenance or disassembly without first isolating the regulator from system pressure and relieving all internal pressure from the regulator.

Filter Element and Trim Maintenance

Key numbers are referenced in figures 2 and 3.

1. Remove four dripwell screws (key 3) from the dripwell (key 5) and separate the dripwell and O-ring (key 4) from the body (key 1). The filter retainer (key 9), filter element (key 6), and gasket (key 26) may come off with dripwell. If not, remove these parts.

2. Inspect the removed parts for damage and debris. Replace any damaged parts. If a replacement is not available, the filter element may be cleaned.

3. To remove the valve cartridge assembly, grasp the end of cartridge and pull it straight out of body (key 1). Replace with new cartridge assembly. The cartridge assembly may be disassembled and parts may be cleaned or replaced. If the soft seat (key 15) was removed, make sure it is properly snapped into place before installing the valve cartridge assembly.

4. Apply lubricant to the O-ring (key 14), then align cartridge key to keyway in body and insert. Reinstall the gasket (key 26), filter (key 6), and filter retainer (key 9). Reinstall the O-ring (key 4), secure the dripwell with screws (key 3), and torque to 24 to 36 inch-pounds (2,7 to 4,1 N´m).

Diaphragm Maintenance

Key numbers are referenced in figure 2.

1. Back out the adjusting screw or handwheel (key 18) until compression is removed from the spring (key 17).

2. Remove the six spring case screws (key 3) to separate the spring case (key 7) from the body (key 1). Remove the upper spring seat (key 20) and spring (key 17).

3. Remove the diaphragm assembly (key 16), inspect the diaphragm, and replace the assembly, if necessary.

4. Place the diaphragm assembly (key 16) on the body (key 1) as shown in figure 4. Push down on the diaphragm assembly to make sure the valve plug (key 11) strokes smoothly and approximately 1/16-inch (2 mm).

Note

In step 5, if installing a control spring of a different range, be sure to delete the spring range originally appearing on the label and indicate the new spring range.

5. Stack the control spring (key 17) and upper spring seat (key 20) onto the diaphragm assembly (key 16).

6. Install the spring case (key 7) on the body (key 1) with the vent oriented to prevent clogging or entrance of moisture. Install the six spring case screws (key 3) using a crisscross pattern and torque to 24 to 36 inch-pounds (3 to 4 N•m).

7. When all maintenance is complete, refer to the Startup and Adjustment section to put the regulator back into operation and adjust the pressure setting. Tighten the locknut (key 19) if used, and install the closing cap if used.

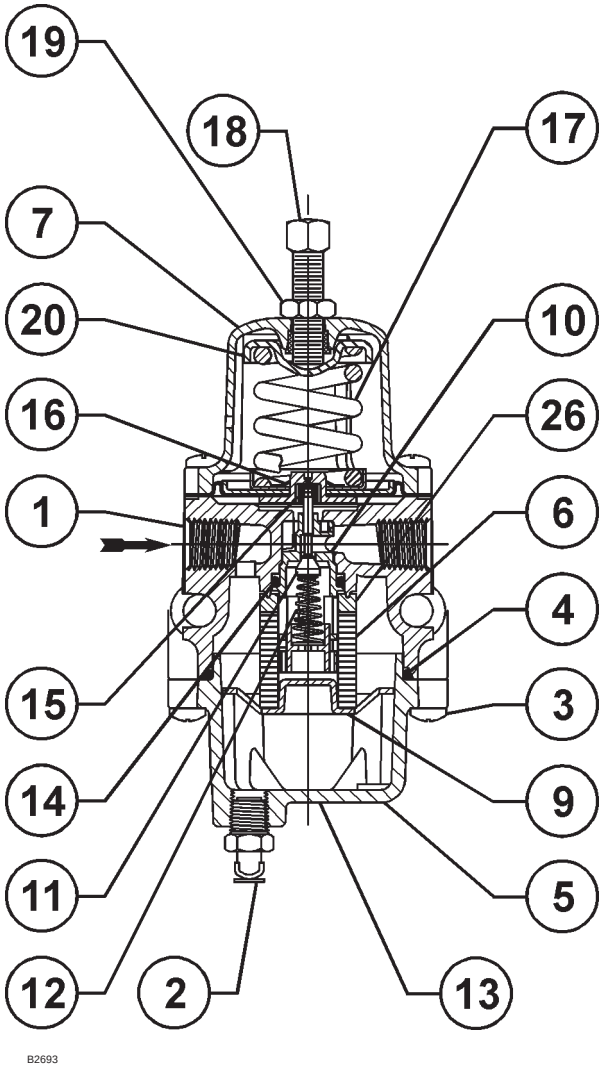
Parts Ordering

When corresponding with the Fisher Sales Office or Sales Representative about this regulator, include the type number and all other pertinent information printed on the label. Specify the eleven-character part number when ordering new parts from the following parts list.

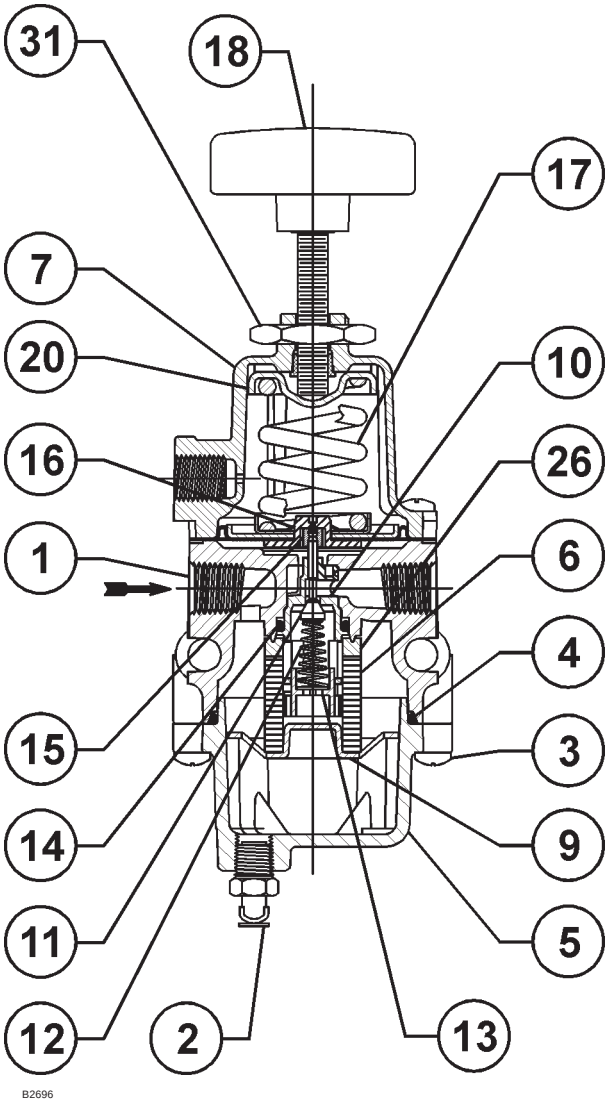
Parts List

Key	Description	Part Number
	Parts Kit Includes valve cartridge assembly (contains keys 10, 11, 12, 13, 14, and 15), diaphragm assembly (key 16), filter element (key 6), filter gasket (key 26), and four screws (key 3)	
	Type 67CF (without relief)	
	Brass stem with nitrile plug	R67CFX00012
	Aluminum stem with nitrile plug (NACE)	R67CFX00N12
	Type 67CFR (with relief)	
	Brass stem with nitrile plug	R67CFRX0012
	Aluminum stem with nitrile plug (NACE)	R67CFRX0N12
	Valve Cartridge Assembly Only	
	Brass stem	
	With nitrile plug	T14121T0012
	With fluoroelastomer plug	T14121T0022
	Aluminum stem	
	with nitrile plug	T14121T0042
	with nitrile plug (NACE)	T14121T0052
1	Body, Aluminum	T80432T0012
2	Drain Valve	
	Brass	1K418918992
	Aluminum	1K4189000B2
	Stainless steel	AH3946X0012
3	Flange Screw	
	Standard spring case and spring case with 1/4-inch NPT vent (10 required)	T13526T0012
	For wire seal	
	Flange Screw (9 required)	T13526T0012
	Flange Screw (1 required)	14B3987X012
4(1)	O-Ring	
	Nitrile (NBR)	T14057T0012
	Fluoroelastomer (FKM)	T14057T0022
	Silicone (VMQ)	T14057T0032
5	Dripwell	T21040T0012
6(1)	Filter Element	
	Cellulose (40 microns) (standard)	1F257706992
	Glass fiber (10 microns)	17A1457X012
	Stainless steel (40 microns)	15A5967X012
7	Spring Case, Aluminum	
	Drilled hole vent (standard)	T14070T0012
	1/4-inch NPT vent	T14070T0022
9	Filter Retainer	T14052T0012
10(1, 2)	Valve Cartridge	T80434T0012
11(1, 2)	Valve Plug	
	Brass stem, nitrile (NBR) plug	T14053T0012
	Aluminum stem, fluoroelastomer (FKM) plug	T14053T0022
	Aluminum stem, nitrile (NBR) plug	T14053T0032
12(1, 2)	Valve Spring	
	Stainless steel	T14105T0012
	Inconel (NACE)	T14116T0012
13(1, 2)	Valve Retainer	T14071T0012
14(1, 2)	O-Ring	
	Nitrile (NBR)	T14063T0012
	Fluoroelastomer (FKM)	T14063T0022
	Silicone (VMQ)	T14063T0032
15(1, 2)	Soft Seat	
	Nitrile (NBR)	T14055T0012
	Fluoroelastomer (FKM)	T14055T0022
16(1)	Diaphragm Assembly	
	67CF (without relief)	
	Nitrile (NBR)	T14119T0022
	Fluoroelastomer (FKM)	T14119T0042
	Type 67CFR (with relief)	
	Nitrile (NBR)	T14119T0012
	Fluoroelastomer (FKM)	T14119T0032
	Silicone (VMQ)	T14119T0052
17	Spring	
	Types 67CF and 67CFR, Plated steel (standard)	
	0 to 20 psig (0 to 1,4 bar), Green stripe	T14130T0012
	0 to 35 psig (0 to 2,4 bar), Silver	T14059T0012
	0 to 60 psig (0 to 4,1 bar), Blue stripe	T14058T0012
	0 to 125 psig (0 to 8,6 bar), Red stripe	T14060T0012
	Type 67CFR (NACE), Inconel (NACE)	
	0 to 35 psig (0 to 2,4 bar), Silver stripe	T14113T0012
	0 to 60 psig (0 to 4,1 bar), Blue	T14114T0012
	0 to 125 psig (0 to 8,6 bar), Red	T14115T0012
18	Adjusting Screw	
	For standard spring case	
	Square head (standard)	T14061T0012
	Handwheel	T14102T0012
	Wire seal (not shown)	T14104T0012
	For spring case with 1/4-inch NPT vent	
	Square head for closing cap	T14101T0012
	Handwheel	T14103T0012
19	Locknut	1A946324122
20	Upper Spring Seat	1B798525062
22	Pressure Gauge	
	Brass	
	0 to 30 psig/0 to 2 bar/0 to 0,2 MPa	11B8579X022
	0 to 60 psig/0 to 4 bar/0 to 0,4 MPa	11B8579X032
	0 to 160 psig/0 to 11 bar/0 to 1,1 MPa	11B8579X042
	Stainless Steel	
	0 to 30 psig/0 to 2 bar/0 to 0,2 MPa	11B9639X012
	0 to 60 psig/0 to 4 bar/0 to 0,4 MPa	11B9639X022
	0 to 160 psig/0 to 11 bar/0 to 1,1 MPa	11B9639X032
23	1/4-Inch Pipe Plug	
	Socket head, steel	1C333528992
	Hex head, stainless steel	1A767535072
24	Tire Valve	1H447099022
26(1)	Filter Gasket	
	Nitrile (NBR)	T14081T0012
	Fluoroelastomer (FKM)	T14081T0022
31	Panel Mounting Nut	10B2657X012
32	Wire Seal (not shown)	1U7581000A2
33	Closing Cap	23B9152X012
34	Spacer	T14123T0012
35	Mounting adaptor plate for Fisher 2500 Series Controler	T21043T0012

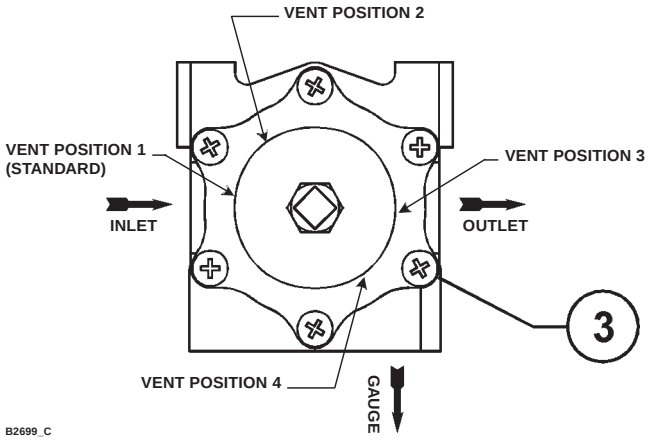
1. Recommended Spare Part
2. Valve cartridge assembly includes keys 10, 11, 12, 13, 14, and 15.



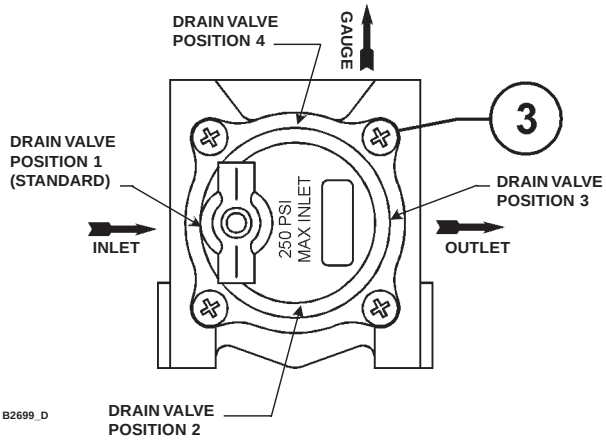
STANDARD CONSTRUCTION



PANEL MOUNT OPTION
(INCLUDES HANDWHEEL, MOUNTING NUT, AND 1/4-INCH NPT SPRING CASE VENT)



SPRING CASE VENT POSITIONS



DRAIN VALVE POSITIONS

Figure 2. 67CF Series Assembly Drawings

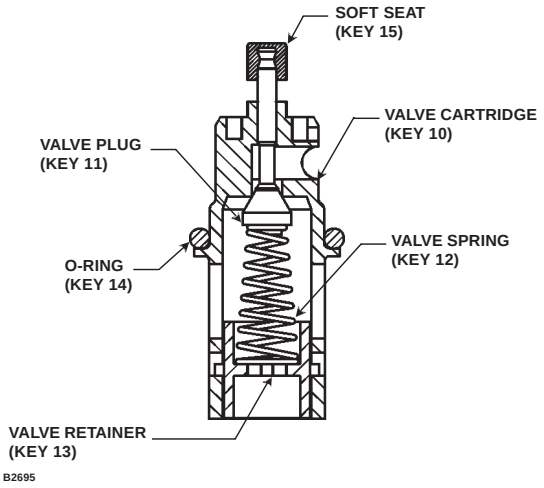


Figure 3. Valve Cartridge Assembly

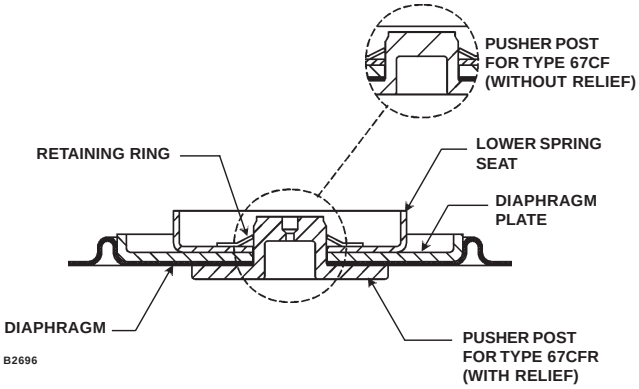


Figure 4. Diaphragm Assembly (Key 16)

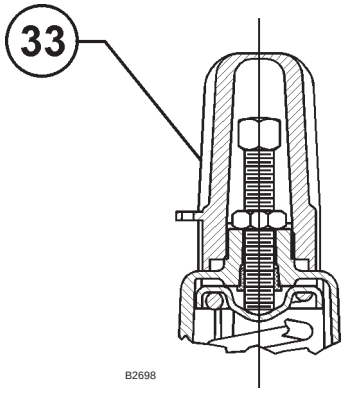


Figure 5. Optional Closing Cap (Only Available with the 1/4-inch Spring Case Vent)

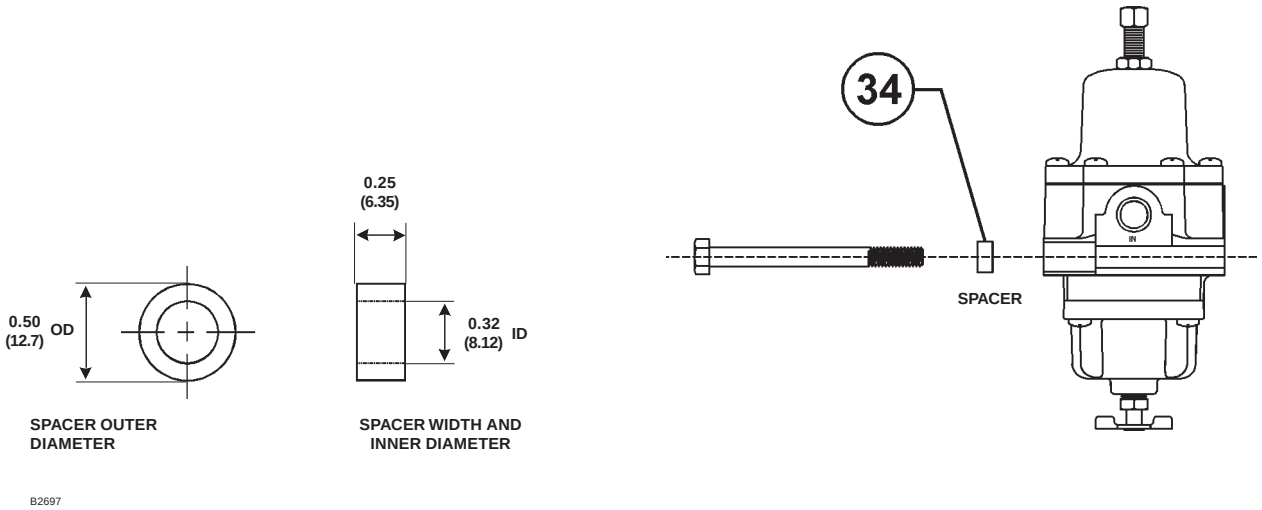


Figure 6. Spacer Diameter and Assembly
(For Installing 67CF Series Regulator in an Existing Installation if the Mounting Bolts are too Long)

For information, contact Fisher Controls:
Marshalltown, Iowa 50158 USA
28320 Gallardon, France
Sao Paulo 05424 Brazil
Singapore 128461

FISHER®

Printed in U.S.A. PRINTED WITH SOY INK recycled paper

FISHER-ROSEMOUNT™ Managing The Process Better.™

800 S. MISSOURI AVENUE
MARCELINE, MO 64658 USA
TELEPHONE: (660) 376-3575
FACSIMILE: (660) 376-2909

MOORE FANS LLC

INSTALLATION MANUAL

158

SOLD TO **AIR-X-CHANGERS**
ATTN: ACCOUNTS PAYABLE
PO BOX 1804
TULSA OK 74101-1804

SHIP TO **AIR-X-CHANGERS**
5275 NORTH GRAND ROAD
CATOOSA OK 74015

JOB NO.: **114539**
INVOICE DATE:
MODEL NO.: **CLASS 10000 HD**
PURCHASE ORDER NO: **1079386 LN 15,16**
CUSTOMER JOB NO: **104078X,79X**
SHIP REQUIRED: **07/07/2010**
PAYMENT TERMS: **NET 30 DAYS**
ROUTING: **MOORE TULSA**
F.O.B. POINT: **MARCELINE, MO.**
FREIGHT: **PREPAID**
CRATING: **STANDARD DOMESTIC**

QTY	DESCRIPTION
2	1060/123-W0-A/60L-VT-3-13-10
2	HD W BUSHING 3.438" BORE .875X.438 KEYWAY H-3.818
1	PACK ALONE 2-FAN SERIES 49/60 MANUAL

DISCOUNT

Serial Nos.: F211046-211047

ASSEMBLY DATA — MATERIAL: ALUMINUM

SERIES:	60	DIA.:	13.00
BLADES:	10	TYPE:	**MANUAL HD**
ARRANGEMENT:	12	MOUNTS:	**Standard**
CLEVIS ANGLE:	0.0°	WEIGHT:	
	Left Hand		
HUB LENGTH C/L TO BASE:	1.50		
DYNAMIC BALANCE HUB: YES			
4 INCH HOLE IN AIR SEAL:	**NO**		

BUSHING:	W	H DIM.:	3.819"
KEYWAY:	0.875" X 0.438"	BORE:	3.438"
STD. BORE TOL.:	+.001"	-.000"	
			°
STOP DROOP:	7.10	CUT DROOP	
CH TO TIP:	49.45		
BALANCE WT.:		COLOR CODE:	

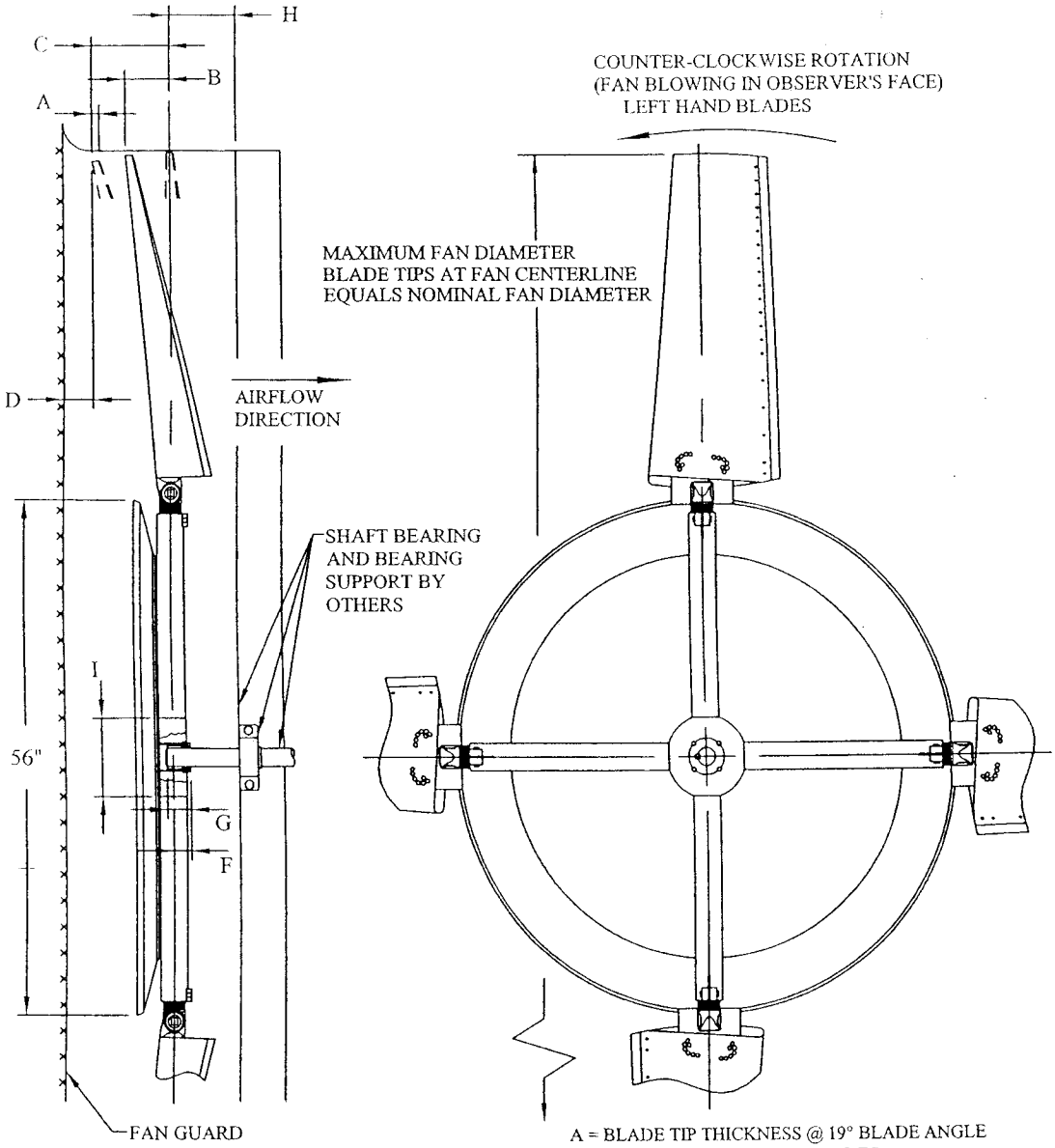
AIR PERFORMANCE DATA

ELEVATION:	Ft.	AIR TEMPERATURE:	°	DENSITY RATIO:	
ACFM/FAN:		RPM:	PHUD:	INLET CORRECTION:	
STATIC PRESSURE:	"WG	VELOCITY PRESSURE:	"WG	TOTAL PRESSURE:	"WG
VELOCITY THROUGH FAN:	FPM	TIP CLEARANCE:	"	EFFICIENCY:	
BHP REQUIRED:		*MOTOR HP:		*MAXIMUM APPLIED TORQUE:	FT.LBS.
THEORETICAL NO. OF BLADES:				BLADE LOAD FACTOR:	

* MAXIMUM APPLIED TORQUE USING FACTOR OF NOMINAL TIMES
CAUTION: (FACTORY SHOULD BE NOTIFIED IF MAX. APPLIED TORQUE OR MOTOR HP IS GREATER THAN THE VALUE SHOWN.)

ADDITIONAL NOTES:

MARKS:
P.O. NO. 1079386
2-FA4793



A = BLADE TIP THICKNESS @ 19° BLADE ANGLE
B = RUNNING POSITION OF BLADES
C = MAXIMUM BLADE TRAVEL
D = MINIMUM OBSTACLE CLEARANCE AT INLET
F = CENTERLINE OF FAN TO BASE OF BUSHING
G = BUSHING OVERALL HEIGHT
H = MINIMUM OBSTACLE CLEARANCE AT OUTLET
I = NOMINAL MECHANICAL HUB DIAMETER
L = MAX . BUSHING TORQUE FT. LBS.
# = WITH S.A.E. STANDARD SQUARE KEYWAY
* = WITH SHALLOW KEYWAY IN BUSHING
° = MAX METRIC BORE WITH STANDARD KEYWAY

WITH FAN OPERATING AT 12000 FT : MINUTE BLADE TIP SPEED / PERCENT BLADE LOADING						
		100%	75%			
DIA	A	B		C	D	H
10'	2.3"	2.5"	2.1"	3.2"	2.0"	7.0"
11'	2.2"	3.4"	2.8"	4.5"	2.0"	7.0"
12'	2.1"	4.3"	3.5"	5.8"	2.0"	7.0"
13'	1.9"	5.1"	4.1"	7.1"	2.0"	7.0"
14'	1.8"	6.0"	4.8"	8.5"	2.0"	7.0"

MAX BLADES	BUSHING TYPE	MAX # BORE	MAX * BORE	MAX ° BORE	I	F	G	L
6	U	2.750"	2.938"	75	7"	2.0"	2.7"	4000
8	U	2.750"	2.938"	75	9"	2.0"	2.7"	4000
8	W	3.750"	4.000"	100	9"	2.2"	2.8"	7300
8	X	3.750"	4.000"	100	9"	2.2"	4.0"	9800
12	U	2.750"	2.938"	75	12"	2.0"	2.7"	4000
12	W	3.750"	4.000"	100	12"	2.2"	2.8"	7300
12	X	3.750"	4.000"	100	12"	2.2"	4.0"	9800
12	Z	5.000"	5.500"	140	12"	2.2"	4.0"	18000

SERIES 60 HD FAN
LEFT HAND ROTATION

CLASS 10000 SERIES 60HD

CLASS 10000 FANS

OWNER'S MANUAL

INSTALLATION

MAINTENANCE

OPERATION

Contents

MOORE FANS LLC, MARCELINE, MO 64658 PHONE (660) 376-3575 FAX (660) 376-2909 E-MAIL info@moorefans.com

ABOUT THIS MANUAL .....

Moore is as interested as are its customers that Moore fans operate at top efficiency for many, many years. This manual has been written to achieve that result and is based on more than 50 years of experience as a manufacturer of axial flow fans.

Moore fans represent the highest degree of axial fan development and are in all respects, regardless of price, the finest obtainable for their intended purpose. As for any fine equipment, certain precautions are necessary and certain abuses must be avoided in order to insure the best performance over the longest period of time If you have any questions regarding the installation or operation of your Moore fan(s), please contact the Company for assistance.

INSPECTION

All Moore units are carefully balanced, inspected and packed at the factory. If any damage is evident before or after unpacking, the delivering carrier should be promptly notified so that an inspection may be made by the claims adjustor. It is the responsibility of the consignee to file damage claims with the carrier. Although Moore will not be responsible for shipping damage, it is requested that any damage, even of a minor nature, be reported to the factory at once.

IDENTIFY YOUR FAN'S FEATURES

Section 1 consisting of your unit's specifications will be found on the Order Information Sheet attached. Section 2 Getting Started should be read carefully before installation begins. Moore fans have several unique features.

2.0 INSTALLATION

2.1 GETTING STARTED

2.1.1 FAN IDENTIFICATION

Every fan, or group of identical fans, is assigned a Job Number. This number will be found on the Order Information Sheet showing fan specifications. A copy is attached to this manual. If non-identical fans are shipped together, a Job Number is assigned to each fan or group and a set of Information Sheets will be included for each Job Number.

The Job Number is written in semi-permanent ink on each blade, hub and air seal. All fan parts bearing the same Job Number are entirely interchangeable. (Blades of the same Series and Diameter are also interchangeable between Job Numbers.)

Fan components covered by more than one Job Number may be crated together. The Job Number that is written on each part, however, will make sorting simple.

Each individual fan produced by Moore is assigned a Serial Number. This Serial Number is embossed on a permanent metal tag and attached to each fan hub. The Fan Information Sheet provided for each Job Number lists all of the individual Serial Numbers of the identical fans covered by that Job Number so that, in future years, reference to the fan specifications provided will identify the characteristics of each individual fan.

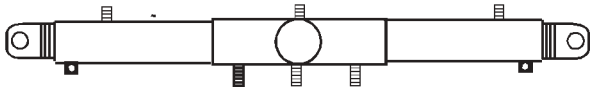
Moore keeps records indexed by serial and job numbers of all fans produced for at least forty years in order to provide proper maintenance advice and information on spare parts and replacements.

2.1.2 PLANNING THE INSTALLATION

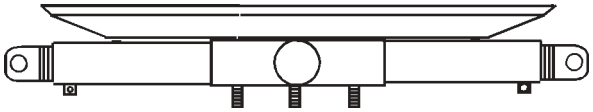
The sequence given for the installation may be changed if the conditions warrant. For example, the air seal may be installed on the hub before the hub is installed on the drive shaft. (In fact, for inverted fans, it is necessary to install the air seal first.) The installation should be planned before beginning so that the steps required are taken in the most convenient order. If you need information not found here, please contact Moore.

Class 10000 fans are suitable for horizontal or vertical mounting, for electric motor or engine drive and may be designed for clockwise (right hand) or counterclockwise (left hand) rotation. Some drawings illustrating the installation assume vertical mounting and need to be mentally rotated for horizontal mounting. Be sure to refer to the dimensional drawing(s) provided. These will illustrate the proper orientation of the fan and the rotation direction.

2.2A INSTALL HUB AND AIR SEAL



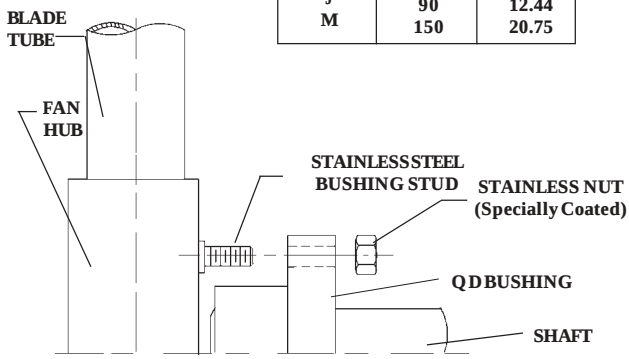
Hub Only Without Air Seal



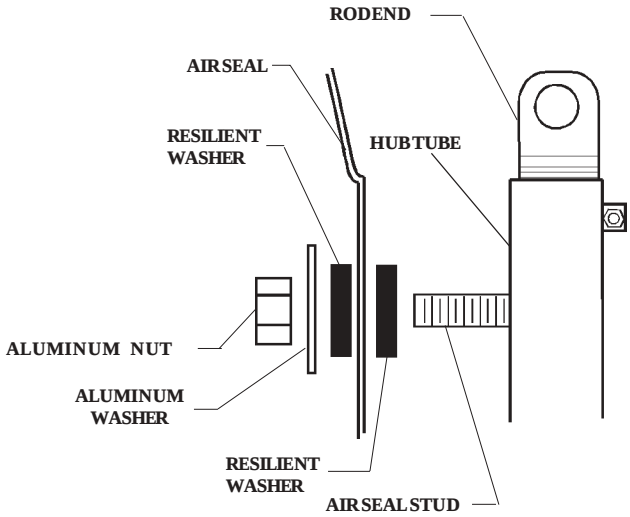
Air Seal Installed on Hub

On orders consisting of more than a small number of fans, the air seals are crated separately and must be installed in the field. When field installed, the air seal may be installed on the fan hub before the hub is installed on the bushing if it is more convenient to do so. **The air seal, however, must not be used to lift the hub.**

BUSHING SIZE	MAXIMUM TORQUE	
	FT-LBS	M-KGS
SF	20	2.77
E	40	5.53
J	90	12.44
M	150	20.75



HUB INSTALLATION ON Q D BUSHING



AIR SEAL INSTALLATION ON HUB

To install the hub:

Install the three hub studs in the hub. Hand-tighten only.

Slip the bushing onto the shaft and check the key for proper fit. Be sure the shaft is completely through the bushing.

Carefully clean the bore of the hub and the outside of the bushing with a clean, dry cloth. **Use no lubricants in this installation.** Use of lubricants can cause hub breakage.

Do not clean or alter the lubricant coating on the hex nuts.

Lift the hub by grasping the hub tubes. Do not lift the hub by grasping the air seal.

Install the fan hub on the bushing with the studs extending through the bushing flange. Place the stud nuts on the studs and tighten the nuts alternately, keeping the pull on all of them as nearly equal as possible while drawing the hub onto the bushing until the bushing tightly grips the shaft. **Caution should be used to prevent the hub from cocking on the bushing.**

Tighten the nuts to the torque shown in the table at left. **Do not over-torque**. Excessive torque can cause hub or bushing breakage.

To install the airseal:

If the airseal is to be installed on the shaft side of the fan, cut out the center to provide clearance for the bushing.

Locate the air seal installation hardware in the plastic bag taped to one of the hub tubes. Install the air seal studs on the appropriate side of the hub tube. Finger tighten.

Place one resilient washer on each stud as shown in the drawings at left. Place the air seal onto the studs and install the remaining hardware, following the sequence shown in the drawings. Do not lubricate this end of the studs.

Note that the diameter of the resilient washers, before they are compressed, is slightly less than the diameter of the aluminum washer. Tighten each nut until the resilient washer's diameter is the same as the aluminum washer. Do not overtighten. Overtightness exists when the resilient washer has expanded in diameter larger than the diameter of the aluminum washer.

Note: Some air seals are provided with more mounting holes than may be required. This is done intentionally to make the air seals more interchangeable between units. For example, an air seal with 8 mounting holes can be used with either a 4-blade or an 8-blade unit.

2.2B INSTALL HUB AND AIR SEAL

Hub Only Without Air Seal

Air Seal Installed on Hub

Hub installation instructions

Some Moore Class 10000 hubs are shipped with Moore Hi-Torque (HT) Aluminum Bushings. The following paragraph details the installation procedure for these hubs.

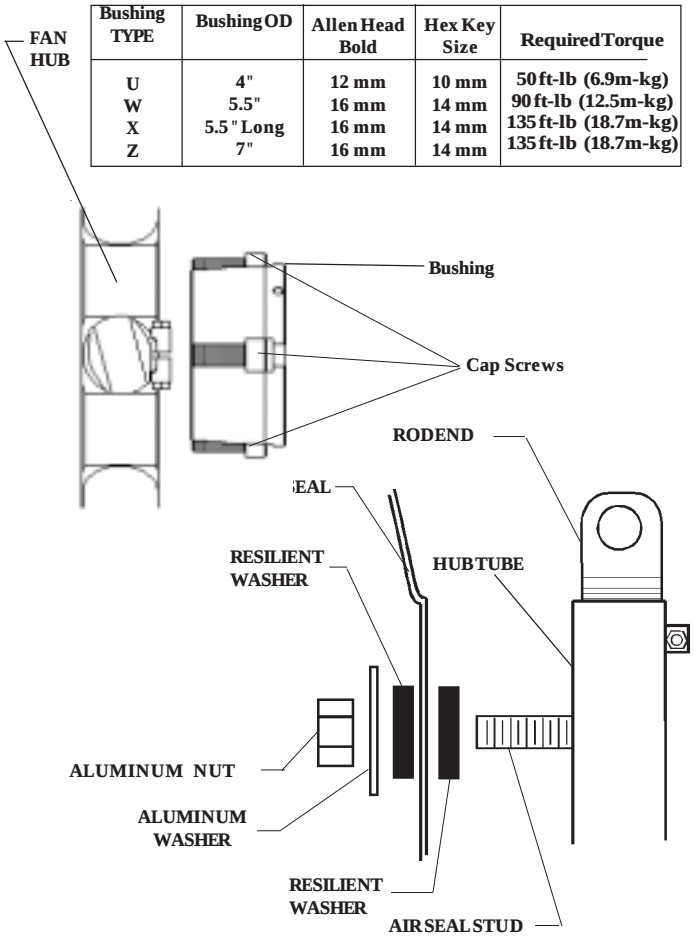
Lubrication:
If the bushing was pre-installed in the hub at the factory, no further lubrication is required prior to installation. If the bushing was not installed in the hub at the factory, it is imperative to apply high quality grease to the following surfaces:

1. The cap screw threads
2. The underside of the cap screw heads
3. The bushing taper / hub bore

DO NOT apply lubricant between the bushing bore and the shaft.

Installation:
Install the bushing in the hub by aligning the threaded holes on the I.D. of the hub with the slots on the OD of the bushing with the cap screws captured between the bushing and the hub. Insert the bushing in the hub. Using a hex key wrench, sequentially tighten the socket head cap screws until the bushing is almost fully engaged in the hub. Leave slight play between the bushing and hub to facilitate installation on the shaft.
Place the hub / bushing on the shaft. (Preferably cap screw heads will be towards free end of shaft.) Insert the key, and tighten the setscrew to secure the hub and key to the shaft. Now begin sequentially tightening the socket head cap screws (approximately 2-3 turns per cap screw initially) to firmly engage the bushing in the hub and seat the bushing on the shaft. Once the bushing / hub is firmly seated on the shaft, continue tightening the cap screws sequentially until the specified torque, shown in the following table, is reached. DO NOT over-tighten cap screws as this could cause damage to the hub.

Bushing TYPE	Bushing OD	Allen Head Bold	Hex Key Size	Required Torque
U	4"	12 mm	10 mm	50 ft-lb (6.9m-kg)
W	5.5"	16 mm	14 mm	90 ft-lb (12.5m-kg)
X	5.5 " Long	16 mm	14 mm	135 ft-lb (18.7m-kg)
Z	7"	16 mm	14 mm	135 ft-lb (18.7m-kg)



AIR SEAL INSTALLATION ON HUB

Caution:

If bushing is expected to see frequent oscillating loads (Greater than 50% of nominal expected Static Torque), Fan should be operated for approximately 15 minutes and then re-torque bushing cap screws.

To install the airseal:

If the airseal is to be installed on the shaft side of the fan, cut out the center to provide clearance for the bushing.

Locate the air seal installation hardware in the plastic bag taped to one of the hub tubes. Install the air seal studs on the appropriate side of the hub tube. Finger tighten.

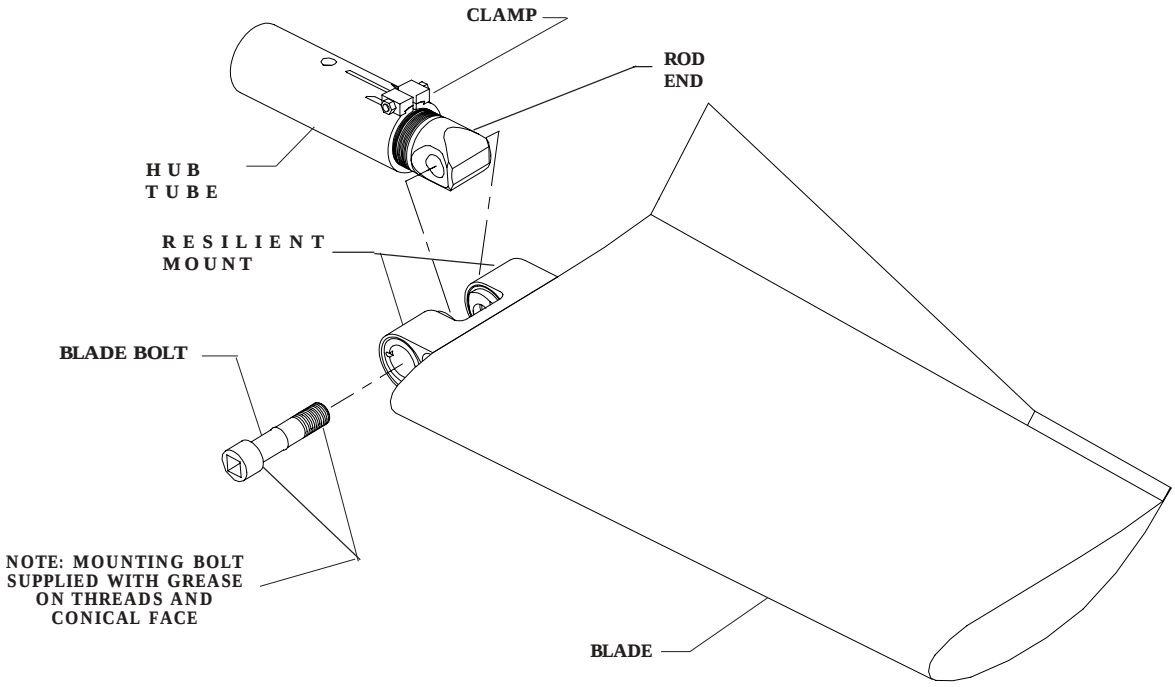
Place one resilient washer on each stud as shown in the drawings at left. Place the air seal onto the studs and install the remaining hardware, following the sequence shown in the drawings. Do not lubricate this end of the studs.

Note that the diameter of the resilient washers, before they are compressed, is slightly less than the diameter of the aluminum washer. Tighten each nut until the resilient washer's diameter is the same as the aluminum washer. Do not overtighten. Overtightness exists when the resilient washer has expanded in diameter larger than the diameter of the aluminum washer.

Note: Some air seals are provided with more mounting holes than may be required. This is done intentionally to make the air seals more interchangeable between units. For example, an air seal with 8 mounting holes can be used with either a 4-blade or an 8-blade unit.

2.3 INSTALL AND ADJUST BLADES

2.3.1 INSTALL BLADES



BEFORE INSTALLING BLADES....

Check to see that the hub is level. If the drive shaft is not truly horizontal (or vertical), causing the hub to be cocked, it will be difficult to adjust blade angles accurately. Eccentric rotation of the fan can also cause serious vibration problems.

If misalignment, vibration or unbalance in the system is present, it will be more easily identified and corrected at this time.

Moore fan blades are carefully balanced to the same moment at the factory. Any Class 10000 blade of the same series and diameter may be installed on any hub furnished on the job. They are completely interchangeable.

Moore Class 10000 Fans are designed for engine drive and other applications with the more severe requirements of this service. Proper installation, with particular attention to tightening nuts to the specified torque, is essential to maintain the design integrity of these units.

Install one blade: Clean any dirt or grease from the rod end and the surfaces of the resilient mounts. Align the rod end hole with the holes in the resilient mounts and insert the blade mounting bolt first through the resilient mount with the recess to accept the bolt head, then through the rod end hole and screw the bolt into the second resilient mount lightly. A 3/4" drive torque wrench with a short extension may be used. The blade mounting bolt is supplied from the factory with grease on the threads and conical face. **Do NOT clean the grease from the bolt.**

Complete the installation of one blade by holding the blade so that the blade extends straight out from the hub tube. Holding the blade in this position, **tighten the bolt using a torque wrench set to 200 ft-lb (28 m-kg) making sure the rod end and the resilient mounts seat.**

After installing the first blade, manually rotate the fan while moving the blade tip in and out to be sure the blade clears the ring or throat at all points. When the blade is held in alignment with the blade tube (that is, straight outward from the hub), it should clear the fan ring by a distance adequate to provide for any relative motion between the fan wheel and the ring. Excess clearance between the blade tips and the ring, however, should be avoided to prevent backflow which seriously reduces fan efficiency. If clearance is excessive, the diameter may be adjusted at this time. See Section 2.3.2.

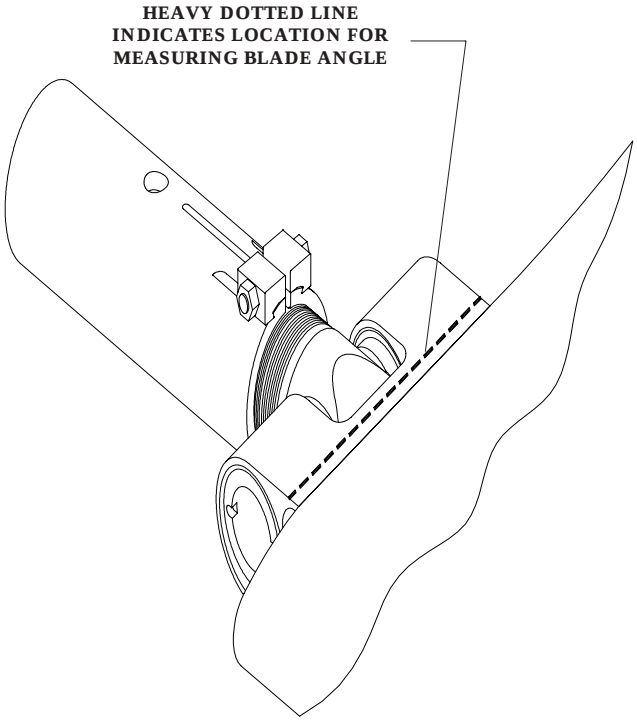
Install the rest of the blades so that they are identical with the first blade. **Torque all bolts to 200 ft-lbs (28 m-kg).** If blades are installed properly, they will return to their undisturbed position if the tips are pressed in the axial direction with moderate force (10 to 20 lb).

2.3.2 ADJUST BLADE ANGLE

Hubs are shipped from the factory with the rod end set for the blade angle indicated by the design performance. A change in blade angle is sometimes necessary, however, to adjust to actual site conditions. Failure to adjust the blade angle when required may result in blade overload. The causes of improper blade loading are explained in Section 4.3 of this manual. Section 4.4 "Checking Blade Load" provides a simple method of determining the maximum blade angle allowable in terms of static pressure vs blade angle. Please refer to these sections before increasing blade angle.

To adjust, loosen the Clamp Nut just enough to allow the blade to be turned. Place a inclinometer on the flat surface of the mounts end as shown in the illustration at right. Turn the blade until the desired angle is achieved.. Make a permanent record of the final angle selected and take care that all blades on the fan are set at the same angle. A typical adjustment may be +/- 3°. **The maximum recommended blade angle is 30°.**

Retighten the Clamp Nut to 18 ft-lbs (2.5 m-kg). Recheck each blade angle before tightening.



WARNING: The fan is designed to consume the horsepower stated on the Fan Specification Sheet. The engine drive typically produces far more power than the fan can absorb. Too great an increase in blade angle can cause serious blade overload which will stall the blades. In this condition, the fan will actually deliver less air and blade life may be shortened. Blade load considerations are discussed in Section 4.0 Operation in this manual.

2.3.3 ADJUST DIAMETER IF REQUIRED

At times it may be necessary to adjust the fan diameter to suit a particular ring. To do so, loosen the clamp nut so that the rod end can be rotated in the hub tube. One complete revolution will increase or decrease the radius of the fan by .059" (1.5 mm). Take care that the clevis is returned to exactly the factory-set angle unless it is intended that the blade loading be changed as discussed in the previous section. A match mark may be made at a point on the threads and the tube before turning to assure that exactly one revolution is made. **Tighten the clamp nut to 18 ft-lbs (2.5m-kg).**

Maximum adjustment possible is about +/- 0.75" (19 mm). At least 1.0" (25 mm) of rod end threads must remain in the tube.

2.4 START-UP PROCEDURES

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

Manually rotate the fan while checking each blade for proper clearance.

Start the fan and watch it in operation. All blades should move to the same operating position, indicating that the blade angles are properly set and that all blades are equally loaded. If vibration or unbalance is evident, see Section 3.3.

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

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

The horsepower given on the Fan Specifications is the calculated horsepower (at the fan shaft) that is required for the specified performance. Consult the factory or the fan curve before increasing the blade angle for the fan to consume more than the specified horsepower.

3.0 MAINTENANCE

3.1 PERIODIC INSPECTION

3.1.1 PURPOSE

Fan failure is most likely the result of destructive repetitive stress acting over a period of time. These stresses may be caused by mechanical abuse, e.g. rough gears or drive shaft imbalance, or by aerodynamic abuse such as blade overload or abnormal flow conditions. Fortunately, these stresses manifest themselves in typical ways that may easily be detected on inspection if one knows what to look for. The purpose of this section of this manual is to describe the symptoms of potentially damaging mechanical problems and how they can be corrected. Aerodynamic abuses are covered in Section 4.0 Operation.

3.1.2 FREQUENCY OF INSPECTION

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

3.1.3 BLADE ANGLE AND RUNNING POSITION

Turn off the unit and watch the blade tips. A looseness in the clamp bolt will permit a blade to flatten in angle. This usually can be detected by looking at the tips of the blades while the fan is slowing down. At the same time, before the unit comes to a complete stop, watch the track of the blade tips to see that all blades move to the same operating position. If one or more blades is at a substantially different position than the other blades, or if all of the blades are at a different position than at the last inspection, investigate further. This condition may be caused by a damaged resilient mount, requiring blade replacement.

3.1.4 CRACKS, DENTS AND CORROSION

Skin cracking may be caused by the tips dragging on the fan ring, or it may be the result of long-term fatigue due to continued operation under conditions of vibration or unbalance as discussed in Section 3.3 which follows. Skin cracking can also be caused by continued operation under overload conditions as discussed in Section 4.3 Causes of Blade Overload.

Cracking in air seals can occur if the airseal has been improperly installed. See Section 2.2. Check to be sure the resilient washers are present and the nuts properly tightened.

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

Dents in blades are caused by objects falling into the fan or the fan striking some obstacle. Minor dents may sometimes be repaired by drilling a small hole in the center of the dent and pulling outward on the blade skin. Blades may be ordered from the factory for replacement. If there is any evidence of this type of damage, the hub should be carefully inspected as discussed in Section 3.1.6 which follows.

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

3.1.5 HUB INSPECTION

If damage to the fan has occurred, the hub should be carefully inspected since subtle damage may have been caused that is not readily apparent. Check the hub for any sign of bending or twisting of the hub tubes. Hub tubes cannot be replaced in the field on manual fans and a new hub should be ordered.

Bushings are frequently cracked during a fan wreck and should be carefully inspected. Damage may occur to the studs that attach the hub to the bushing. It is a good idea to replace the studs when replacing a damaged fan blade.

As with any industrial equipment, before entry into fan chamber, strict adherence to ***ALL Lock-out / Tag-out procedures is well advised!***

3.2 ANNUAL INSPECTION

3.2.1 CLEAN BLADES IF INDICATED

A smooth blade surface is essential for efficient fan performance. If an incrustation forms on the blades it should be removed. Use steel wool as an abrasive along with a mild detergent or a very mild form of solvent. Lye must not be used because it attacks aluminum readily.

3.2.2 CHECK SYSTEM PRESSURE

Radiator sections may be effected by the accumulation of dust and dirt in some atmospheres. (Cottonwood seeds are particularly troubling.) These accumulations may significantly increase the static pressure. Adjust the blade angle if necessary as described in Section 4.4 Checking Blade Load.

3.2.3 CLOSE INSPECTION

The yearly inspection should be a very thorough one. All nuts and bolts should be checked and careful scrutiny given to all highly stressed areas.

Inspect the resilient mounts as follows: With the fan turned off, grasp each blade and feel for looseness at the mount. If in doubt, the blade should be removed and the mount assembly visually inspected. Wear is indicated by a fretting effect and the resilient mount material will show signs of extruding from the cavity. If these indications are not apparent, replace the blade and continue normal operations.

Inspect the blade tips for any signs of cracking and the fan ring for any scoring that might indicate that the blades have been striking or rubbing against the fan ring.

3.3 VIBRATION AND UNBALANCE

3.3.1 GENERAL

No piece of rotating equipment is perfectly balanced. It is always possible that the minute unbalances of the various components may combine to provide a noticeable lack of balance. This rarely occurs, since it is unlikely that all unbalanced components will become assembled with their heavy sides in the same direction. Nevertheless, if unbalance is noted, the various components should be rotated into different positions to see if this might cure the unbalanced condition.

If vibration or unbalance occur, either at the time of installation or later during the operation of the unit, its cause may be determined by following the directions below.

3.3.2 FAN UNBALANCE

Vibration is most likely to be caused by the fan if the blades are not set at the same angle. If the blades are properly set, the fan is the least likely cause of vibration. All fan components are balanced to within ±0.2 ft-lbs.

If the fan is in an unbalanced condition, the frequency of vibration of the structure will be that of the RPM of the fan and is quite low. In the case of large fans, the frequency is often low enough to be mentally counted along with the rotation of the fan. A vibration of 500 RPM or less will be felt as a weave in the structure rather than a vibration. Below 400 RPM, the vibration may be mentally counted and above that point may be read with a frequency meter.

Before assuming fan unbalance, check for loose bearing seats or bearings journaling the shaft on which the fan is mounted. This condition will cause the shaft to rotate eccentrically, throwing the weight of the fan off-center, resulting in unbalance of the frequency of the fan RPM.

After all checks have been made and the fan is still determined to be unbalanced, field balancing may be accomplished as described below in Section 3.3.6.

It should be noted that the loads imposed on the drive shaft and its supporting bearings by fan unbalance are negligible. A rotating centrifugal load of 100 pounds, due to unbalance, would be extremely objectionable and possibly even damage the structure on which the drive was mounted. By contrast, it would be unlikely that the drive shaft of a fan, of perhaps 25 HP, would be supported on bearings rated less than 2000 or 3000 pounds radial load. For higher horsepowers, the bearing capacity would be correspondingly increased. From this it is evident that speed reducer or drive shaft bearing failure could never be caused by moderate or even objectionable fan unbalance.

3.3.3 BELT DRIVE UNITS

The more common causes of vibration in belt drive units are not the drives themselves but the result of shafts that are too flexible or non-rigid supporting members. Vibration can be caused by misalignment of the sheaves or poorly adjusted belt tension. Consult the manufacturer of the drives for information. The quickest way to identify the cause of vibration in belt drive units is to operate the fan with the blades removed.

3.3.4 ROUGH GEARS

Continued operation on rough gears and bearings is almost certain to develop cracks in the blade skins. Rough gears may be of two types:

1. Rough or failed bearings in the drives or gears will result in a high frequency vibration being transmitted into the fan where some areas of the skin will respond to the frequencies applied. Cracks will appear in the blade skin and eventually, in some areas, the skin may actually fall away.

2. The other type of rough gear occurs when the output shaft accelerates and decelerates with each pinion tooth engagement. With a six tooth pinion and a motor speed of 1800 RPM, or 30 cycles per second, this gear misalignment impresses upon the fan a vibrating frequency of 30 x 6 = 180 cycles per second. If the engagement of teeth is also included, the frequency is 360 cycles per second. This type of high frequency vibration is at least as serious as that caused by bad bearings.

3.3.5 THROAT FLUTTER

Any fan that is effectively moving air at the tips of the blades will develop a reduced pressure area (or suction) on the fan throat or ring at the tip of the blade. This suction tends to draw the throat toward the tip of each blade, which means that a four blade fan would tend to draw the throat into something approaching a square while a six blade fan would draw it into something resembling a hexagon, etc. Since the fan is rotating, the effect on the throat is that of continually drawing it into a rotating polygon. The resulting throat flutter is frequently mistaken for fan unbalance.

A substantial throat or ring will be sufficiently rigid that flutter will not exist. A weak or flexible throat, particularly when used with a fan of a low number of blades, will be greatly affected by this type of vibration. Throat flutter is easily detected due to the fact that it is invariably of a frequency of the fan RPM times the number of blades on the fan.

Throat flutter will cause no damage to the fan so long as the throat does not disintegrate and fall into the fan blades. It may be eliminated by stiffening or bracing the throat.

If in doubt that throat flutter is the cause of vibration, reduce the angle of the blades until the fan is doing little or no work. If the vibration ceases under this condition, it is certain that throat flutter is present when the blades are loaded.

3.3.6 FIELD BALANCING

Unbalance in older fans may develop because of some structural change or by installing one new blade on an old fan where the existing blades had changed in weight in the course of operation.

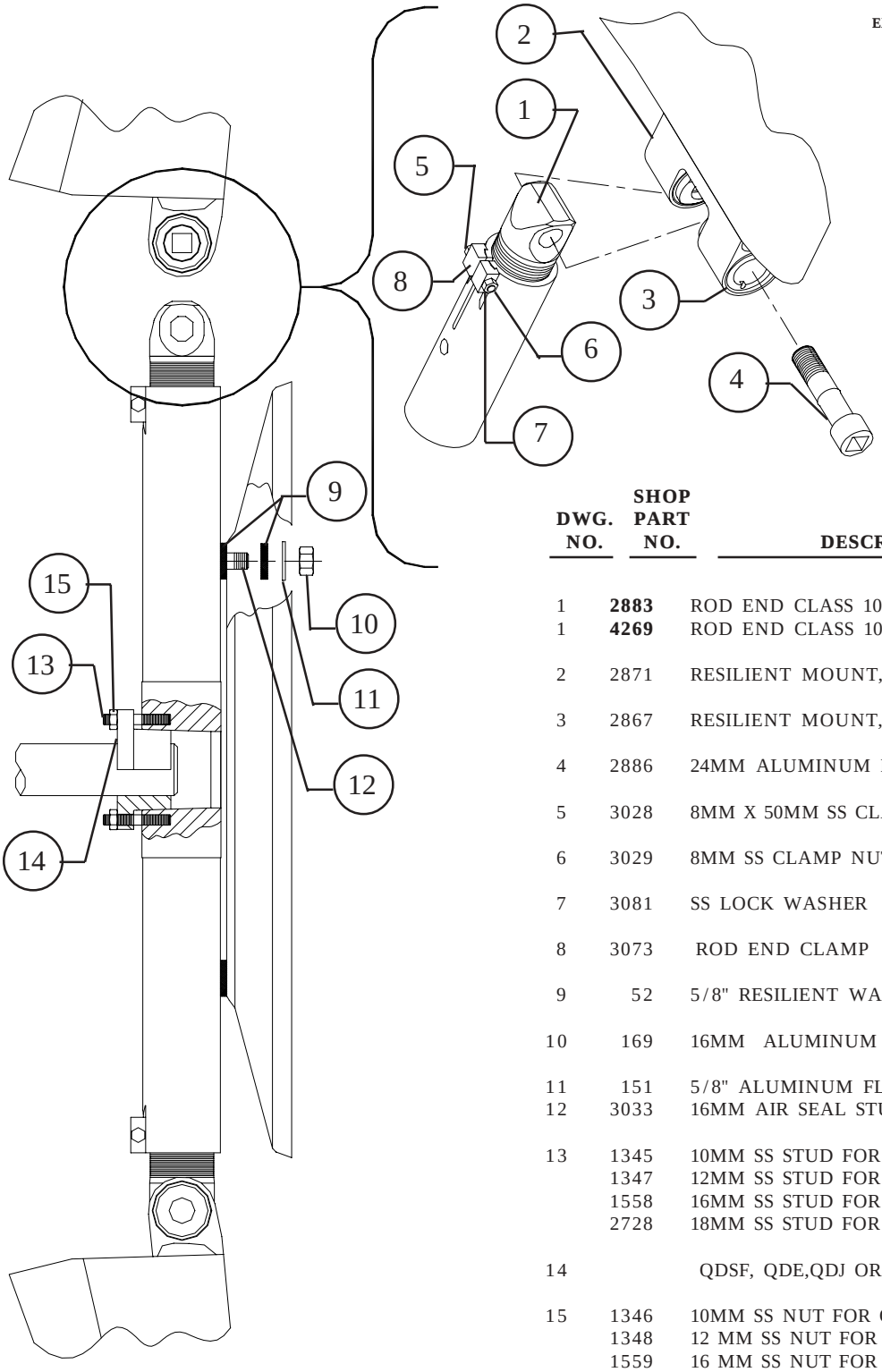
Use wire to attach a small weight in succession to each of the air seal studs until the best location for the weight is found. The weight should then be increased or decreased until the best balance is achieved. The permanent weight may then be secured to the stud or hub tube, whichever is the most convenient for the type and shape of weight to be used. One or more pieces of metal shaped like a washer could be placed over the stud, on the hub tube, behind the stud, or over the threaded portion of the rod end. Aluminum or stainless weights should be used and weights should not be attached to the blade skin.

3.4 WARRANTY

MOORE FANS LLC (the Seller) warrants only to Buyer, as its purchaser for resale, that the fans manufactured and sold by Seller to Buyer under this Agreement will be free from all defects in material and workmanship under ordinary use for a period of two (2) years from the date of shipment or one (1) year from the date the fan is installed on a customer's premises, whichever occurs first. This warranty period shall apply only if Seller receives written notice of any defect within the warranty period. Upon receipt of such notice, Seller, at its option, may require Buyer to return the fan at Buyer's cost to Seller for inspection by Seller. If the fan is found to be defective on inspection by Seller, as a sole and exclusive remedy, Seller will, at its option, either repair or replace the fan. This warranty shall not apply to damage on account of misuse, neglect or accident or shipping damage, or if repairs or part replacements have been made or attempted without Seller's prior written authorization. SELLER SHALL NOT BE LIABLE IN ANY EVENT FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR BREACH OF THIS OR ANY WARRANTY. THIS WARRANTY IS IN LIEU OF ALL OTHER GUARANTEES OR EXPRESSED WARRANTIES AND ALL IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR A PARTICULAR PURPOSE. DUE TO THE VARIETY OF CONDITIONS UNDER WHICH THE FANS MAY BE USED, RISKS OF RESULTS OBTAINED FROM USE OF THE FANS, WHETHER USED ALONE OR IN COMBINATION WITH OTHER PRODUCTS, IS ENTIRELY BUYER'S. THE ABOVE LIMITATIONS ON DAMAGE AND EXCLUSION OR LIMITATION OF IMPLIED WARRANTIES ARE NOT APPLICABLE TO THE EXTENT PROHIBITED BY STATE LAW.

3.5A PARTS LIST

NOT TO SCALE: SOME DIMENSIONS AND ANGLES HAVE BEEN EXAGGERATED FOR CLARITY

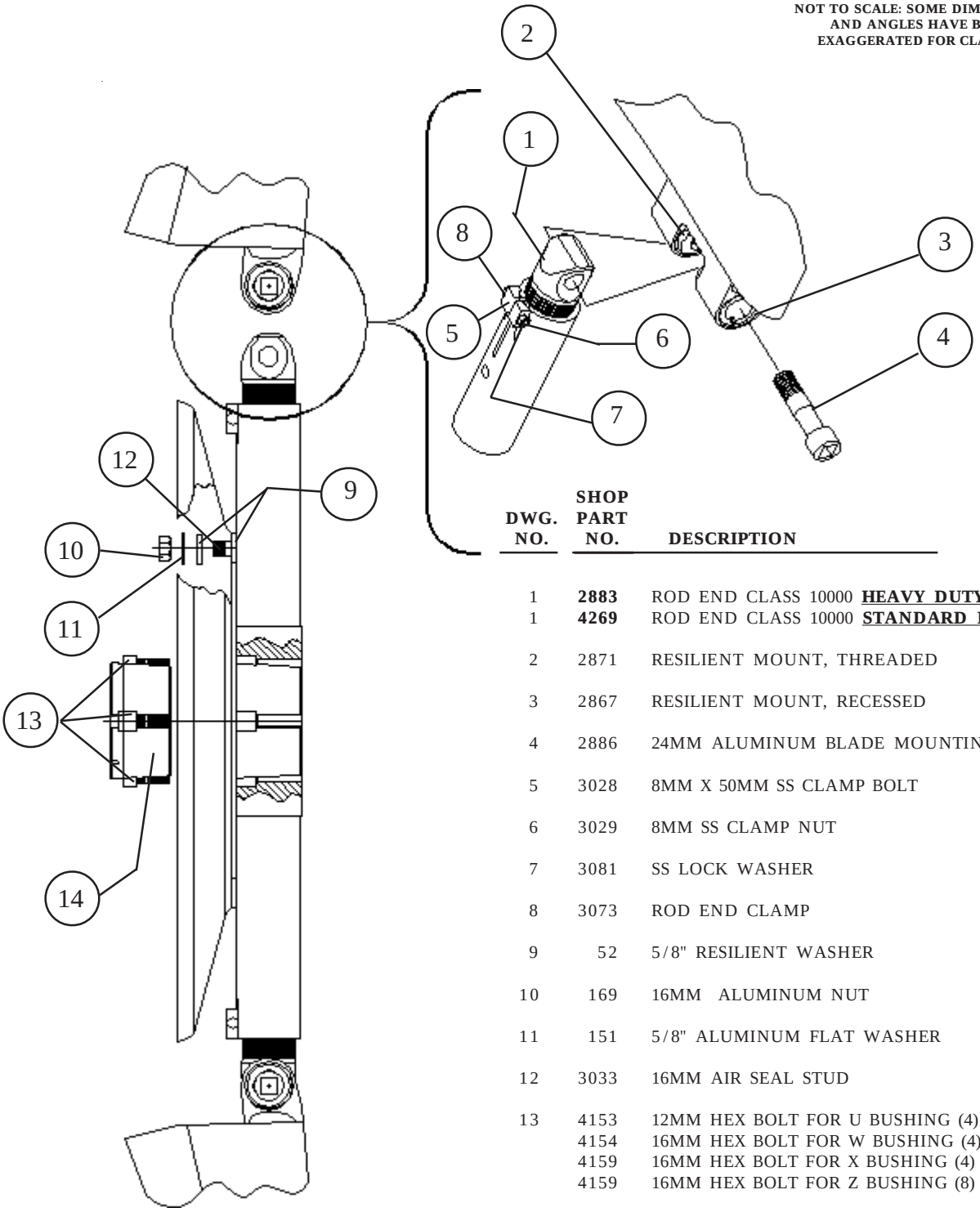


DWG. NO.	SHOP PART NO.	DESCRIPTION
1	**2883**	ROD END CLASS 10000 **HEAVY DUTY**
1	**4269**	ROD END CLASS 10000 **STANDARD DUTY**
2	2871	RESILIENT MOUNT, THREADED
3	2867	RESILIENT MOUNT, RECESSED
4	2886	24MM ALUMINUM BLADE MOUNTING BOLT
5	3028	8MM X 50MM SS CLAMP BOLT
6	3029	8MM SS CLAMP NUT
7	3081	SS LOCK WASHER
8	3073	ROD END CLAMP
9	52	5/8" RESILIENT WASHER
10	169	16MM ALUMINUM NUT
11	151	5/8" ALUMINUM FLAT WASHER
12	3033	16MM AIR SEAL STUD
13	1345	10MM SS STUD FOR QDSF BUSHING (3)
	1347	12MM SS STUD FOR QDE BUSHING (3)
	1558	16MM SS STUD FOR QDJ BUSHING (3)
	2728	18MM SS STUD FOR QDM BUSHING (3)
14		QDSF, QDE,QDJ OR QDM TYPE BUSHING
15	1346	10MM SS NUT FOR QDSF BUSHING (3)
	1348	12 MM SS NUT FOR QDE BUSHING (3)
	1559	16 MM SS NUT FOR QDJ BUSHING (3)
	2729	18 MM SS NUT FOR QDM BUSHING (3)

MOORE FANS LLC, Marceline, MO 64658 Phone (660) 376-3575 FAX (660) 376-2909

3.5B PARTS LIST

NOT TO SCALE: SOME DIMENSIONS AND ANGLES HAVE BEEN EXAGGERATED FOR CLARITY



DWG. NO.	SHOP PART NO.	DESCRIPTION
1	**2883**	ROD END CLASS 10000 **HEAVY DUTY**
1	**4269**	ROD END CLASS 10000 **STANDARD DUTY**
2	2871	RESILIENT MOUNT, THREADED
3	2867	RESILIENT MOUNT, RECESSED
4	2886	24MM ALUMINUM BLADE MOUNTING BOLT
5	3028	8MM X 50MM SS CLAMP BOLT
6	3029	8MM SS CLAMP NUT
7	3081	SS LOCK WASHER
8	3073	ROD END CLAMP
9	52	5/8" RESILIENT WASHER
10	169	16MM ALUMINUM NUT
11	151	5/8" ALUMINUM FLAT WASHER
12	3033	16MM AIR SEAL STUD
13	4153	12MM HEX BOLT FOR U BUSHING (4)
	4154	16MM HEX BOLT FOR W BUSHING (4)
	4159	16MM HEX BOLT FOR X BUSHING (4)
	4159	16MM HEX BOLT FOR Z BUSHING (8)
14		U BUSHING (4")
		W BUSHING (5.5")
		X BUSHING LONG (5.5")
		Z BUSHING (7")

4.0 OPERATION

4.1 AERODYNAMIC ABUSE

4.1.1 ABOUT THIS SECTION . . . .

It is widely acknowledged that the kinds of mechanical abuse described on the preceding pages are destructive for all types of operating equipment. It is less well recognized that — for fans — aerodynamic stresses are an even more serious hazard. This section deals with the causes of destructive aerodynamic stresses and how they can be avoided.

Although this information is given primarily for the benefit of operators of Moore equipment, it may be applied to fans of any manufacture.

Unlike smaller fans, which are typically furnished complete with their surroundings, the large fan wheel is supplied as an unprotected component of the system and is installed in innumerable types of surroundings. Not only do the types and conditions of the drives for these fan wheels vary widely, but the entrance and exit conditions and the enclosure for the wheel assume a myriad of possible combinations. In designing his product, the manufacturer of fan wheels must anticipate the operating conditions based upon his knowledge of what is reasonable and customary for the industry. He may over-design for abnormal stresses only until the practical limit is reached to avoid excessive weight, cost and inefficiency.

4.1.2 NORMAL OPERATING CONDITIONS

The fan manufacturer assumes a fairly reasonable atmosphere for the operation of his product, including the following:

- ☐ The fan selection will be reasonably in line with the performance the unit is expected to maintain, with an adequate blade area for the pressure required at the given RPM. Blades will not be loaded beyond their capacity to maintain air flow.
- ☐ A fan ring will be provided that is round, rigid and of a depth at least sufficient to cover the tips of the blades. Tip clearances will be uniform and controlled.
- ☐ The approach air will represent a relatively uniform and axial flow with, of course, some unavoidable turbulence expected. Adequate open area will be provided at the inlet of the fan.
- ☐ Major obstructions will not be present at either the inlet or discharge of the fan.
- ☐ The RPM of the fan will be within the design limits.
- ☐ The relative direction and velocity of approaching air to the blades will be fairly constant and protection will be provided from extreme wind conditions.

Under such conditions, the unit stresses in the blades would not be expected to vary more than plus or minus 50%. Fan design based on such assumptions is entirely reasonable and, with proper drives and installation conditions, has proven highly successful.

4.1.3 ABNORMAL CONDITIONS

Abnormal operating conditions result in destructive repetitive stresses that can seriously shorten fan life. The aerodynamic abuses discussed in this section can cause repeated flexing of the fan blades and hub. Violent displacement of the resiliently mounted Moore fan blades may occur — a greater displacement than would occur in rigidly mounted blades. The resilient mounting, of course, minimizes the structural unit stresses which would be transmitted to the root of the blade and into the hub and drive. Although Moore units may be expected to resist greater stress than units of conventional design, such repetitive stresses may exceed the capability of the resilient mounts to absorb them. If so, fatigue of the mounts and metal may develop, adjusting linkages may wear, and ultimate failure becomes a possibility.

Some of the abuses set out in the following text are far less important than others. All of them may occur in varying degrees.

Specifically, abuse due to serious repetitive stresses can lead to mount failure and, if carried to extremes, can require blade replacement. In units of other manufacture with rigidly mounted blades, repetitive stresses of this type may lead to blade breakage, probably near the root or at the point of attachment to the hub where stresses are highest, or may lead to failure of the hub itself. The resilient mount design, unique with Moore fans, dampens these vibrational forces and results in a fan that is far less vulnerable to failure from these conditions than other units with rigidly mounted blades. Even so, extreme conditions can cause damage.

A well-designed fan can be expected to operate for many years without trouble under normal operation as described above. The extreme repetitive stresses described below, however, will certainly reduce the life of the fan, causing failure many years sooner than would occur if the fan were operated as intended. Fortunately, these destructive conditions are readily observable to someone who is knowledgeable about them, and they can be corrected with reasonable effort and expense once they are observed.

4.2 BLADE OVERLOAD

Of all the aerodynamic abuses to be avoided in the operation of a fan, the most important is that of overloading the fan blades. Blade overload occurs because of insufficient blade area: In other words, when there is an inadequacy in the number of blades on the fan selected.

The Moore system of rating is based upon the pressure that each blade will produce at a given RPM with good efficiency. This pressure is called 100% blade load. When blade load exceeds 110%, the fan will not only operate at lower efficiency, it may be subject to structural damage as well.

In selecting a fan, the total pressure divided by the pressure to be produced by one blade determines the number of blades required for the anticipated performance. Whenever information is available, The Moore Company checks the selection. Even so, underestimation of the pressure requirements by the system designer, or changes in the operating conditions over time, may result in overload conditions.

Why is a blade overload condition of such concern? We are all aware of the fact that an airplane traveling at a given speed can carry only a certain load. If the speed of the airplane is decreased or the load increased, stalling flow over the wing will occur. In the case of an airplane, approximately two-thirds of the lift provided by the wing is the result of the air flow over the top or convex portion of the wing. Lift is provided as a reaction to the flow of air being accelerated and deflected downward as it passes over the wing. A negative pressure area is thus formed on the top surface of the wing which tends to lift it upward.

So long as air flow over the wing is smooth and clings to the surface of the wing, little turbulence is present. When the load is increased, or the speed decreased, the angle of the wing to the air stream must be increased to a point where the air flow breaks away from the upper surface of the wing. This is known as stalling or burbling flow, since the air, instead of clinging to the wing, breaks away near the leading edge and leaves what might be called a turbulent void above the upper wing surface, nullifying the accelerated flow which was responsible for the greater part of the lift of the wing.

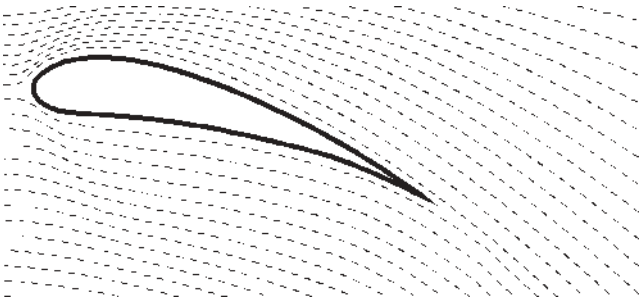
When this occurs, the wing loses a large portion of its lift. Flow, however, will re-establish briefly and break again, the cycle being repeated continuously, resulting in a severe vibration throughout the aircraft as the flow alternately makes and breaks. Anyone who has experienced a stall in an airplane will be familiar with this violent phenomenon.

A fan blade is no different than an airplane wing except that the air usually is being deflected upward rather than downward, the convex side of the blade being the lower surface rather than the upper surface as in the case of an airplane. The result of blade overload is identical: When blade load exceeds that allowable, a violent vibration will take place in the blade as the laminar, or uniform, flow makes and breaks perhaps many times a second.

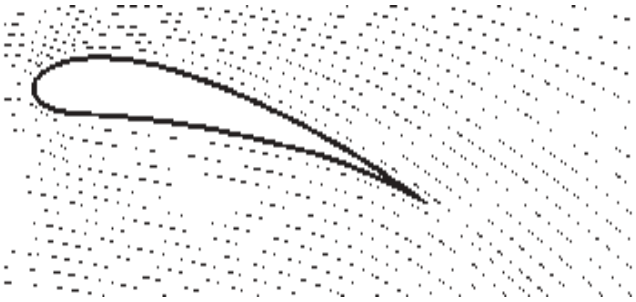
Another way of looking at this problem is to consider that the available number of blades are set at too steep an angle to be able to move air at the axial velocity which is necessary to maintain a smooth flow over the convex surface. In other words, to move air at the velocity necessary for this blade angle, plus overcoming the static resistance of the system, the total pressure which would have to be maintained for an air flow corresponding to this angle is greater than the total pressure capability of the given number of blades at this RPM. Such a condition can only be corrected by decreasing the blade angle until smooth flow is obtained or by increasing the number of blades and the total pressure potential of the fan until the fan's pressure potential equals the pressure necessary to move the specified quantity of air through the system.

Continued operation under conditions of stalling flow, or blade overload, will significantly shorten the life of the fan. Operation under these conditions will also reduce efficiency to a ridiculously low figure. See the chart under Section 4.4 Checking Blade Load which follows. Note that although air flow remains constant or decreases, horsepower continues to increase with increased blade angle.

In conclusion, if a given fan, in a given installation, can only absorb forty horsepower, for example, the blades may be pitched up to consume fifty horsepower without any increase in air delivery, and possibly with a decrease. As a result, the extra ten horsepower is totally wasted -- perhaps worse than wasted. It is good practice to select a sufficient number of blades so that blade load will amount to slightly less than 100% of full blade load when consuming 100% of the rated fan horsepower. There are a number of reasons for allowing this safety factor which are set out in detail below.



AIRFLOW IN NORMAL FLOW
Downward flow provides lift to the wing



AIRFLOW IN STALLING FLOW
Note lack of air deflection downward.

4.3 CAUSES OF IMPROPER BLADE LOADING

4.3.1 VARIATION FROM PREDICTED CONDITIONS

Although those who design air coolers and cooling towers undoubtedly do their best to accurately state the calculated static resistance of the system, a number of factors may cause the actual conditions to vary from the design conditions. When a variation occurs, it may be found, upon testing, that the static pressure for a given volume through the system is higher than anticipated. In this case, the number of blades provided may be inadequate to meet the performance. On the other hand, the static pressure may have been overestimated and excess blade area provided, resulting in a fan with unutilized capacity operating at low efficiency.

Inadequate Blade Area: The blade angle is selected to move the anticipated volume of air and the number of blades is selected to maintain the total anticipated pressure required to move this volume at a given RPM. If the static pressure turns out do be higher than predicted, the fan may then be operating in an overload condition. If the RPM cannot be increased, the only solution to this condition is to reduce the blade angle until the fan can carry the then reduced volume at the originally anticipated pressure. Since reducing the volume, while holding the total pressure as originally anticipated, can only reduce the horsepower, it is then impossible to consume the horsepower originally intended without overloading the fan. This is one of a number of reasons for providing some safety factor in blade loading at the time of original fan selection.

Excessive Blade Area: Occasionally, an excessive number of blades may be specified in the interest of making a conservative selection. If the static pressure has been overstated, the theoretical number of blades will be greater than needed. This theoretical number of blades is usually a fractional number and the actual number of blades used must, of course, be the next larger integer, resulting in some "safety factor" in the selection. If, in addition, a blade or two is added as a "safety factor" or in anticipation of increased future requirements, it may be impossible to meet the original performance requirement efficiently. The only way to provide the original performance and draw no more than the original horsepower is to flatten the blade angle. There is a limit, however, in how far the blade angle may be reduced before further reduction will decrease airflow without a further reduction in horsepower. For belt drive units, the most practical solution to this problem is to reduce the RPM of the fan.

4.3.2 EXCESSIVE TIP CLEARANCE

Unless the fan ring is very close to the tip of the blade, air from the high pressure surface of the blade will flow around the tip and nullify the negative pressure on the underside of the blade for some distance in from the tip. For a fan of, say, 12-ft diameter, the last 12 to 18 inches of the blade could be producing no pressure whatever and performing no useful function. The balance of the fan blade toward the hub then must produce a higher pressure to compensate for the portion near the tip.

Excessive tip clearance also leaves an unswept area between the tip of the blade and the fan ring. Air that has been pumped by the fan will return downward through this unswept area at a velocity greater than that at which it passed through the fan in the desired direction. This condition adds even further to the requirements of the portion of the blade which is doing the work and efficiency will be greatly reduced.

With the loss of a foot at the tips of the blades, plus the back flow between the tips and the ring, the 12-ft fan in this example might be considered an effective 10-ft fan. It would have to deliver sufficient air to satisfy the performance requirements of the installation, plus the amount of air which is returning in the void between the tips and the throat. Under such circumstances, excessive blade loading could occur even though the required system pressure is not achieved.

4.3.3 POOR ENTRANCE CONDITIONS

Air will approach the fan from all possible directions, increasing in velocity as it nears the opening, then accelerating rapidly as it enters. The air approaching from the side must be turned through 90^{O} to enter a ring whose entrance terminates in a flat plate. If the inlet end of the ring projects some distance out, with approach possible from all directions, a portion of the air must be turned through 180^{O}. The inertia of the approaching air prevents it from turning sharply and advancing parallel to the desired flow. It consequently swoops toward the center, leaving the outer area of the fan with reduced flow or even reverse flow near the ring.

The effect of poor entrance conditions is similar to that previously described for excessive tip clearance in that the effective diameter has been reduced and excessive blade loading could occur even though the required system pressure is not achieved. Efficiency will be greatly reduced.

4.3.4 EXCESSIVE DEFLECTION

The pressure which the fan can achieve is dependent upon the square of the velocity of the blades relative to the air. If the air could be moved into the fan in an axial direction and passed through the fan into the discharge without changing direction, the relative velocity of the blades to the air stream would be the true velocity of the blades at any point. This, of course, is not the case. For the blades to accomplish work upon the air, they must also deflect the air in the direction of rotation of the fan. The air when rotated with the fan is moving with a certain

velocity in the same direction as the rotation of the fan, which reduces the relative velocity between the fan blades and the air by some portion of this rotational velocity.

Moore fans are designed in contemplation of a maximum deflection of 50° at the hub, decreasing to a very small value at the tip. This deflection is considered in the determination of the pressure which may be provided by each blade over its full length. If fans are selected, or if conditions exist, which cause the deflection to exceed 50° at the hub, the velocity of the blades relative to the air is less than anticipated and the blades will not provide the rated pressure. The test below, however, will show the full allowable pressure capability of the fan, even though it does not reach the full rated pressure.

4.3.5 CONCLUSION

As can be seen by the various points discussed in this section, there are a number of complex factors which tend to cause fans to be operated in a condition of improper blade loading which can shorten fan life or lower efficiency. When blade angles are set to consume the specified horsepower (at the fan shaft), the resulting performance should be very close to the specified performance. If this is not the case and the problem cannot be identified or corrected, please contact Moore for assistance.

4.4 CHECKING BLADE LOAD

One method of checking blade load is to run a complete field test on the fan. Although laborious, this method will provide ample proof so long as neither excessive tip clearance nor poor entrance conditions are present. If either are present, however, the conditions set out above under Section 4.3.3 would apply and the fan could be overloaded even though the total pressure indicated by the test was within the allowable blade loading.

A better, more convenient and simpler method of detecting blade overload, or determining maximum allowable blade angle, is set out below. The equipment needed is a wrench, a torque wrench, a protractor and a draft gauge (or manometer).

All fans are shipped with the blade angle set for the anticipated performance requirements furnished to The Moore Company by the purchaser. This blade angle is called out on the Fan Specification Sheet. This angle refers to the angle measured at the location shown in Section 2.3.3. Hubs are shipped with the clevises set at this angle.

To start the test, adjust the blades to an angle of approximately half that called out on the specifications or measured on the units. Connect the draft gauge to as quiescent a spot in the plenum as possible, preferably in the corner of the plenum and either ahead of or following the fan, depending upon whether the application is induced or forced draft. Since the figures obtained are purely relative, it is not necessary that accurate static pressure readings be obtained, but rather that the readings taken represent a consistent series of pressures at the point of reading chosen.

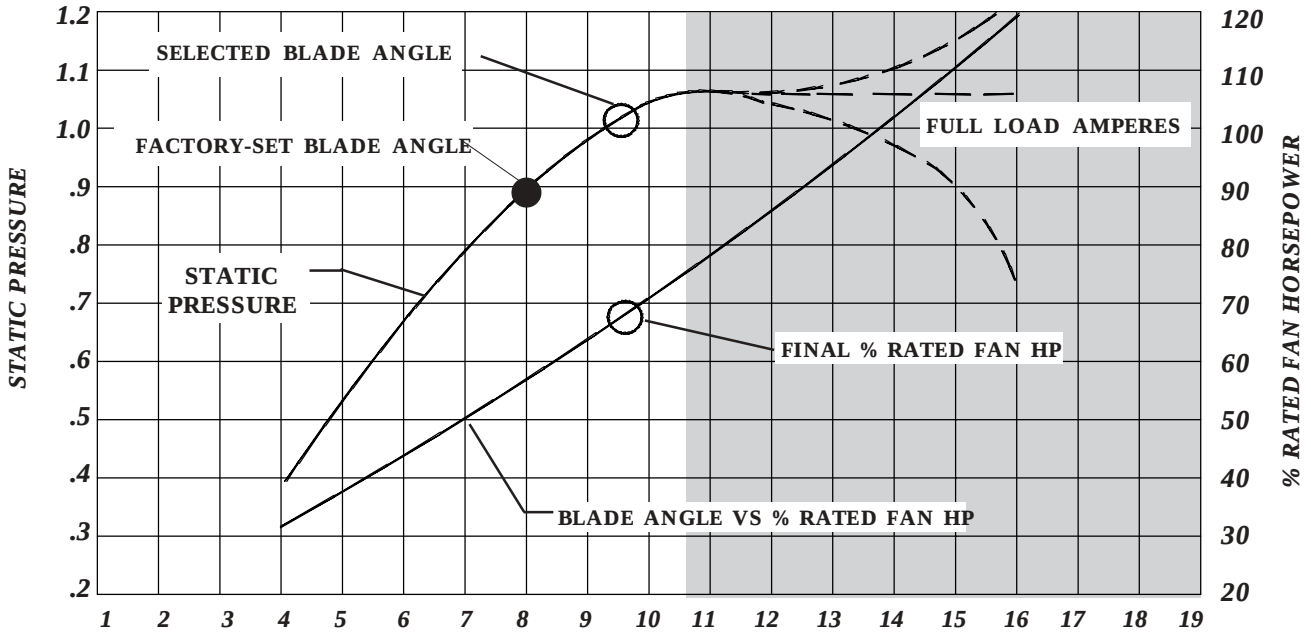
Start the fan and record on the chart provided the blade angle and he static pressure indicated. Advance the blade angle by one or two degrees and repeat the performance, recording again these readings. Keep increasing the angle and following this procedure until the motor is fully loaded, in which case the fan is able to consume full rated fan horsepower without overload OR until the curve which will have started on a definite slope begins to approach the horizontal. It will be noted that the static pressure will be consistently increasing with increased blade angle until the blade loading reaches maximum, at which point it will level off.

Subsequent increases in blade angle may have quite different effects, depending on the individual installation. The static pressure curve may merely stay level or may drop off sharply. In rare cases, it may level off and again start rising as the fan begins operating as a centrifugal blower.

Typical examples are shown in dotted lines on the chart opposite. Operation beyond the first point of levelling, or in the area of the dotted lines, is indicative of blade overload. Note that power consumption load will continue to increase even though the fan has passed into overload condition. The maximum blade angle allowable is that which produces a static pressure about 5% below the point where the curve becomes level. This represents a safe loading, and the blades may be set and left at this angle regardless of the location on the chart, assuming the motor is not overloaded.

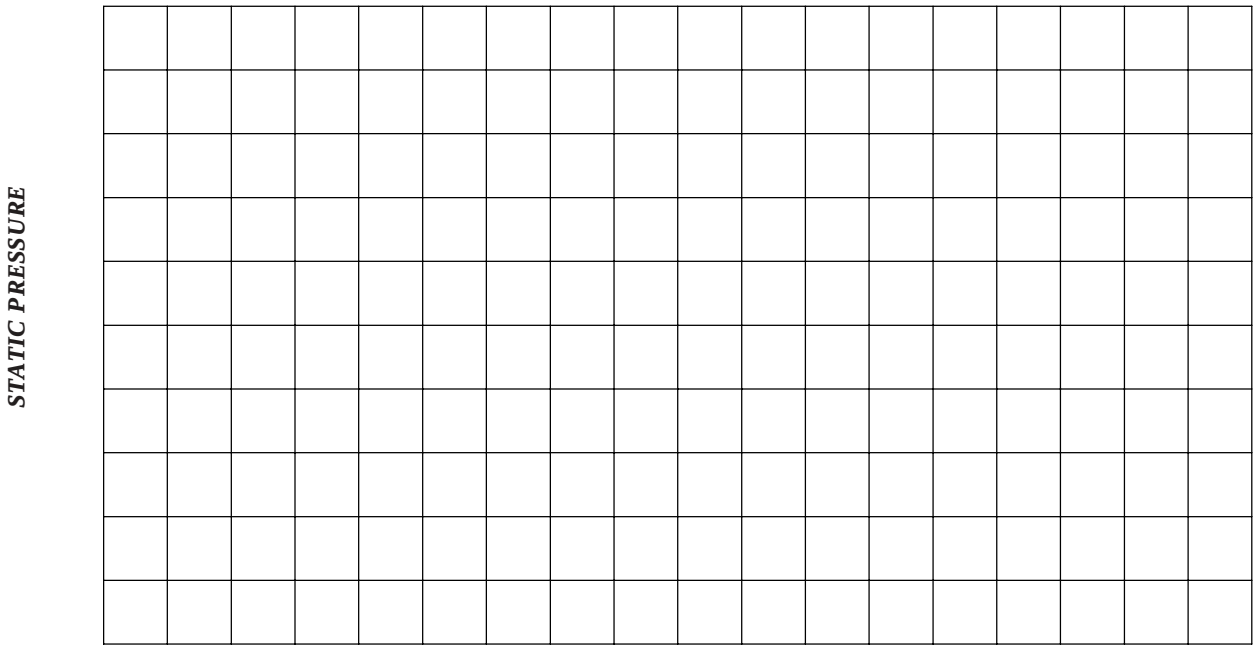
The point so selected will also approximate the point of the most efficient operation of the fan. Due to possible error in static pressure predictions, or in readings which are intended only to be relative, as well as other variables, the final blade setting chosen may fall below or above the specified static pressure.

A typical performance chart is shown opposite for a fan capable of a higher blade loading than origianally specified. A blank chart is also provided for your use.



4.4.1 SAMPLE GRAPH of BLADE ANGLE IN DEGREES

Note in the chart above that static pressure (and air flow) has reached its maximum at an 11 degree blade setting and blade overload is beginning. With further increase in blade angle, anything may happen, as indicated by the dotted extensions into the shaded overload area. Note that the final selected blade angle is 5% below the point where the static pressure curve becomes level. The horsepower curve has been added to illustrate the point that in an overload condition, horsepower will increase without increased performance.



BLADE ANGLE IN DEGREES

BLANK CHART FOR CUSTOMER USE

4.5 DAMAGING OPERATING CONDITIONS

4.5.1 GENERAL

Any condition which causes repeated blade loading and unloading is detrimental to fan performance, both in terms of efficiency and structural durability. Normal obstructions, of course, must be expected in the air stream. There are certain conditions, however, which may be avoided by reasonable attention to the points briefly discussed in this section. Additional information on the importance of inlet and discharge conditions can be found in Moore's General Catalog.

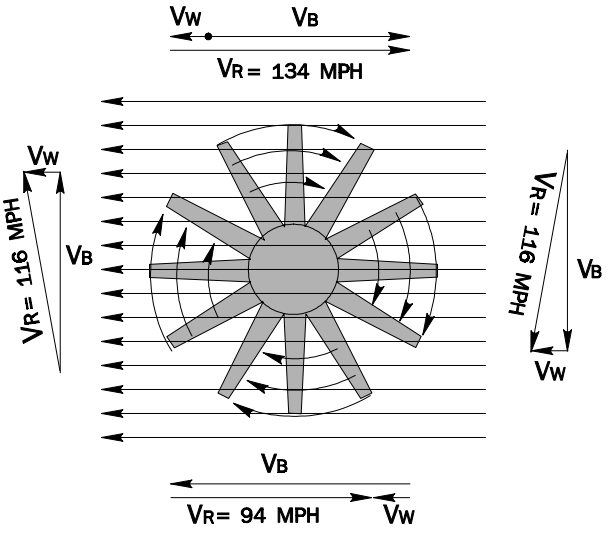
Ideally, air should approach a fan in an axial direction and at a uniform velocity over the area of the fan. Air approaching a fan at an angle tends to increase the relative velocity of the blades to the air on one side of the fan and decrease the relative velocity on the other side. This means that the fan blade during one-half of its revolution is picking up a heavier air load due to the higher relative velocity and, through the other half of its revolution, a lower air load as it goes "down wind". The net result is a repetitive loading and unloading of the blades at each revolution of the fan. This condition can be quite serious if the velocities are high and the angle of approach deviates considerably from axial.

4.5.2 WIND

With a vertically mounted fan blowing outward into the wind and surrounded by a short fan ring or stack, high winds may cause some concern. The farther the ring extends beyond the fan, the less effect would be expected from wind. It is a fact, however, that wind across the face of the ring will affect the direction of air flow well down into the ring. In the case of a fan installed near the outlet of the ring, the direction from axial of the fan discharge may be increased by as much as 45° under high wind conditions.

In the case of a fan blowing inward in a short ring, the condition is even more critical. In such an installation, the air on the inlet side of the fan has a horizontal velocity which may be quite high. It is necessary for the fan to pick up this air and direct it inward. In a strong wind, the angle of air moving through the fan may be increased more than 45°.

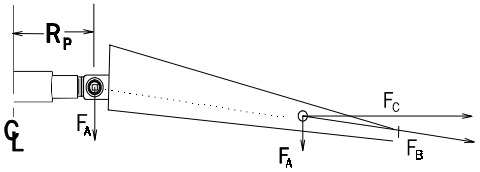
The illustration above assumes a fan operating with a tip speed (V_B) of 10,000 feet per minute (114 miles per



hour) with a horizontal component of wind velocity (V_W) of 20 miles per hour. Note that the velocity (V_R) of the fan blade relative to the air varies by a factor of 1.43. The blade load varies as the square of this velocity, or 2.05.

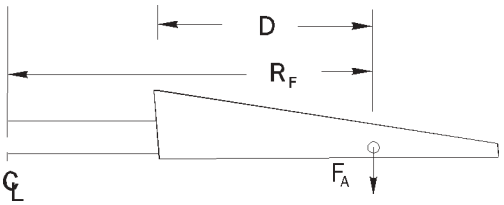
THE EFFECT OF AIR LOAD ON HUB AND DRIVE

Moore fan blades are attached to the hub by a pivot. As the fan rotates, centrifugal force causes the blades to rise (as do the blades of a helicopter). The air load (F_A) is uniform over the blade, but there is a point (shown on the blade in the drawing below) where, if the total load were applied at that point, the effect would be the same. The resultant of the air load (F_A), assumed in this example to be downward, and the horizontal centrifugal force (F_C) is the force on the blade (F_B). The blade automatically posi-



tions itself in the direction of this force with the result that the force is translated inward to the pivot point, as illustrated by the dotted line. The effect of this arrangement is exactly as if the total air load (F_A) were applied at the pivot point rather than at the point outward on the blade. The maximum bending moment applied to the shaft by the air load is equal to the load (F_A) multiplied by the distance from the fan centerline to the pivot point (R_P).

In conventional fans with rigidly attached blades, the bending moment at the shaft due to the air load is equal to the load (F_A) multiplied by the distance from the fan centerline to the point of application of the force on the blade (R_F). This moment will be from 2 to 4 times as great as that produced by the Moore fan under the same condi-



tions.

Also of concern with the conventional fan is the bending moment due to the air load at the point of attachment of the blades to the hub since this is usually the structurally weakest area of the fan. The moment due to the air load at this point is the load (F_A) times the distance (D). For the Moore fan, this moment is zero since the blades are attached at the pivot point.

A more complete discussion of the Moore fan design can be found in The Moore Company's General Catalog.

In this rather common wind condition, then, it can be seen that the blade load on the side where the blade is going against the wind will be double the load on the side where the blade is going with the wind. In a 40 mile per hour wind, the blade load would vary by a factor greater than 4. In a 60 mile per hour wind, the load would vary by a factor of more than 10! It is obvious that operation under such conditions will impose tremendous repetitive loadings on the fan blades.

In areas of unusually high wind velocities, it may be advisable to shield the fan in some manner.

4.5.3 OBSTRUCTIONS

Obstructions of one type or another in the air stream, ahead of or beind the fan, are to be expected. In fact, it would be virtually impossible to eliminate all obstructions. Structural supporting members, foundations and the like, need not be of serious concern although all obstructions, even small ones, will increase the static pressure and must be taken into consideration by the system designer in specifying the fan performance.

The total free area from which the fan can draw air should be twice the net area of the fan (fan area minus hub area). In other words, the air approaching the inlet of the fan should have no more than half the velocity of the air passing through the fan. This area should be distributed reasonably uniformly. It would be unwise to attempt to operate a fan with one-half or one-third of the fan area completely blanked off. Such a condition would cause stalling of the fan blade through one-half the revolution but create a condition of overload in the half which was not blocked off. Excessive vibration would result. Any condition which forces the air to approach the fan in a non-axial direction should be avoided.

4.5.4 UNEVEN TIP CLEARANCE

Where fan rings are out of round or not centered with the fan, the tip clearance of each blade will vary as it makes a revolution. If tip clearance is tight at one point and excessive at another, proper flow will establish itself at the tight point, loading the blade to the very tip, while at the loose point the air will flow from the high pressure side of the blade through the opening between the blade tip and the ring and nullify the negative pressure on the under side of the blade. This will unload the blade near the tip within the area of excessive tip clearance. Under this condition, the blade will load and unload near the tip one or more times per revolution, resulting in an undesirable repetitive vibration. Every effort should be made to keep the tip clearance to a minimum and to have this clearance as constant as possible around the entire ring.

MOORE FAN RATING

HARSCO INDUSTRIAL
Air-X-Changers

PO Box 1804
Tulsa, OK 74101-1804
Phone: 918-619-8000
Fax: 918-384-5202

Proposal No.	**104078**
Date	6/7/2010
Page	1 OF 1

Purchaser	ENERFLEX	Item	156EH-122-24

Class	10000	HD
Series	60	Manual
Temperature	104.0	farenheit
Volume	271858	ACFM
Static Pressure	0.8438	in H2O
Power Req'd	62.89	bhp
Min. Temp.	0.0	farenheit

Diameter	13.00	feet
Elevation	1890	feet
Air Velocity	2331	fpm
Velocity Pressure	0.296	In H2O
Motor	75.0	bhp
Power@Min. Tem	77.10	bhp

Blades:	10	
Density:	0.8763	Ratio
RPM:	240	
Total Pressure	1.229	In H2O
Efficiency:	0.8	

No. Blds Req'd	9.56	
Tip Speed	9802	ft/min
Entry Correction	1.3	
Starting Torque	2.0	
Vortex Tips	YES	

API Blds Reqd	11.00	
Deflection Angle	48.4	
Tip Clearance	0.625	inches
Max Torque	3283	Ft-Lbs

Blade Load	0.956	
Pitch Number	1.9	
Clevis Angle	14.9	degrees
Torque/Blade	328	Ft-Lbs

Fan Weight	245	Lbs

WR2	2330	Lbs Ft2

Fan Thrust Load	847	Lbs

PREDICTED FAN NOISE LEVEL(PER FAN)

HZ	PWL	SPL1	SPL2	SPL3
Dba	100.9	86.3	81.5	69.18928
63	106.9	92.3	87.5	75.18928
125	105.9	91.3	86.5	74.18928
250	102.9	88.3	83.5	71.18928
500	97.9	83.3	78.5	66.18928
1000	95.9	81.3	76.5	64.18928
2000	89.9	75.3	70.5	58.18928
4000	83.9	69.3	64.5	52.18928
8000	77.9	63.3	58.5	46.18928

NOTES:

SPL1 = 1 m Below Fan
SPL2 = 1 m At Side
SPL3 = 50 FT At Side
SPL3 = 3.3 FT Below F
SPL3 = 100% Reflectivi
SPL3 = Fan Centerline = 8 FT Above Ground

DRAFT **Forced**

Rating generated by Moore Fans Version 1.53 at 06/07/10 14:29:40

INSTRUCTION MANUAL FOR
DODGE® S-2000 SPHERICAL ROLLER BEARINGS

GENERAL INFORMATION

DODGE S-2000 Spherical Roller Bearing mounted units incorporate a unique way of sealing the internal components of the bearing while still allowing a full + or - 1 degree of misalignment. The patented sealing system (Pat. #5,908,249) has proven effective, due to its constant contact pressure, in protecting the internal bearing components under maximum allowable misaligned conditions.

INSTALLATION INSTRUCTIONS

NON-EXPANSION BEARING

WARNING

TO ENSURE THAT DRIVE IS NOT UNEXPECTEDLY STARTED, TURN OFF AND LOCK OUT OR TAG POWER SOURCE BEFORE PROCEEDING. FAILURE TO OBSERVE THESE PRECAUTIONS MAY RESULT IN BODILY INJURY.

1. Clean shaft and bore of bearing. The shaft should be straight, free of burrs and nicks, and correct size (see shaft tolerance table). If used shafting is utilized, then the bearing should be mounted on unworn section of shafting.
2. Lubricate shaft and bearing bore with grease or oil to facilitate assembly. Slip bearing into position. When light press fit is required, press against the end of the inner ring of bearing. Do not strike or exert pressure on the housing or seals.
3. Bolt bearing to support, using shims where necessary to align bearing so inner ring does not rub on seal carrier. Use full shims which extend across the entire housing base.
4. Determine final shaft postion and tighten setscrews in the locking collar(s) of non-expansion bearing to recommended torque while the other bearings remain free. Rotate the shaft slowly under load, if possible, to properly center the rolling elements with respect to the raceways. Then tighten setscrews into the locking collar of the remaining bearings to the recommended torque.
5. Check rotation. If there is any strain, irregular rotational torque or vibration, it could be due to incorrect alignment, bent shaft or bent supports. Installation should be rechecked and correction made where necessary.

EXPANSION BEARING

Steps (1, 2, 3) Same as Non-Expansion Bearing.

4. Position expansion bearing in the housing. For normal expansion conditions, the bearing insert should be positioned in the center of the housing. To center bearing insert in housing, move bearing insert to extreme position and mark shaft. Then using bearing maximum total expansion table, move bearing insert in opposite direction one-half the total expansion to center bearing in the housing. If maximum expansion is required, move bearing insert to the extreme position in the housing to permit full movement in direction of expansion. After expansion bearing has been positioned in the housing, tighten the setscrews in the locking collar to the recommended torque.
5. Same as Non-Expansion Bearing.

FIELD CONVERSION (RE-OP) OF A NON-EXPANSION BEARING INTO AN EXPANSION BEARING

All non-expansion bearing sizes can be re-oped to become expansion bearings. To re-op a non-expansion to an expansion bearing follow these steps:

1. Move the snap ring, opposite from the collar side of bearing, to the outermost snap ring groove.
2. Install bearing per Expansion Bearing instructions listed above. **NOTE:** Bearing nameplate has a non-expansion Part Number. When bearing is re-oped the bearing should be marked as expansion for future reference.

BEARING MAXIMUM TOTAL EXPANSION TABLE

SHAFT SIZE in.	TOTAL EXPANSION in.
$1\frac{3}{8}$ - $1\frac{1}{2}$	$\frac{3}{16}$
$1\frac{11}{16}$ - $3\frac{7}{16}$	$\frac{1}{4}$
$3\frac{15}{16}$	$\frac{5}{16}$
$4\frac{7}{16}$ - $4\frac{15}{16}$	$\frac{3}{8}$

WARNING: Because of the possible danger to persons(s) or property from accidents which may result from the improper use of products, it is important that correct procedures be followed: Products must be used in accordance with the engineering information specified in the catalog. Proper installation, maintenance and operation procedures must be observed. The instructions in the instruction manuals must be followed. Inspections should be made as necessary to assure safe operation under prevailing conditions. Proper guards and other suitable safety devices or procedures as may be desirable or as may be specified in safety codes should be provided, and are neither provided by Rockwell Automation nor are the responsibility of Rockwell Automation. This unit and its associated equipment must be installed, adjusted and maintained by qualified personnel who are familiar with the construction and operation of all equipment in the system and the potential hazards involved. When risk to persons or property may be involved, a holding device must be an integral part of the driven equipment beyond the speed reducer output shaft.

LUBRICATION INSTRUCTIONS

OPERATION IN PRESENCE OF DUST, WATER OR CORROSION VAPORS

This bearing is factory lubricated with No. 2 consistency lithium complex base grease which is suitable for most applications. However, extra protection is necessary if bearing is subjected to excessive moisture, dust, or corrosive vapor. In these cases, bearing should contain as much grease as speed will permit (a full bearing with consequent slight leakage through the seal is the best protection against contaminant entry).

In extremely dirty environments, the bearing should be purged daily to flush out contaminants. For added protection, it is advisable to shroud the bearing from falling material.

HIGH SPEED OPERATION

At higher operation speeds, too much grease may cause overheating. In these cases, the amount of lubrication can only be determined by experience. If excess grease causes overheating, remove grease fittings and run for ten minutes. This will allow excess grease to escape. Then wipe off excess grease and replace grease fittings.

In higher speed applications, a small amount of grease at frequent intervals is preferable to a large amount at infrequent intervals. However, the proper volume and interval of lubrication can best be determined by experience.

AVERAGE OPERATIONS

The following table is a general guide for normal operating conditions. However, some situations may require a change in lubricating periods as dictated by experience. If the bearing is exposed to unusual operating conditions, consult a reputable grease manufacturer.

Lubrication Guide

Read Preceding Paragraphs Before Establishing Lubrication Schedule

Suggested Lubrication Period in Weeks								
Hours run per day	1 to 250 rpm	251 to 500 rpm	501 to 750 rpm	751 to 1000 rpm	1001 to 1500 rpm	1501 to 2000 rpm	2001 to 2500 rpm	2501 to 3000 rpm
8	12	12	10	7	5	4	3	2
16	12	7	5	4	2	2	2	1
24	10	5	3	2	1	1	1	1

OPERATING TEMPERATURES

Abnormal bearing temperatures may indicate insufficient lubrication. If the housing is too hot to touch for more than a few seconds, check the temperature by applying a thermometer at the top of the pillow block with the thermometer tip surrounded by putty.

Because the thermometer reading will be approximately 10°F lower than the actual bearing temperature, add ten degrees to the reading and compare to the temperature rating of your grease. If the bearing temperature reading is consistent and operating within the recommended limits of your grease, the bearing is operating satisfactorily.

The recommended maximum operating temperature for S-2000 Spherical Roller Bearings is 200 °F.

STORAGE OR SPECIAL SHUT DOWN

If equipment will be idle for some time, before shutting down, add grease to the bearing until grease purges from the seals. This will ensure protection of the bearing, particularly when exposed to severe environmental conditions. After storage or idle period, add fresh grease to the bearing before starting.

SET SCREW TORQUE TABLE

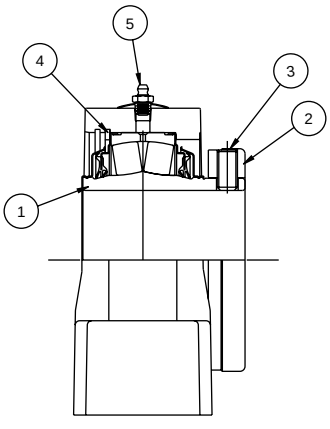
Shaft Size	Socket Set Screw Size	Tightening Torque
$1\frac{3}{8}$ - $1\frac{3}{4}$ inches	$\frac{5}{16}$ inches	165 Inch Pounds
$1\frac{15}{16}$ - $2\frac{7}{16}$ inches	$\frac{3}{8}$ inches	290 Inch Pounds
$2\frac{11}{16}$ - $3\frac{7}{16}$ inches	$\frac{1}{2}$ inches	620 Inch Pounds
$3\frac{15}{16}$ - $4\frac{15}{16}$ inches	$\frac{5}{8}$ inches	1325 Inch Pounds

RECOMMENDED SHAFT TOLERANCE TABLE

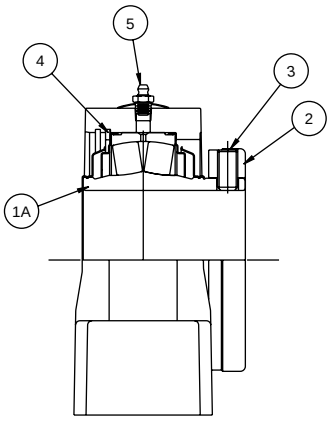
Normal Shaft Size	Low to Normal Equivalent Load and Catalog Speed*	
Up to $1\frac{1}{2}$ inches	+.000 inches	–.0005 inches
Over $1\frac{1}{2}$ to $2\frac{1}{2}$ inches	+.000 inches	–.001 inches
Over $2\frac{1}{2}$ to 4 inches	+.000 inches	–.001 inches
Over 4 to 5 inches	+.000 inches	–.0015 inches

On severe applications and where dynamic balance and minimum runout are important, a snug to light press fit may be required to obtain optimum bearing performance. Consult factory.

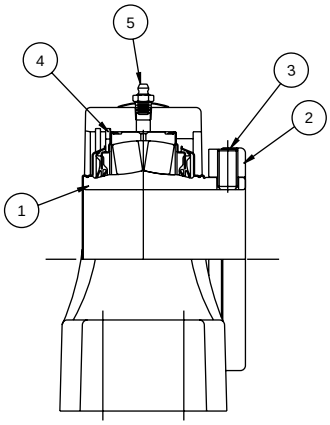
*Normal equivalent load .08C to .18C.



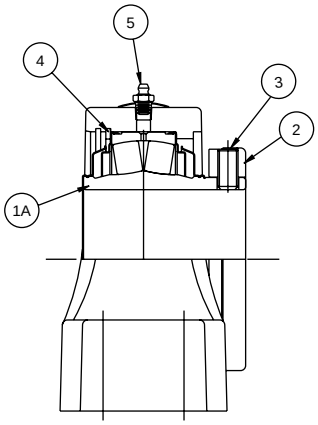
2 BOLT PILLOW
BLOCK S2000-R



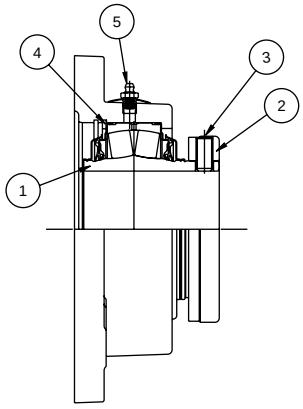
2 BOLT PILLOW
BLOCK S2000-L



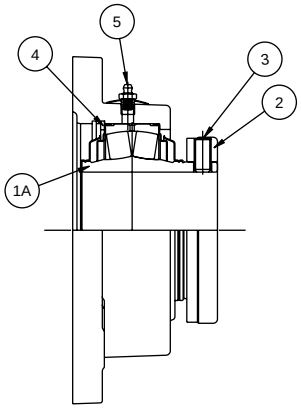
4 BOLT PILLOW
BLOCK S2000-R



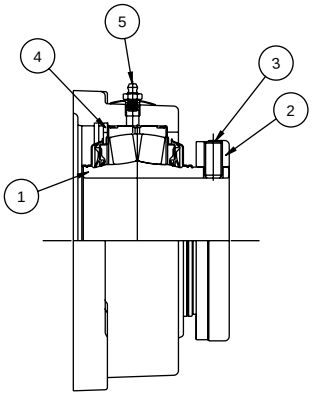
4 BOLT PILLOW
BLOCK S2000-L



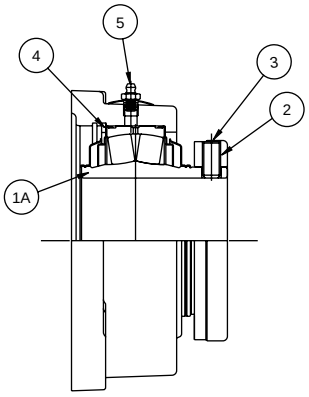
3 & 4 BOLT ROUND
FLANGE S2000-R



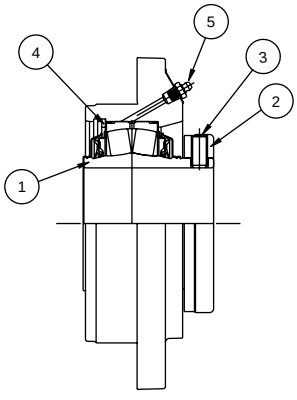
3 & 4 BOLT ROUND
FLANGE S2000-L



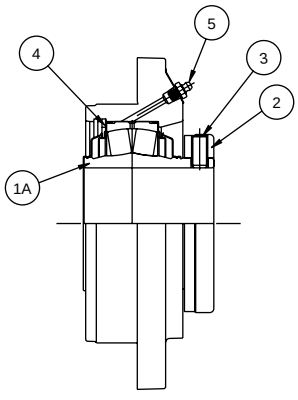
4 BOLT SQUARE
FLANGE S2000-R



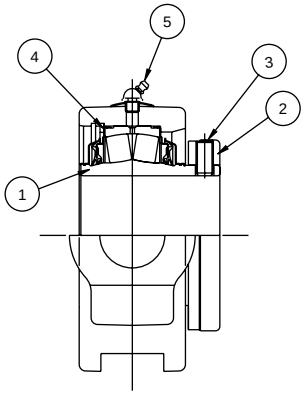
4 BOLT SQUARE
FLANGE S2000-L



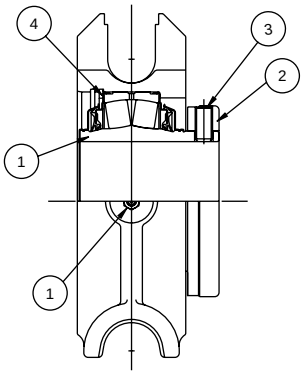
PILOTED FLANGE
S2000-R



PILOTED FLANGE
S2000-L



WIDE SLOT TAKE-UP
S2000-R



TPHU TAKE-UP
S2000-R

COMPONENT PART NUMBERS (1 3/8" - 4 15/16")

ITEM	1	1A	2	3	4	5
Shaft Size Size	Bearing Insert Assembly (R) Seal	Bearing Insert Assembly (L) Seal	* Collar	* Set Screw	Snap Ring	** Grease Fitting
1 3/8	070000	070016	040050	400058	069276	405015
1 7/16	070001	070017	040050	400058	069276	405015
1 1/2	070002	070018	040050	400058	069276	405015
1 11/16	070003	070019	040051	400058	069277	405015
1 3/4	070004	070020	040051	400058	069277	405015
1 15/16	070005	070021	070587	400094	069278	405015
2	070006	070022	070587	400094	069278	405015
2 3/16	070007	070023	070588	400094	069279	405015
2 7/16	070008	070024	040054	400094	069280	405015
2 11/16	070009	070025	070589	400150	069281	405015
2 15/16	070010	070026	070589	400150	069281	405015
3	070011	070027	070589	400150	069281	405015
3 7/16	070012	070028	040056	400154	069282	405015
3 15/16	070013	070029	060946	400186	069283	405015
4 7/16	070014	070030	* 060947	* 400186	069284	405015
4 15/16	070015	070031	* 040059	* 400190	069285	405015
QTY/PER	1	1	1	2	1	1

*Shaft sizes 4 7/16" - 4 15/16" have two collars a

** WSTU and TPHU TU take a 405016 grease fitting.

www.rockwellautomation.com **www.ptplace.com** **www.dodge-pt.com** **www.reliance.com** **www.ptplace.ca**

Corporate Headquarters
Rockwell Automation, 777 East Wisconsin Avenue, Suite 1400, Milwaukee, WI, 53202-5302 USA, Tel: (1) 414.212.5200, Fax: (1) 414.212.5201

Headquarters for Dodge and Reliance Electric Products
Americas: Rockwell Automation, 6040 Ponders Court, Greenville, SC 29615-4617 USA, Tel: (1) 864.297.4800, Fax: (1) 864.281.2433
Europe/Middle East/Africa: Rockwell Automation, Brühlstraße 22, D-74834 Elztal-Dallau, Germany, Tel: (49) 6261 9410, Fax: (49) 6261 17741
Asia Pacific: Rockwell Automation, 55 Newton Road, #11-01/02 Revenue House, Singapore 307987, Tel: (65) 6356-9077, Fax: (65) 6356-9011

Headquarters for Allen-Bradley Products, Rockwell Software Products and Global Manufacturing Solutions
Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation SA/NV, Vorstlaan/Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, 27/F Citicorp Centre, 18 Whitfield Road, Causeway Bay, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

02/04 16M-K

IM499330