



AIR COOLED EXCHANGERS, INC.

P.O. BOX 577 - BROKEN ARROW, OKLAHOMA 74013

Ph (918) 251-7477

Fax (918) 258-1833

E-MAIL: MAILHUB@ACE-COOLERS.COM

COOLER PERFORMANCE SPECIFICATION

CUSTOMER	TOROMONT	PROPOSAL NUMBER	05322R2.dat
REFERENCE	11957	DATE	12/1/2005
MODEL	E108-15	PAGE	1

PERFORMANCE OF ONE UNIT

SERVICE	AC-100	AC-102
FLOW	4785.50#/HR	567.0#/HR
FLUID	1.516	HC LIQ
TEMPERATURE IN, F	162.0	252.4
TEMPERATURE OUT, F	110.0	120.0
INLET PRESSURE, PSIA	225.9	255.0
PRESSURE DROP, PSI	0.2	0.2
DUTY, BTU/HOUR	739300	48570
CORRECTED MTD	14.2	67.6
BARE TUBE RATE	85.5	22.9
FOULING	0.00100	0.00100
BARE SURFACE, SQ. FT.	608	31
TOTAL SURFACE SQ. FT.	14536	499

CONSTRUCTION

NO. SECTIONS	1	1
NO. TUBES/SECTION	210	13
LENGTH	15.0	15.0
NO. ROWS	4	3
NO. PASSES	4	4
COUNTERFLOW	YES	
TUBE O.D. AND BWG	.75X16BWG	5/8X16BWG
TUBE MATERIAL	SA214(WLD)	SA214(WLD)
DESIGN PRESSURE, PSI	300	400
DESIGN TEMPERATURE, F	300/-20	400/-20
NOZZLES-INLET	3-300RF	1-300RF
NOZZLES-OUTLET	3-300RF	1-300RF
HEADER TYPE	BOX W/PLUGS	BOX W/PLUGS
HEADER MATERIAL	SA-516-70 NORM	SA-516-70 NORM
ASME CODE STAMP	YES W/NB	YES W/NB
GROOVED TUBE SHEET	YES	YES
CORROSION ALLOWANCE	0.063	0.063
PLUGS, TYPE	SHOULDER	SHOULDER
PLUGS, MATERIAL	SA-105	SA-105
TURBULATORS		
ACCELERATORS		
LOUVERS	MANUAL	MANUAL
STRESS RELIEVE	NO	NO
NDE	BUTT WELDS	BUTT WELDS
ADDITIONAL CODES		
CANADIAN REGISTRATION	AB	AB
ADDITIONAL COUPLINGS		
BYPASS NOZZLE		
FINS	HYPERF MARINE	HYPERF MARINE

AIR DATA

INLET AIR, F	95.0	ELEVATION, FT.	2500
OUTLET AIR, F	103.4	TOTAL SCFM	86716

MECHANICAL EQUIPMENT

NO FANS	1	HP/FAN	17.0	RPM	389	DIA	108
FAN	MOORE SERIES 30	FAN MATERIAL	ALUM	NUMBER OF BLADES	6	PITCH	17 DEGREES
V-belt drive by (1) 20 HP 1800 rpm 460/3/60 EXP electric motor							
DRAFT TYPE	FORCED						
EST SHIPPING WEIGHT	10481	WIDTH	9.9	LENGTH	16.0	HEIGHT	8.6
ACCESSORIES	HAILGUARD. BUGSCREEN. MURPHY XP VIB. SWITCH						
FINISH ACE std prep. w/ one precoat and one finish coat of ACE std enamel Tinted To TOROMONT GRAY SLX-1260-01 Color							
NOISE: 85dBA@1M BELOW/79dBA@1M BESIDE/64dBA@15M, Minimum 10% Excess Surface							

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

1. Manufactured and certified by Air Cooled Exchangers, Inc. 1201 South 9th Broken Arrow, Oklahoma 74012
(Name and address of manufacturer)

2. Manufactured for TOROMONT PROCESS SYSTEMS (USA) 10815 TELGE ROAD HOUSTON, TX 77095
(Name and address of purchaser)

3. Location of installation Unknown
(Name and address)

4. Type Horiz 0532201-1 T4487.2 05322-H1 3613 2005
(Horiz. or vert., tank) (Mfg'r's serial No.) (CRN) (Drawing No.) (Nat'l. Bd. No.) (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 2004
Year

to N.A. None None
Addenda (Date) Code Case Nos. Special Service per UG-120(d)

6. Tube & Plug: SA-516-GR-70 0.750 0.063 4.375 IN. 8 IN.
Mat'l. (Spec. No., Grade) Nom. Thk. (in.) Corr. Allow (in.) Diam. I.D. (ft. & in.) Length (overall) (ft. & in.)

7. Seams: Single Bevel N.A. N.A. N.A. N.A. N.A. N.A. N.A. N.A.
Long. RT (Spot or Full) Eff. (%) H.T. Temp. (°F) Time (hr) Girth (Welded, Dbl. Sngl. Lap, Butt) R.T. (Spot, Partial, or Full) No. of Courses

8. Heads: (a) Mat'l. SA-516-GR-70 (b) Mat'l. SA-516-GR-70
(Spec. No., Grade) (Spec. No., Grade)

	Location Top, Bottom, End	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure
(a)	Top/Bottom	0.5 IN.	0.0625 IN.	N.A.	N.A.	N.A.	N.A.	N.A.	4 IN.	N.A.
(b)	Ends	0.5 IN.	0.0625 IN.	N.A.	N.A.	N.A.	N.A.	N.A.	4 IN.	N.A.

If removable, bolts used (describe other fastenings) _____

(Mat'l., Spec. No., Gr., Size, No.)

9. MAWP 400 psi at max. temp. 400 °F
 Min. design metal temp. -20 °F at 400 psi at max temp psi Hydro test pressure 520 psi.

10. Nozzles, inspection and safety valve openings: Safety Relief Valves to be provided elsewhere by others

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Mat'l.	Nom. Thk.	Reinforce Mat'l.	How Attached	Location
In/Outlet	1	1 in.	Pipe	SA-106-GR B	0.25 in.	Mat&Weld	UW16.1(a)	
	1	1 in.	RFWN	SA-105	300RF	Mat&Weld	Welded	
	1	1 in.	Pipe	SA-106-GR B	0.25 in.	Mat&Weld	UW16.1(a)	
	1	1 in.	RFWN	SA-105	300RF	Mat&Weld	Welded	

11. Supports: Skirt NO Lugs 2 Legs 0 Other N.A. Attached Tubesheet/Welded
(Yes or no) (No.) (No.) (Describe) (Where and how)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned inspectors have been furnished for the following items of the report: Constructed in conformance w/ Appendix 28, IMPACT EXEMPT PER UG-20(F)(1)(b) Vessel volume .4 CuFt
(Name of part, item number, Mfg'r's. name and identifying stamp)

Tubes: (13) SA214(WLD) X 0.625" OD X 0.06" MW X 15ft long Straight Type
 100% RT NO: (26) SA-105 SHOULDER

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME Code for Pressure Vessels, Section VIII, Division 1. "U" Certificate of Authorization No. 7618 expires 11/30/2008
 Date 11-7-05 Co. name Air Cooled Exchangers, Inc. Signed [Signature]
(Manufacturer) (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by Air Cooled Exchangers, Inc. at 1201 S. 9th St Broken Arrow, Oklahoma 74012
 I the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of Oklahoma and employed by OneBeacon America Insurance Co. Boston, Mass.
 have inspected the component described in this Manufacturer's Data Report on 11-28-05, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.
 Date 11-28-05 Signed [Signature] Commission NB 11921AB OK823
(Authorized Inspector) (Nat'l Board (incl. endorsements), State, and No.)

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(Alternative Form for Single Chamber, Completely Shop or Field Fabricated Vessels Only)
As Required by the Provisions of the ASME Code Rules, Section VIII, Division 1

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2. Manufactured for TOROMONT PROCESS SYSTEMS (USA) 10815 TELGE ROAD HOUSTON, TX 77095
(Name and address of purchaser)

3. Location of installation Unknown
(Name and address)

4. Type Horiz 0532201-2 T4488.2 05322-H2 3614 2005
(Horiz. or vert., tank) (Mfg'r's serial No.) (CRN) (Drawing No.) (Nat'l. Bd. No.) (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 2004
Year

to N.A. None None
Addenda (Date) Code Case Nos. Special Service per UG-120(d)

6. Tube & Plug: SA-516-GR-70 0.875 0.063 7.25 IN. 106.5 IN.
Mat'l. (Spec. No., Grade) Nom. Thk. (in.) Corr. Allow. (in.) Diam. I.D. (ft. & in.) Length (overall) (ft. & in.)

7. Seams: Single Bevel N.A. N.A. N.A. N.A. N.A. N.A. N.A. N.A.
Long. RT (spot or Full) Eff. (%) H.T. Temp. (°F) Time (hr) Girth (Welded, Dbl. Sngl. Lap. Butt) R.T. (Spot, Partial, or Full) No. of Courses

8. Heads: (a) Mat'l. SA-516-GR-70 (b) Mat'l. SA-516-GR-70
(Spec. No., Grade) (Spec. No., Grade)

	Location Top, Bottom, End	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure
(a)	Top/Bottom	0.5 IN.	0.0625 IN.	N.A.	N.A.	N.A.	N.A.	N.A.	4 IN.	N.A.
(b)	Ends	0.5 IN.	0.0625 IN.	N.A.	N.A.	N.A.	N.A.	N.A.	4 IN.	N.A.

If removable, bolts used (describe other fastenings) _____
(Mat'l., Spec. No., Gr., Size, No.)

9. MAWP 300 psi at max. temp. 300 °F
 Min. design metal temp. -20 °F at 300 psi at max temp psi Hydro test pressure 390 psi.

10. Nozzles, inspection and safety valve openings: Safety Relief Valves to be provided elsewhere by others

Purpose (Inlet, Outlet, Drain)	No.	Diam. or Size	Type	Mat'l.	Nom. Thk.	Reinforce Mat'l.	How Attached	Location
In/Outlet	1	3 in.	Pipe	SA-106-GR B	0.3 in.	Mat&Weld	UW16.1(a)	
	1	3 in.	RFWN	SA-105	300RF	Mat&Weld	Welded	
	1	3 in.	Pipe	SA-106-GR B	0.3 in.	Mat&Weld	UW16.1(a)	
	1	3 in.	RFWN	SA-105	300RF	Mat&Weld	Welded	

11. Supports: Skirt NO Lugs 2 Legs 0 Other N.A. Attached Tubesheet/Welded
(Yes or no) (No.) (No.) (Describe) (Where and how)

12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned inspectors have been furnished for the following items of the report: Constructed in conformance w/ Appendix 28, IMPACT EXEMPT PER UG-20(F)(1)(b) Vessel volume 10.6 CuFt
(Name of part, item number, Mfg'r's. name and identifying stamp)

Tubes: (210) SA214(WLD) X 0.75" OD X 0.06" MW X 15ft long Straight Type
 100% RT NO: (420) SA-105 SHOULDER

CERTIFICATE OF SHOP/FIELD COMPLIANCE

We certify that the statements made in this report are correct and that all details of design, material, construction, and workmanship of this vessel conform to the ASME Code for Pressure Vessels, Section VIII, Division 1. "U" Certificate of Authorization No. 7816 expires 1/30/2008
 Date 11-7-05 Co. name Air Cooled Exchangers, Inc. Signed [Signature]
(Manufacturer) (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by Air Cooled Exchangers, Inc. at 1201 S. 9th St Broken Arrow, Oklahoma 74012
 I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State or Province of Oklahoma and employed by OneBeacon America Insurance Co. Boston, Mass.
 have inspected the component described in this Manufacturer's Data Report on 11-28-05, and state that, to the best of my knowledge and belief, the Manufacturer has constructed this pressure vessel in accordance with ASME Code, Section VIII, Division 1. By signing this certificate neither the inspector nor his employer makes any warranty, expressed or implied, concerning the pressure vessel described in this Manufacturer's Data Report. Furthermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or a loss of any kind arising from or connected with this inspection.
 Date 11-28-05 Signed [Signature] Commission NB11921AB OK823
(Authorized Inspector) (Nat'l Board (incl. endorsements), State, and No.)

Parts List



Air Cooled Exchangers, Inc.

1201 S. 9th Street
 Broken Arrow, Oklahoma 74012
 Phone: 918-251-7477
 Fax: 918-251-7482

Customer: TOROMONT

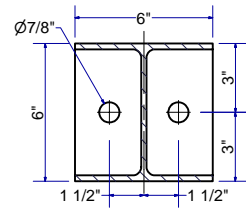
ACE Serial Number(s): 0532201-02

Cooler Model: E108-15

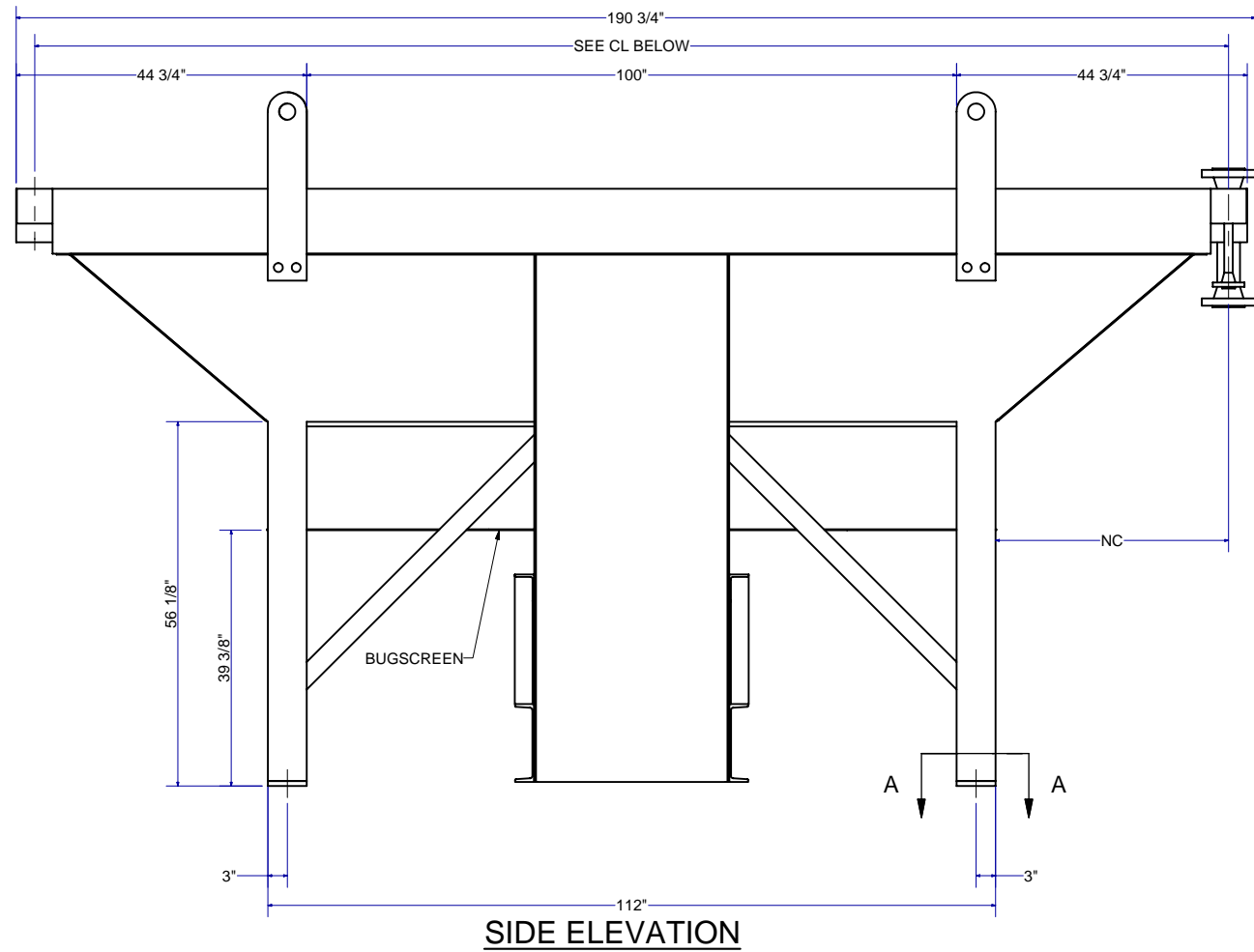
Fan Make & Model	1	9 Dia.	6 Blades	17 deg. Pitch at	CLEVIS	Fan RPM: 389
MOORE 30 HDVT		LEFT HAND	1.9375 Bore with	STD Keyway	Special Note:	
Fan Shaft	1	1.9375 Dia.	42.33 Long with	4.25 in Keyway Fan end	6 in Keyway other end	
### ##						
Idler Shaft		0 Dia.	0 Long with	Keyway one end		
Fan Bearing ##	2	1.9375 in REXNORD MODEL ZA-2115				
Idler Bearing	0	0				
Electric Motor	1	20 HP	1800 RPM	460 Volt	3 Phase	60 Cycle
		XP Enclosure	256T Frame Size	WITH	SlideBase	
		0				
Motor Sheave	1	6.3 O.D.	5V Type	2 Groove	1.6250 Bore	
Fan Sheave	1	28.0 O.D.	5V Type	2 Groove	1.9375 Bore	
V-Belts	2	VB5VX1000				
Vibration Switch	0	MURPHY XP VIBRATION SWITCH				
LOUVER FOR AC-100	0	180 IN X 106.75 IN ALUMINUM MANUAL				
LOUVER FOR AC-102	0	180 IN X 8.25 IN ALUMINUM MANUAL				

FAN, SHAFT, BEARINGS & V-BELTS ARE RECOMMENDED SPARE PARTS.

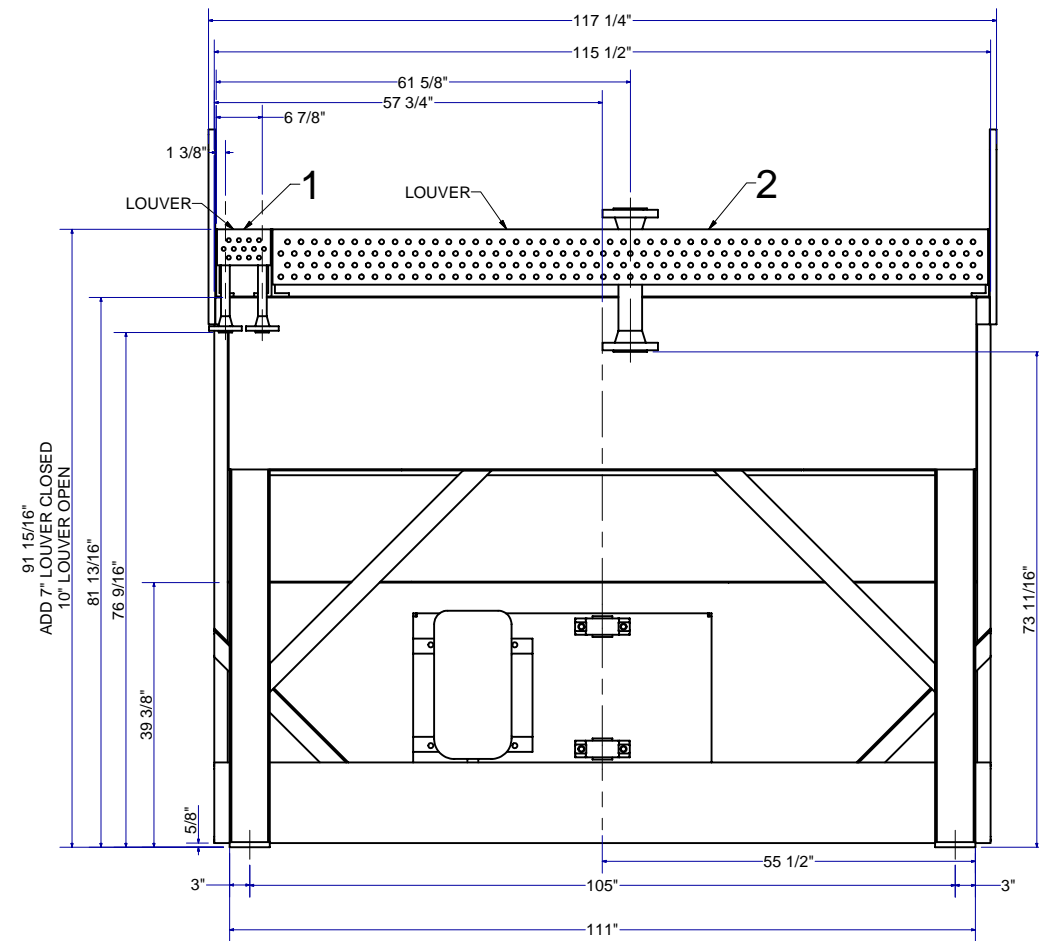
ALL INQUIRIES AND ORDERS MUST BE ACCOMPANIED BY COOLER SERIAL NUMBER.



SECTION A-A
(4 PLACES)



SIDE ELEVATION



END ELEVATION

RPM= 389
HP= 17
BLADE ANGLE= 17

UNIT: 0532201-02
TAG: 11957-11958
JOB: 05322

NOTES

- WEIGHT: 10412 POUNDS
- FINISH: PRECOAT AND FINISH COAT OF TOROMONT GRAY SLX-1260-01
- ASME CODE ON AC-100,AC-102, WITH CRN'S FOR ALBERTA
- HAILGUARD,BUGSCREEN

FLAG	SERVICE	CL	LOUVERS	DESIGN PRESSURE	DESIGN TEMPERATURE	NOZZLES IN	NOZZLES OUT	OTHER NOZZLE	NC
1	AC-102	183.75	MANUAL	400 PSI	400 Deg F/-20 Deg F	(1)1-300RF	(1)1-300RF	N/A	35.875
2	AC-100	183.75	MANUAL	300 PSI	300 Deg F/-20 Deg F	(1)3-300RF	(1)3-300RF	N/A	35.875

ACE AIR COOLED EXCHANGERS, INC.

SCALE: 1:1 (FIT TO PLOT)
DATE: 8/30/2005

ACE MODEL E108-115-15

CUSTOMER: TOROMONT

DRAWN BY: AID / DB
CHECKED BY: KWL

P.O: PON188349

BY	DATE	DESCRIPTION	CK'D	DRAWING NUMBER	REV
				05322	-C 0



AIR COOLED EXCHANGERS, INC.
ELECTRIC MOTOR TEST DATA

TEST DATE 11-30-05

JOB NO. 0532201

APPROXIMATE AIR TEMP°F 60

FAN DESCRIPTION

MODEL MOORE-30HOUT-6BL.

ANGLE 17°

LH RH LH

	MOTOR 1	MOTOR 2	MOTOR 3	MOTOR 4
MOTOR MAKE	EMERSON			
MOTOR SERIAL NO.	J01AG25M504 014			
MOTOR HP	20			
MOTOR FULL LOAD AMPS	24.4			
ACTUAL VOLTAGE	495			
MOTOR VOLTAGE	460			
ACTUAL AMPS	22.8			
HERTZ	60			
FAN RPM (DESIGN)	389			
FAN RPM (ACTUAL)	N/A			

TESTED BY Marty Winters



AIR COOLED EXCHANGERS, INC.

ELECTRIC MOTOR TEST DATA

TEST DATE 11-30-05

JOB NO. 0532202

APPROXIMATE AIR TEMP °F 60°

FAN DESCRIPTION

MODEL 1100RE-30HPAUT-LBL
 ANGLE 17°
 LH RH LH

	MOTOR 1	MOTOR 2	MOTOR 3	MOTOR 4
MOTOR MAKE	EMERSON			
MOTOR SERIAL NO.	J01A625MS	04015		
MOTOR HP	20			
MOTOR FULL LOAD AMPS	24.4			
ACTUAL VOLTAGE	495			
MOTOR VOLTAGE	460			
ACTUAL AMPS	23.4			
HERTZ	60			
FAN RPM (DESIGN)	389			
FAN RPM (ACTUAL)	N/A			

TESTED BY Marty Winters

OPERATING AND MAINTENANCE INSTRUCTIONS FOR ACE COOLERS

IMPORTANT

Before start up, check set screws and bolts in the fan assembly and set screws in locking collars of all bearings and sheaves. These items should be checked again several days after start up.

FAN & DRIVE

Although the fan and drive are inspected before shipment, clearance between the fan blades and the fan ring and guard, and alignment of the fan shaft should be checked to assure that rough handling during shipment has not loosened bearing mounting bolts or caused misalignment.

V-belt drives should be adjusted until tight enough to prevent excessive belt slippage. The belt is generally tight enough when it can be twisted one-quarter of a turn with the thumb and fore-finger.

LUBRICATION

Bearings should be greased in accordance with normal maintenance practice. Over-lubrication is the most common cause of bearing failure. In general, about one cubic inch of grease in each bearing every 2 to 3 months is adequate. The operating temperature of the bearing may indicate how much lubrication is required.

Normal temperature may range from “cool to warm to touch” up to a point “too hot to touch for more than a few seconds” depending on bearing size and speed, and surrounding conditions. Unusually high temperature accompanied by excessive leakage of grease indicates too much grease. High temperature with no grease showing at the seals, particularly if the bearing seems noisy, usually indicates too little grease. Normal temperature and slight showing of grease at the seals indicates proper lubrication.

TUBE CLEANING

Operating conditions sometimes cause an accumulation of dirt on the outside fin surface. This can be removed by directing compressed air, or a greaseless solvent followed by a water spray through the fins in a direction opposite the normal air flow. The inside of the tubes will require periodic inspection and cleaning as necessary. Removal of access plugs allows visual inspection, and if necessary, the use of mechanical tube cleaners.

PLUG LEAKS

Should tapered plugs develop leaks, additional tightening is normally all that is required. Thread dope may be used if tightening alone is not sufficient. If shoulder type plugs develop leaks, the gaskets should be replaced. Tapered plugs that are removed for the tube inspection or cleaning should be replaced in the same hole.

TUBE LEAKS

Tube leaks can be of two types: (1) leaks in the tubewall itself (usually corrosion) and (2) leaks in the tube to tubesheet joint. In the first case, it is usually most practical to plug both ends of the tube with the resulting loss in heat transfer surface. When so many tubes have been plugged that performance is affected, retubing will be necessary. If leaks develop in the tube to tubesheet joints, re-rolling of the tube will be required. Care must be used in selection of the proper tube expander for the size and BWG of the tube being used. As with all rolled tube joints, over-rolling must be avoided.

GENERAL

If it is ever necessary to contact our plant for service or replacement parts, it is essential that our serial number or other identifying data be obtained from the metal nameplate attached to the cooler. This is the only way to positively identify the correct parts that may be required.

Shock/Vibration Control Switches Installation Instructions

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

MURPHY

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

GENERAL INFORMATION

WARNING

BEFORE BEGINNING INSTALLATION OF THIS MURPHY PRODUCT

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



Model VS2EX

Description

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

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

Models

VS2: Base mount; non hazardous locations.

VS2C: C-clamp mount; non hazardous locations.

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

VS2EXR: Explosion-proof with remote reset.

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

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

Remote Reset Feature (VS2EXR, VS2EXRB and VS94 only)

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

-R15: Remote reset for 115 VAC

-R24: Remote reset for 24 VDC

Time Delay Option (VS94 only)

Overrides trip operation on start-up. For VS94 series models, the delay time is field-adjustable from 5 seconds up to 6-1/2 minutes with a 20-turn potentiometer (15 seconds per turn approximately). Options listed below:

-T15: Time delay for 115 VAC

-T24: Time delay for 24 VDC

Space Heater Options (VS94 only)

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

-H15: Space heater for 115 VAC

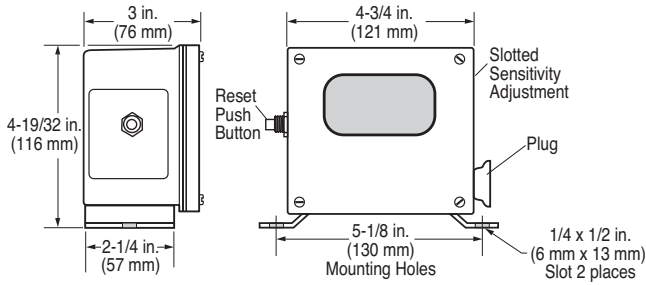
-H24: Space heater for 24 VDC

Warranty

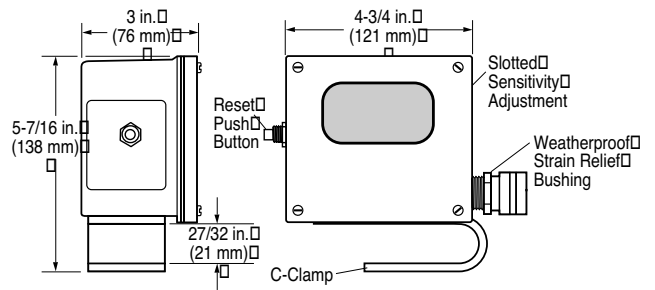
A limited warranty on materials and workmanship is given with this FW Murphy product. A copy of the warranty may be viewed or printed by going to www.fwmurphy.com/support/warranty.htm

DIMENSIONS

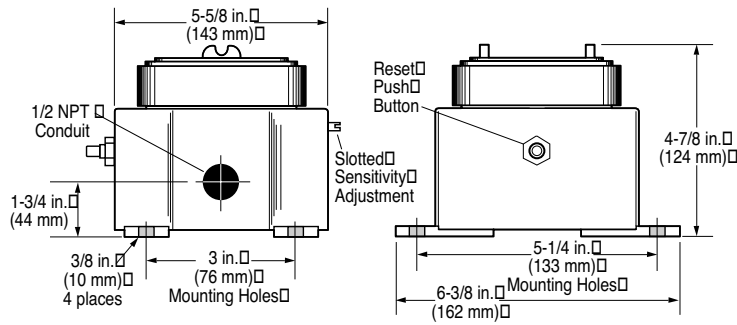
VS2



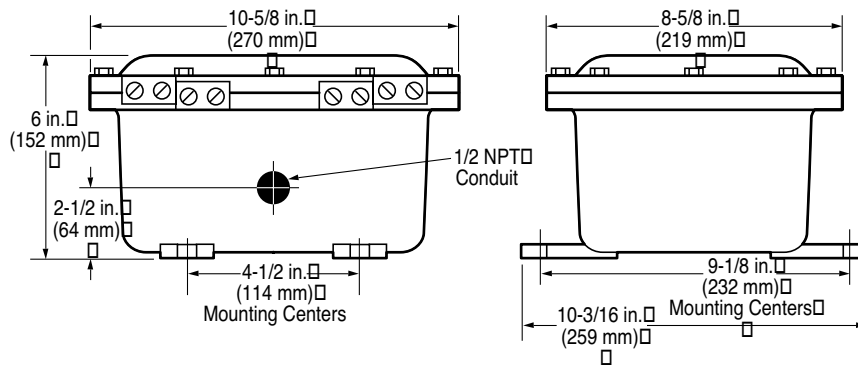
VS2C



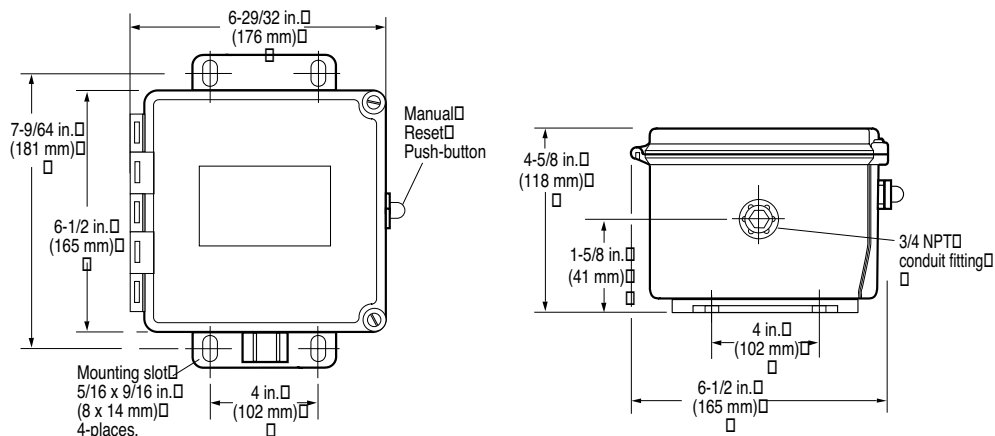
VS2EX and VS2EXR



VS2EXRB



VS94



SPECIFICATIONS

VS2 and VS2C

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

VS2EX

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

VS2EXR

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

<i>Option</i>	<i>Operating Current</i>
-R15:	350 mA @ 115 VAC
-R24:	350 mA @ 24 VDC
- **Range adjustment:** 0 - 7 G's; 0 - 100 Hz /0.100 in. displacement.
- **Normal Operating Temperature:** -40 to 140°F (-40 to 60°C).

VS2EXRB

- **Case:** Explosion-proof aluminum alloy housing; rated Class I, Division 1, Group B hazardous areas.
- **Snap-switch:** 1-SPDT snap-switch with reset coil (option available for

additional SPDT switch); 5A @ 480 VAC; 2A resistive, 1A inductive, up to 30 VDC.

Remote Reset:

Option Operating Current

- R15: 350 mA @ 115 VAC
- R24: 350 mA @ 24 VDC

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

VS94

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

<i>Option</i>	<i>Operating Current</i>
H15	.023 A @ 115 VAC
H24	.12 A @ 24 VDC
- **Remote Reset (optional):**

<i>Option</i>	<i>Operating Current</i>
R15	.17 A @ 115 VAC
R24	.36 A @ 24 VDC
- **Time Delay (optional):**

<i>Option</i>	<i>Operating Current</i>	<i>Standby Current</i>
T15	.360 A @ 115 VAC	.01 A @ 115 VAC
T24	1.15 A @ 24 VDC	.01 A @ 24 VDC
- **Time Delay/Remote Reset:** Adjustable 20-turn potentiometer from 5 seconds to 6-1/2 minutes (15 seconds per turn approximately).

*CSA and UL listed with 480 VAC rating.

INSTALLATION



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

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

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



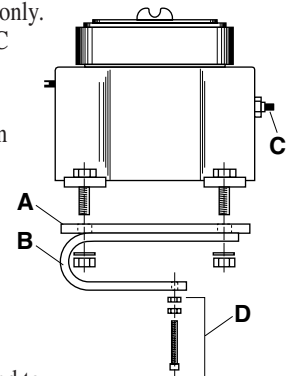
CAUTION: A dust boot is provided on the reset pushbutton for all series to prevent moisture or dust intrusion. The sensitivity adjustment for model VS2EX is not sealed; therefore, mounting

orientation should be on a horizontal plane or with the sensitivity adjustment pointing down. Sensitivity adjustment for model VS2 is covered by a plug. The plug must be in place and tight to prevent moisture or dust intrusion.

C-Clamp Installation (VS2C model only)

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

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



Continued on next page.

All Models



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

1. Firmly secure the unit to the equipment using the base foot mount or C-Clamp if applicable. See *C-Clamp Installation* page 3.
For oilwell pumpjacks attach the VS2 and VS94 Series to the Sampson post or walking beam. See *Typical Mounting Locations* page 5.
2. Make the necessary electrical connections to the vibration switch. See *Internal Switches*, page 6 for electrical terminal locations and page 7 for typical wiring diagrams. **DO NOT EXCEED VOLTAGE OR CURRENT RATINGS OF THE CONTACTS.** Follow appropriate electrical codes/methods when making electrical connections. Be sure that the run of electrical cable is secured to the machine and is well insulated from electrical shorting. Use of conduit is recommended.

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

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

Sensitivity Adjustment

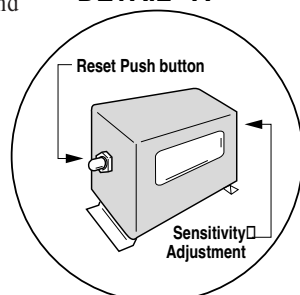


WARNING: REMOVE ALL POWER BEFORE OPENING THE ENCLOSURE. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON PERFORM ADJUSTMENTS, AND MAKE SURE IT CONFORMS WITH NEC AND LOCAL CODES. DO NOT ADJUST SENSITIVITY WHILE THE MACHINE IS RUNNING. STAND CLEAR OF THE MACHINE AT ALL TIMES WHEN IT IS OPERATING.

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

1. REPLACE ALL COVERS, LIDS, AND ELECTRICAL ENCLOSURES.
2. Press the reset push button to engage the magnetic latch. To be sure the magnetic latch has engaged, observe latch through the window on the VS2 and VS2C (see DETAIL “A”). On the VS2EX, VS94 series the reset button will remain depressed meaning the magnetic latch has engaged.
3. Start the machine.
4. If the instrument trips on start-up,

DETAIL “A”



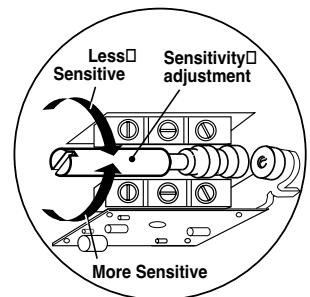
allow the machine to stop. Turn the sensitivity adjustment 1/4 turn clockwise, (adjustment for VS94 and VS2EXRB models is located within the box, see DETAIL “B”).



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

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

DETAIL “B”



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

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

VS94 Time Delay Adjustment

1. Apply power to the time delay circuit. (see page 7 for time delay circuit). The time delay function will be initiated.
2. Time the length of the delay with a watch. Let time delay expire. After it expires, the override circuit will de-energize the solenoid, allowing the latch arm to trip. A clicking noise is heard.



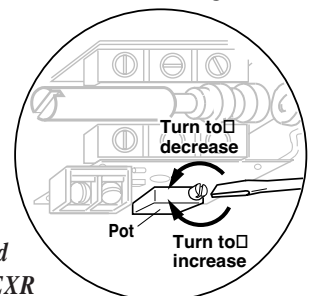
WARNING: REMOVE ALL POWER BEFORE OPENING ACCESS DOOR. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON ADJUST THE UNIT, AND MAKE SURE IT CONFORMS WITH NEC AND LOCAL CODES.

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

NOTE: Allow 30 seconds bleed-time between turning the power “OFF” and “ON”

4. Locate the time adjustment pot (DETAIL “C”). The time is factory-set at the lowest setting (5 seconds approximately). To increase time, rotate the 20-turn pot clockwise as needed (15 seconds per turn approximately).

DETAIL “C”



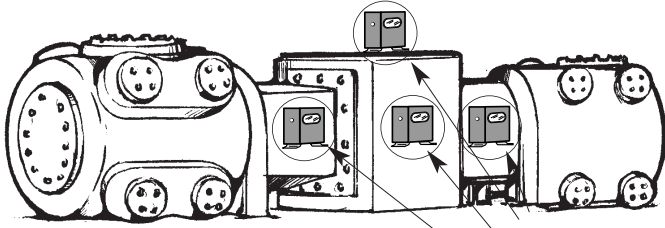
5. Repeat the above steps as necessary to obtain desired time delay.

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

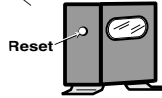
TYPICAL MOUNTING LOCATIONS

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

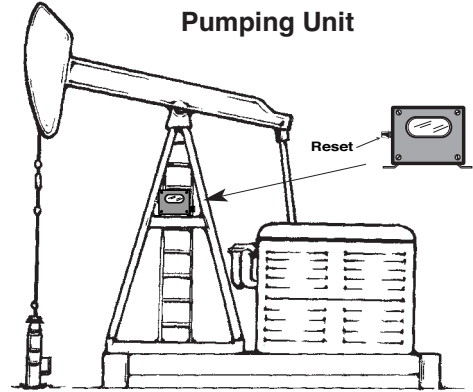
2-Throw Balance-Opposed Compressor



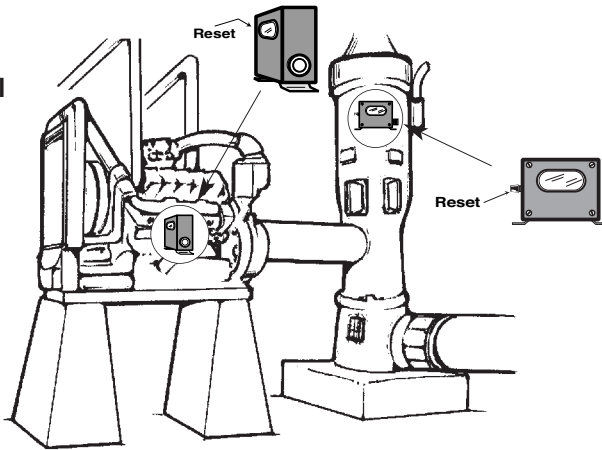
NOTE: If installing on cylinders, 2 vibration/shock switches are recommended- 1 for each cylinder.



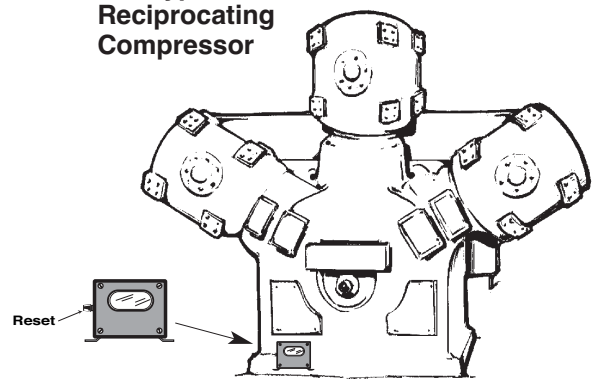
Pumping Unit



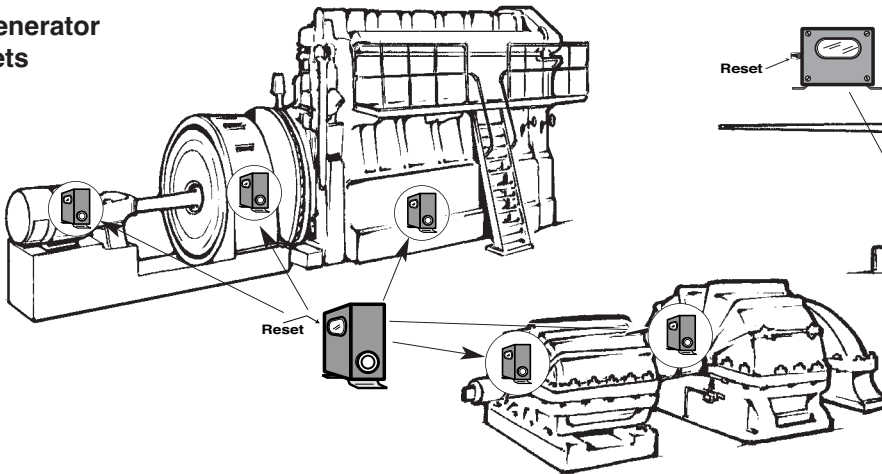
Engine and Vertical Shaft Pump



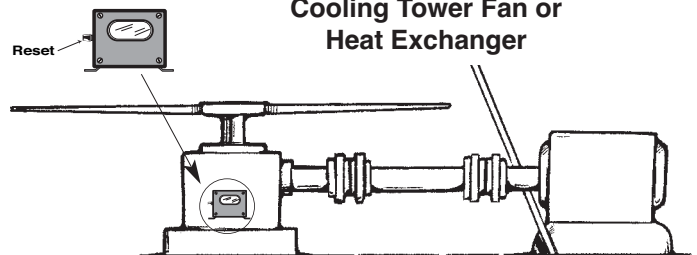
"Y" Type Reciprocating Compressor



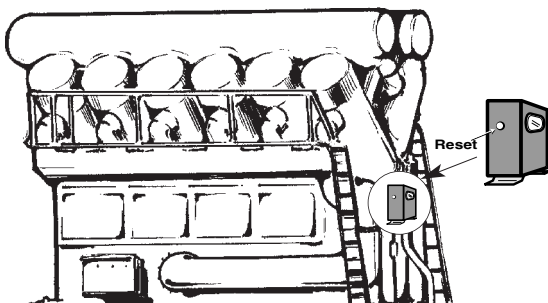
Generator Sets



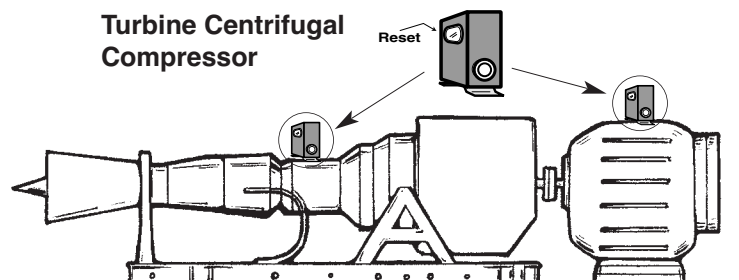
Cooling Tower Fan or Heat Exchanger



Engine Compressor

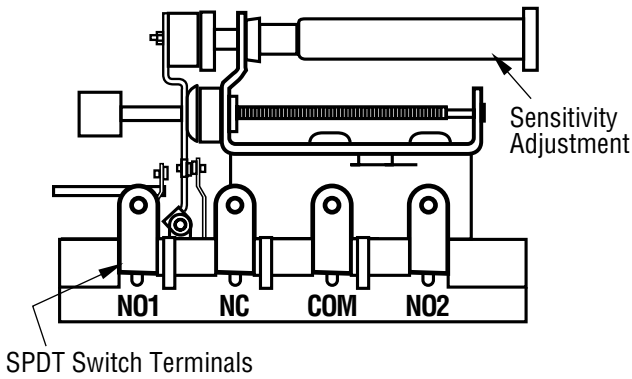


Turbine Centrifugal Compressor

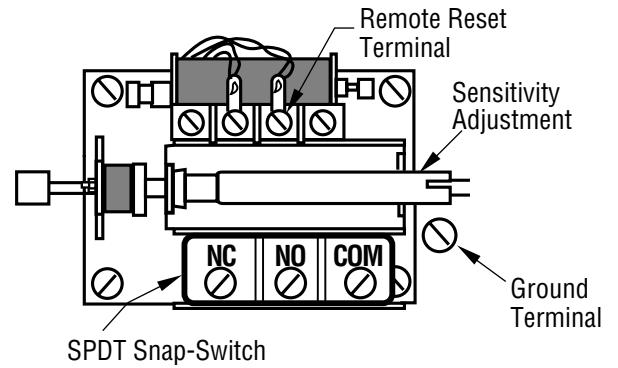


INTERNAL SWITCHES

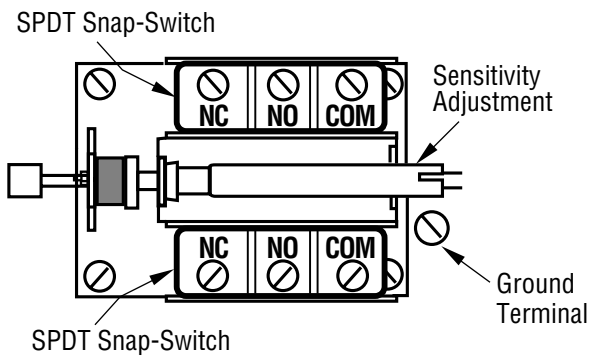
VS2 and VS2C



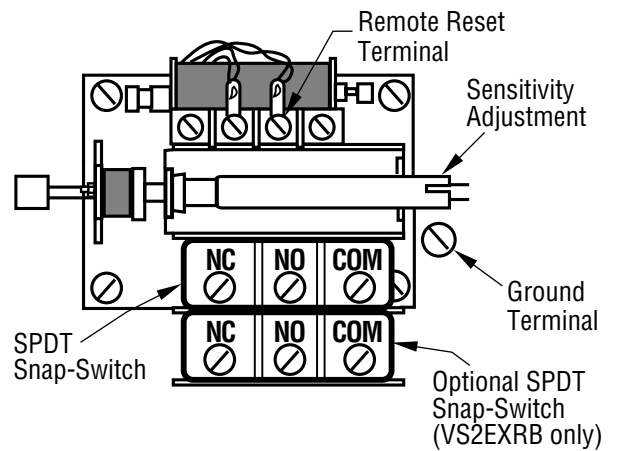
VS2EXR



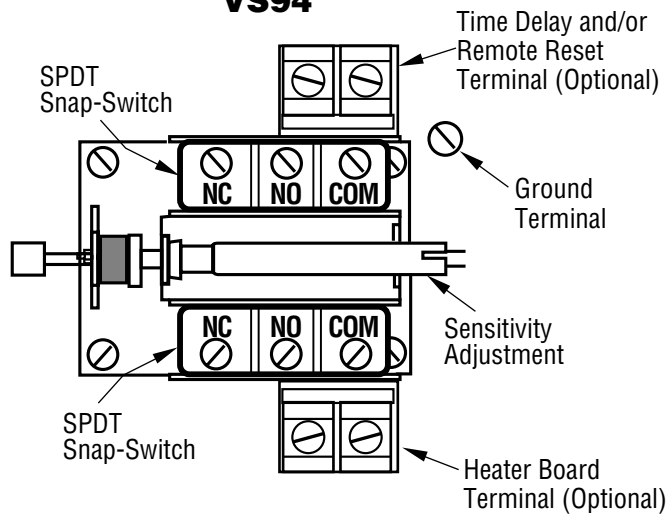
VS2EX



VS2EXB and VS2EXRB



VS94

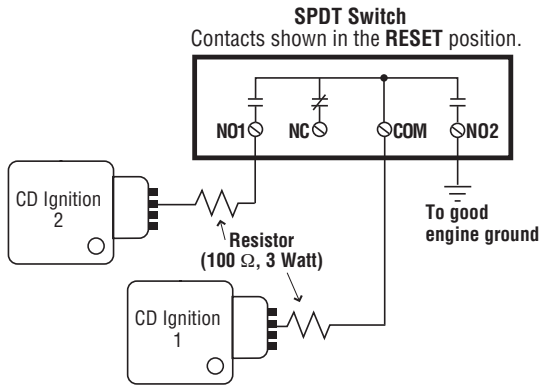


ELECTRICAL

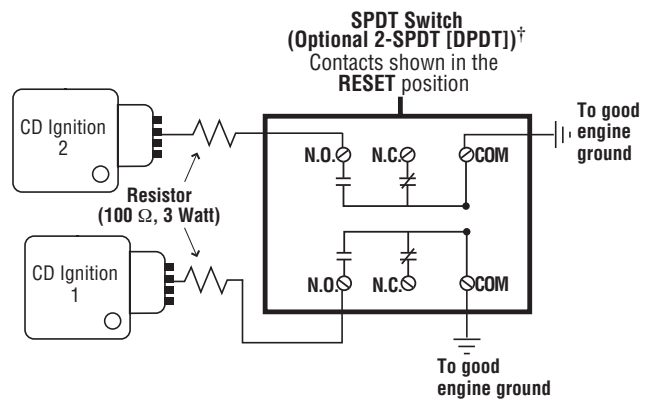


WARNING: REMOVE POWER BEFORE OPENING THE UNIT (ACCESS DOOR). STOP THE MACHINE AND DISCONNECT ALL ELECTRICAL POWER BEFORE BEGINNING THE WIRING OPERATION. IT IS YOUR RESPONSIBILITY TO HAVE A QUALIFIED PERSON INSTALL AND WIRE THE UNIT, AND MAKE SURE IT CONFORMS WITH NEC AND APPLICABLE CODES.

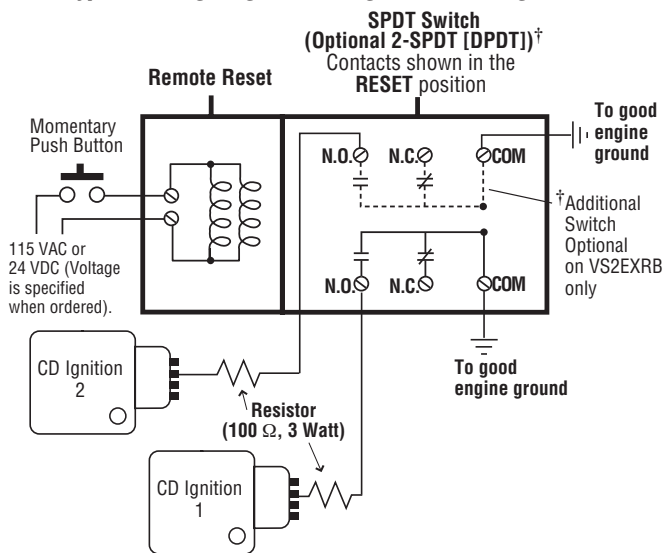
VS2 and VS2C Typical Wiring Diagram for Single or Dual CD Ignition



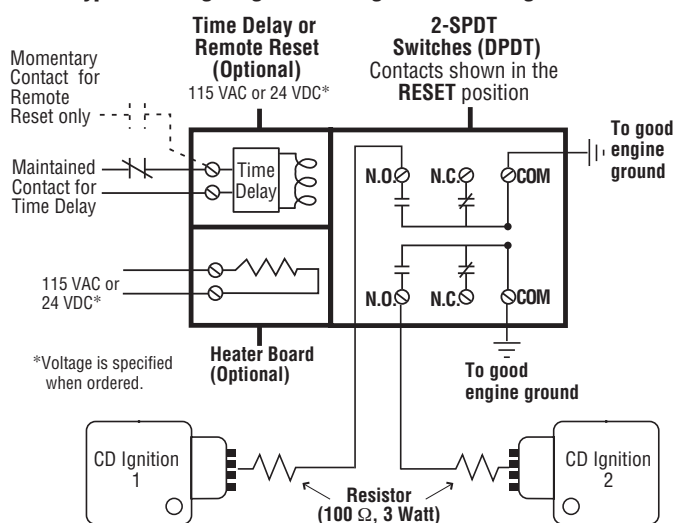
VS2EX Typical Wiring Diagram for Single or Dual CD Ignitions



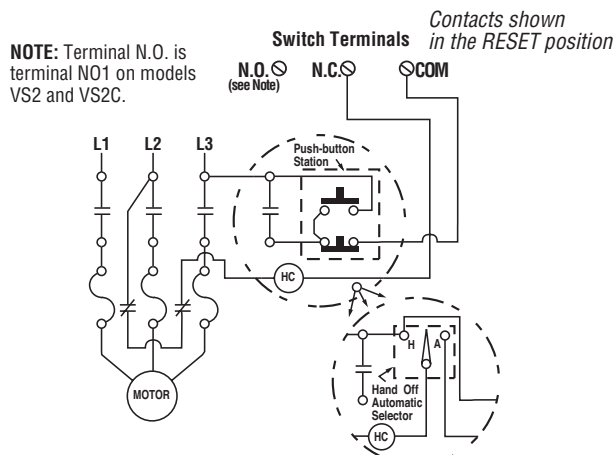
VS2EXR and VS2EXRB Typical Wiring Diagram for Single or Dual CD Ignitions



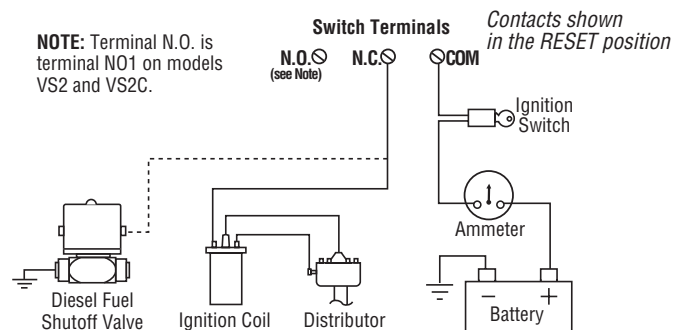
VS94 Typical Wiring Diagram for Single or Dual CD Ignitions



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



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



SERVICE PARTS

PART NO. DESCRIPTION

VS2

20000030 Movement assembly
 20000031 Glass and gasket assembly
 20000032 Reset push button assembly

VS2C

20000030 Movement assembly
 20000031 Glass and gasket assembly
 20000032 Reset push button assembly
 20050021 Mounting clamp
 20000185 VS2C 5-clamp hardware package assembly.
 20050465 2-Conductor electrical cable, 45 feet (13.7 meters)

VS2EX

20010091 Movement assembly
 20050087 Cover
 00000309 Cover gasket
 20010090 Snap-switch and insulator kit (1 switch per kit)
prior to September 1, 1995.*
20000288 Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.*
 20000289 C-clamp conversion mounting kit

VS2EXR

20000262 Movement assembly
 20050087 Cover
 00000309 Cover gasket
 20010090 Snap-switch and insulator kit (1 switch per kit)
prior to September 1, 1995.*
20000288 Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.*
 20000049 Reset solenoid assembly (115 VAC)
 20000234 Reset solenoid assembly (24 VDC)
 20000289 C-clamp conversion mounting kit

PART NO. DESCRIPTION

VS2EXRB

20010090 Snap-switch and insulator kit (1 switch per kit)
prior to September 1, 1995.*
20000288 Snap-switch and insulator kit (1 switch per kit) for models manufactured on September 1, 1995 or later.*
 20000057 *Inside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D **prior to September 1, 1995.***
 20000058 *Outside* snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D **prior to September 1, 1995.***
20000287 Outside snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D manufactured on September 1, 1995 or later.*
20000290 Inside snap-switch and insulator kit (1 switch per kit) for model VS2EXRB-D manufactured on September 1, 1995 or later.*
 20050077 Adjustment shaft
 20000262 Movement assembly
 20000049 Reset solenoid assembly (115 VAC)
 20000234 Reset solenoid assembly (24 VDC)

VS94 Series

25050506 Dust boot
 00000232 Conduit fitting
 20010090 Snap-switch and insulator kit (1 switch per assembly)
prior to September 1, 1995.**
20000288 Snap-switch and insulator kit (1 switch per assembly) for models manufactured on September 1, 1995 or later.***

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

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

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



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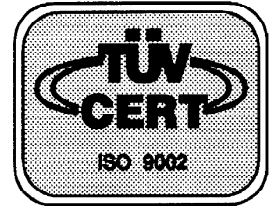
USA-ISO 9001:2000 FM 28221
 UK-ISO 9001:2000 FM 29422



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

Moore



Reg No. 12 100 6699

CLASS 10000 FANS

OWNER'S MANUAL

INSTALLATION

MAINTENANCE

OPERATION

ABOUT THIS MANUAL

The Moore Company 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 The Moore Company 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. Those unfamiliar with these units should read the short summary of these important features on the last page of this manual.

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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 The Moore Company 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.

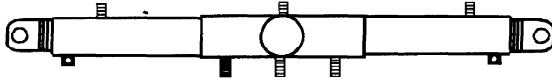
The Moore Company keeps records indexed by serial and job numbers of all fans produced for at least forty years in order to provide proper maintenance advice and information on spare parts and replacements.

2.1.2 PLANNING THE INSTALLATION

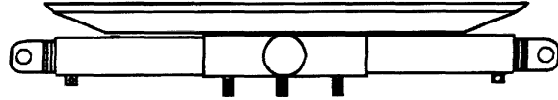
The sequence given for the installation may be changed if the conditions warrant. For example, the air seal may be installed on the hub before the hub is installed on the drive shaft. (In fact, for inverted fans, it is necessary to install the air seal first.) The installation should be planned before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

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.

2.2 INSTALL HUB AND AIR SEAL

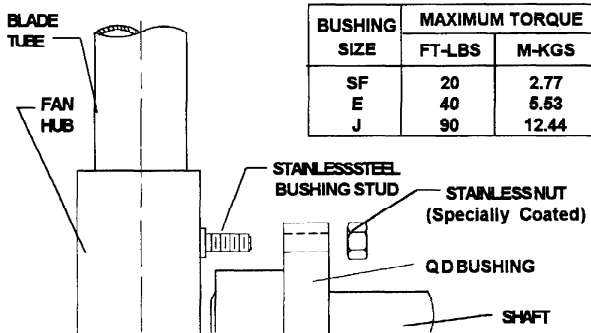


Hub Only Without Air Seal



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

HUB INSTALLATION ON QD BUSHING

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.

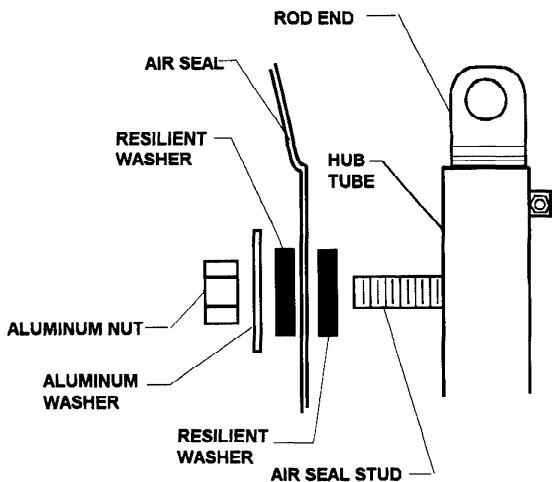
To install the airseal:

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.

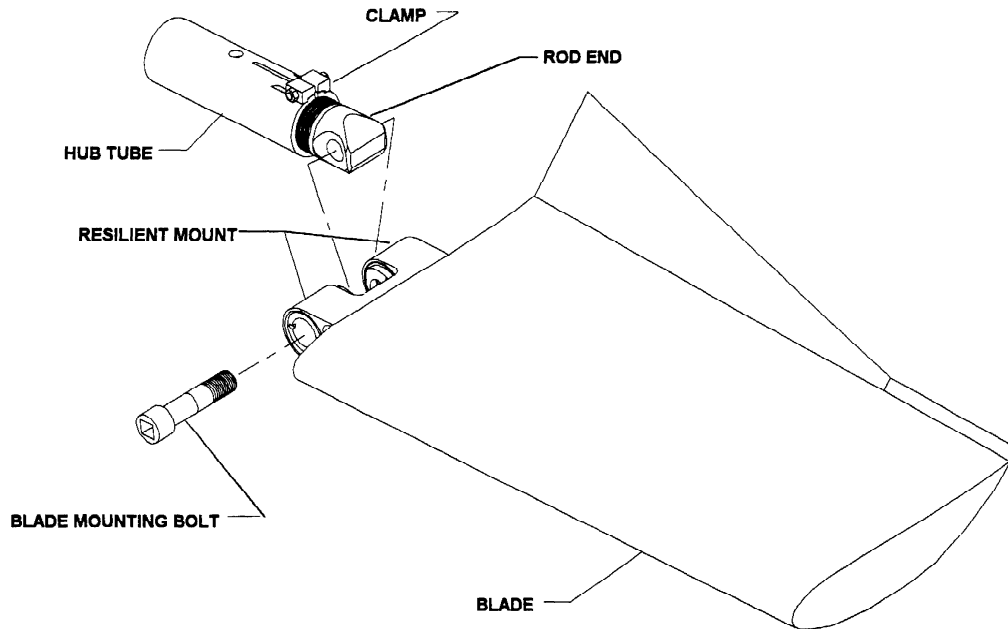


AIR SEAL INSTALLATION ON HUB

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 socket wrench with a short extension may be used.

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).**

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 blade tips 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).

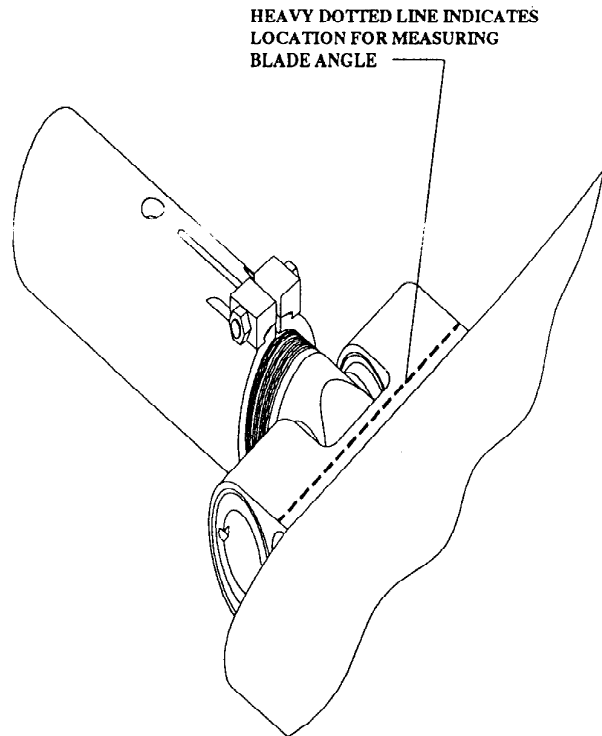
2.3.3 ADJUST BLADE ANGLE

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 angle is 24°.**

Retighten the Clamp Nut to 18 ft-lbs (3.36 m-kg). Re-check 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 (3.36m-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 frequently than inspection of the drive.

3.1.3 CHECK 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.

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 +/- .02 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 horsepower, 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 $30 \times 6 = 180$ 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.

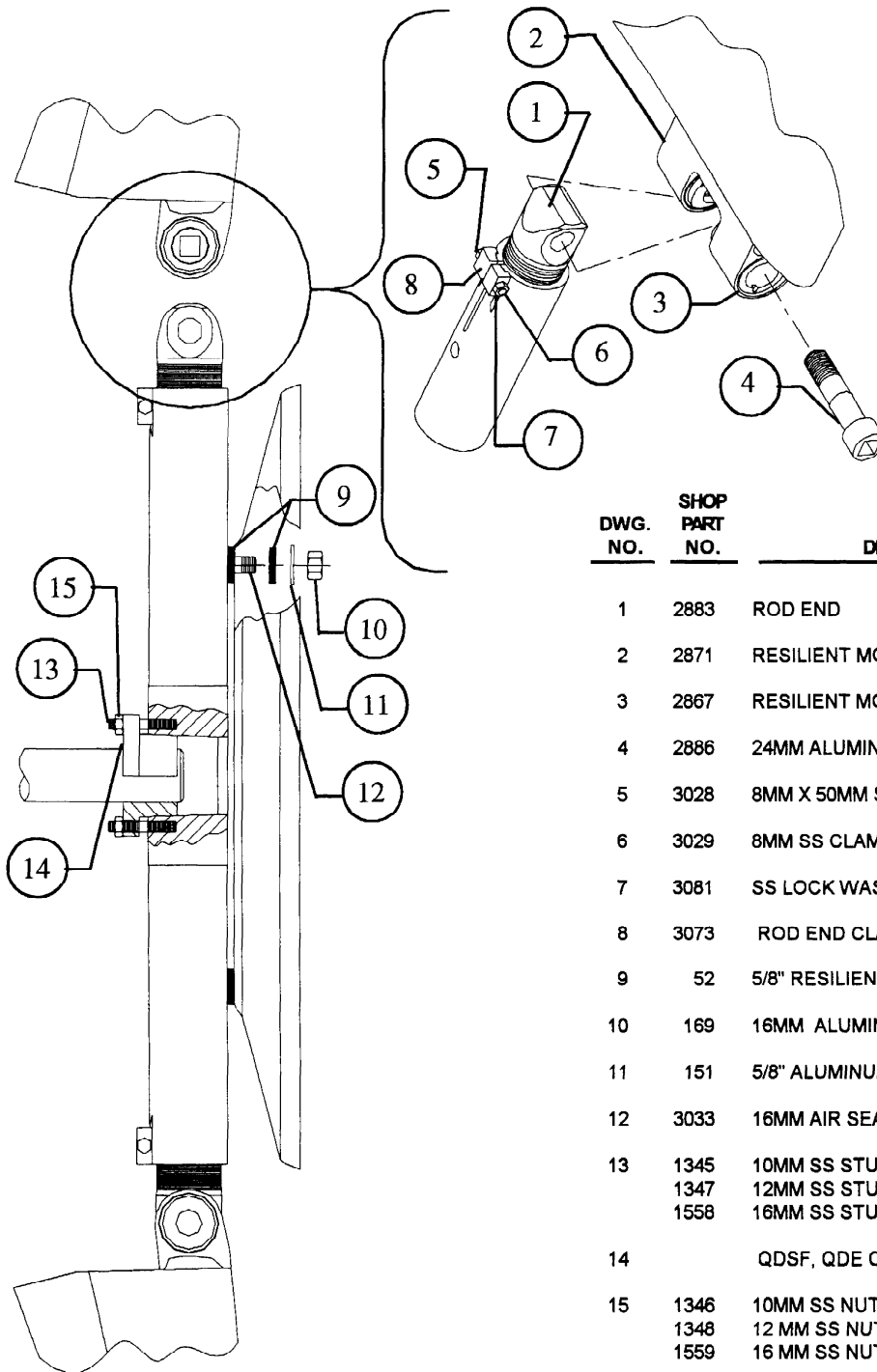
3.4 WARRANTY

The Moore Company (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.

3.5 PARTS LIST

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



DWG. NO.	SHOP PART NO.	DESCRIPTION
1	2883	ROD END
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)
14		QDSF, QDE OR QDJ 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)

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

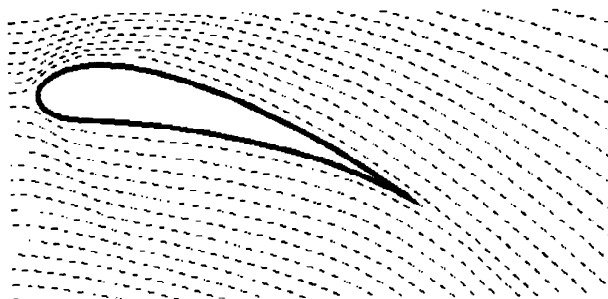
who has experienced a stall in an airplane will be familiar with this violent phenomenon.

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.

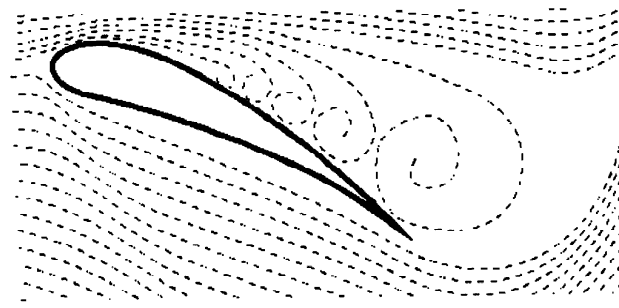
Another way of looking at this problem is to consider that the available number of blades are set at too steep an angle to be able to move air at the axial velocity which is necessary to maintain a smooth flow over the convex surface. In other words, to move air at the velocity necessary for this blade 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 to 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° 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°. 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

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 The Moore Company 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 the static pressure indicated. Advance the blade angle by one or two degrees and repeat the

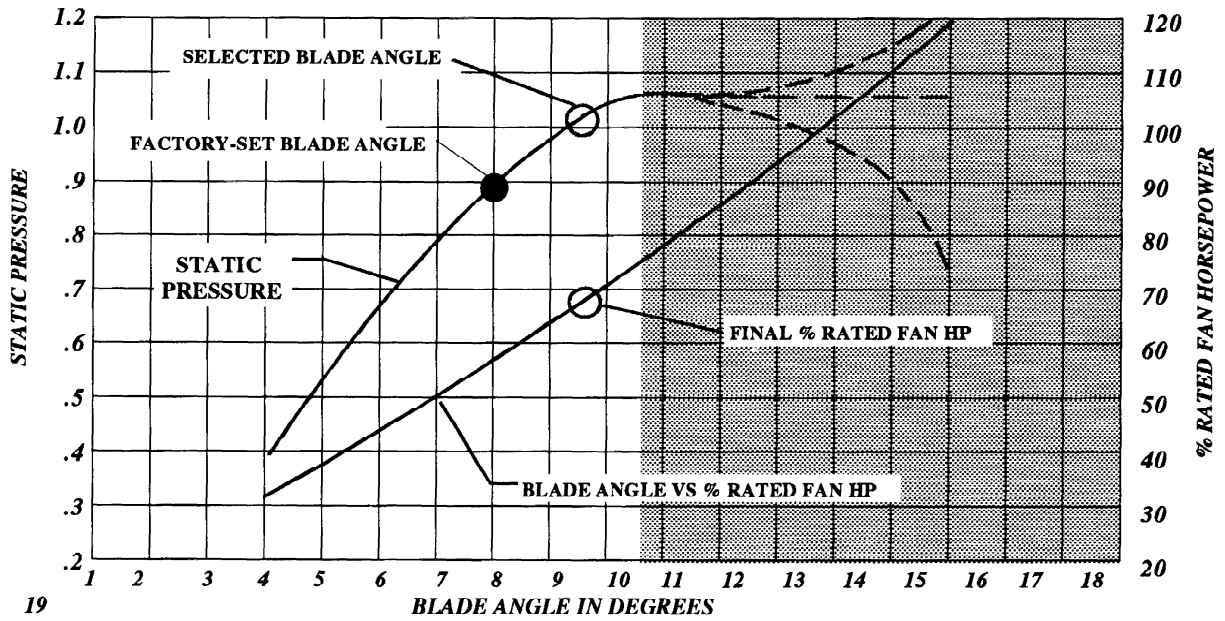
performance, recording again these readings. Keep increasing the angle and following this procedure until the motor is fully loaded, in which case the fan is able to consume full rated fan horsepower without overload OR until the curve which will have started on a definite slope begins to approach the 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.

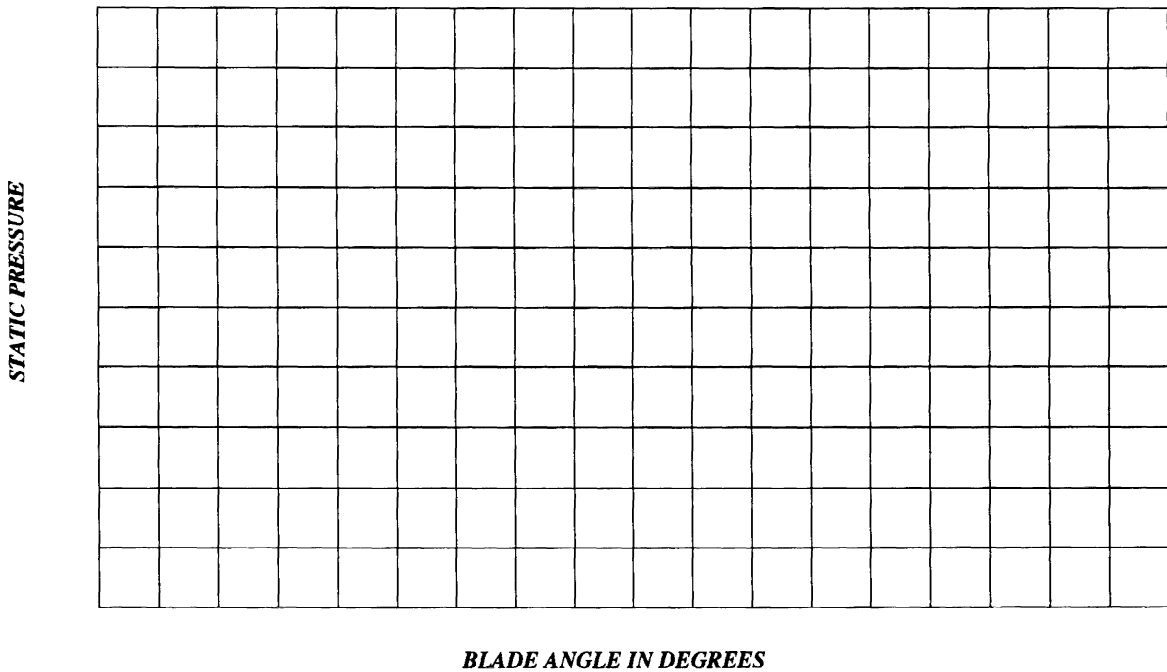
The point so selected will also approximate the point of the most efficient operation of the fan. Due to possible error in static pressure predictions, or in readings which are intended only to be relative, as well as other variables, the final blade setting chosen may fall below or above the specified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

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



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.



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 The Moore Company'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.

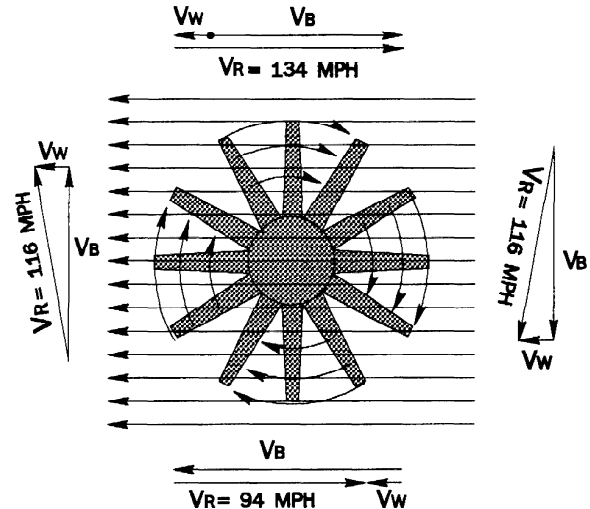
4.5.2 WIND

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°.

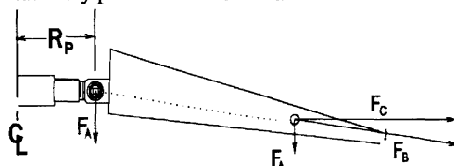
The illustration above assumes a fan operating with a tip



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.

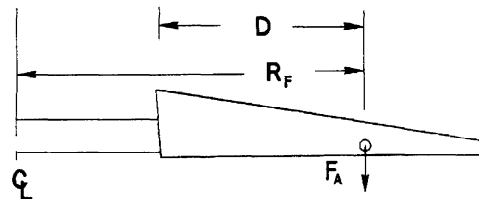
THE EFFECT OF AIR LOAD ON HUB AND DRIVE

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 positions 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 conditions.



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 behind 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.

For new users of Moore fans

Moore fans have a number of unique features. Some of these features are summarized here so that our new customers will understand their important advantages. If you would like to have more information about Moore fan design, please request a copy of The Moore Company's Engineering Catalog.

Resilient Blade Mounting

Like the blades of a helicopter, Moore fan blades are attached to the hub by a pivot. In operation, centrifugal force causes the blades to rise to their working position. The pivot itself is surrounded by a vibration-absorbing resilient material. There are two major advantages to this design:

1. Compared to fans with rigidly mounted blades, only 1/4 to 1/2 of the stresses caused by the air load are transmitted to the hub and drive, substantially increasing the life of the fan driving mechanism.
2. Moore fans are ideally suited for operation by variable speed motors -- the most efficient method for varying air flow -- since resonant frequencies are eliminated and there are no critical speeds to be avoided.

Low Inertia

Fan blades are jig-formed to the complex shape required for high aerodynamic efficiency. This method provides a blade that is rigid, yet lighter weight than possible with other forming methods. This lighter weight results in low blade inertia and lowers the possibility of fan damage in case of sudden emergency stops typical of engine drive operation.

Odd or Even Numbers of Blades

Moore fans do not require an even number of blades since all blades are balanced to a standard moment. Because of the importance of avoiding either excess or insufficient blade area for efficient performance, it is an advantage to be able to select any number of blades up to the physical limitation of the unit.

Two Hubs

The ideal size of a fan hub from an aerodynamic point of view is much larger than the ideal size from a structural

point of view. If the fan hub is too small, the blades do not terminate at the point where they become inefficient. Air flow will deteriorate or even reverse near the hub, resulting in wasted power. Yet, a hub of the size required by these aerodynamic considerations would be an extremely heavy and expensive structural member.

Moore avoids compromising on hub size by providing two hubs -- a structural hub and an aerodynamic hub -- each properly proportioned for its function. The aerodynamic hub is referred to as the air seal.

Uniform Velocity from Hub to Tip

Uniform velocity over the entire blade area is the most important criteria of efficient axial flow fan design. To produce a uniform velocity throughout its length, a fan blade must vary from a thin, narrow tip to a thick, cambered root. Each point on the blade must have the proper combination of chord (blade width) and angle. This results in a great deal of twist in a properly designed blade.

Moore fan blades are jig-formed to provide the complex contour needed for high aerodynamic efficiency. Extruded blades (which must be of uniform width) cannot match the efficiency of blades that are properly proportioned.

Adjustable Fan Diameter

Minimizing the clearance between the tips of the blades and the fan ring is essential if a fan is to operate efficiently and satisfy the performance requirements of the installation. Most Moore hubs provide a means of increasing or decreasing the fan diameter by as much as 1-1/2" -- an important feature in "fitting" the fan precisely to an existing ring.

**THE MOORE COMPANY
800 S. MISSOURI AVENUE
MARCELINE MO 64658-9985**

REX® 2000, 3000, 5000 & 9000 ROLLER BEARING GREASE LUBRICATION SCHEDULES

Size Code	Normal Duty 2000 Series	Medium Duty 3000 Series	Heavy Duty 5000 Series	Adapter 9000 Series	Initial Grease Fill (oz.)	Relube Grease Amount (oz.)	Suggested Months Between Re-lubrication					
							Up to 100 RPM	100-300 RPM	300-500 RPM	500-1000 RPM	1000-1750 RPM	1750-3000 RPM
2	2012-2100	-----	-----	-----	0.4	0.1	12	8	5	2	1	1/2
3	2102 - 2104	-----	-----	-----	0.5	0.1	12	8	5	2	1	1/2
4	2107 - 2108	3107 - 3108	5107	-----	0.6	0.1	12	8	5	2	1	1/2
5	2111 - 2112	3111 - 3112	5108 - 5111	-----	0.8	0.2	8	5	3	1	1/2	-----
6	2115 - 2200	3115 - 3200	5115	-----	0.9	0.2	8	5	3	1	1/2	-----
7	2203 - 2204	3203 - 3204	5200 - 5203	9115 - 9200	1.1	0.2	8	5	3	1	1/2	-----
8	2206 - 2208	3206 - 3208	5207	9203	1.5	0.3	8	5	3	1	1/2	-----
9	2211 - 2300	3211 - 3300	5208 - 5215	9207 - 9208	2.8	0.5	8	5	3	1	1/2	-----
10	2303 - 2308	3303 - 3308	5303 - 5307	9211 - 9300	3.7	0.6	6	4	2	1	1/2	-----
11	2311 - 2400	3311 - 3400	5311 - 5400	9303 - 9307	6.9	1.1	6	4	2	1	1/2	-----
12	-----	-----	5403 - 5407	9311 - 9400	8.4	1.5	6	4	2	1	1/2	-----
13	-----	-----	5415 - 5500	9403 - 9407	14.3	2.5	4	2	1	1/2	-----	-----
14	-----	-----	5507	9415 - 9500	22.1	4.0	4	2	1	1/2	-----	-----
15	-----	-----	5515 - 5600	9503 - 9507	25.3	4.5	4	2	1	1/2	-----	-----
16	-----	-----	5615 - 5700	9515 - 9607	33.0	6.0	4	2	1	1/2	-----	-----

* BASED ON ONE SHIFT, 40 HRS/WEEK OPERATION. ADJUST MONTHLY INTERVALS TO REFLECT ACTUAL USAGE HOURS/WEEK.

* OPERATING TEMPERATURES LIMITED TO -40 TO +225°F.

* "DIRTY", CORROSIVE OR WET ENVIRONMENTS REQUIRE MORE FREQUENT RE-LUBE.

* MAXIMUM SPEEDS FOR STANDARD SEALS ONLY

* **REDUCE LUBRICATION INTERVALS BY HALF FOR VERTICAL SHAFT APPLICATIONS**

* SUGGESTED GREASES ARE: MOBILITH AW2 (FACTORY FILL), TEXACO PREMIUM RB, SHELL ALVANIA GREASE 2, GULF CROWN NO.2 AND AMOCO RYKON 2.



AIR COOLED EXCHANGERS, INC.

PHONE 918 251-7477
FAX 918 251-7482
ACE-COOLERS.COM
1201 S. 9TH STREET
BROKEN ARROW, OK 74012

WARRANTY POLICY

A) PERFORMANCE

The Purchaser shall furnish the Seller with all information needed for clear understanding of performance requirements and with any special requirements not included in the standard. The Seller shall guarantee thermal and mechanical performance of an Air Cooled Heat Exchanger when operated at the design condition specified by the Purchaser in his order or shown on the cooler specification sheet furnished by the Seller. This guarantee shall extend for a period of twelve (12) months after start up date or eighteen (18) months after shipping date whichever occurs first. The Seller shall assume no responsibility for excessive fouling of the unit by material such as coke, silt, scale or any foreign substance that may be deposited. The thermal guarantee shall not be applicable to coolers where the thermal performance rating was made by the Purchaser.

- 1) Thermal Performance Test: A performance test shall be made if it is established after operation that the performance of the cooler is not satisfactory, provided the thermal performance rating was made by the Seller. Test conditions and procedure shall be selected by agreement between the Purchaser and Seller to permit extrapolation of the test results to the specified design conditions. The Purchaser shall bear all expenses pertaining to said test.
- 2) Defective Parts: The Seller shall repair or replace, f.o.b. his plant, any parts proven defective within the guarantee period. Finished materials and accessories purchased from other manufacturer's warranty. The Seller shall not be responsible for any defective part resulting from misuse, abuse or negligence. If the Purchaser/User requests, and Seller agrees, repairs will be made in the field at the Seller's expense. Such repairs will be made promptly and effectively. Should the Purchaser/User request the services of the Seller for any repair not within the Seller's warranty, such service shall be rendered and charged at the established rate at the time of performing said service plus all other expenses including travel, hotel bills and living expenses.



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B) CORROSION AND VIBRATION

The Seller assumes no responsibility for deterioration of any part or parts of the equipment due to corrosion, erosion, induced tube vibration or any other cause, regardless of when such deterioration occurs after leaving the Seller's premises.

C) REPLACEMENT AND SPARE PARTS

When replacement or spare sections or other parts are purchased, the Seller is to guarantee satisfactory fit of such parts only if he was the original manufacturer. Parts fabricated to drawings furnished by the Purchaser shall be guaranteed to meet the dimensions and tolerance specified.

D) LIFTING DEVICES

The Seller assumes no liabilities for the Purchaser's use or application of lifting devices attached to or installed on the cooler.

Except as otherwise agreed to by the Seller in writing, THIS WARRANTY IS EXCLUSIVE AND IS IN LIEU OF ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR PURPOSE OR OTHER WARRANTY OR QUALITY, WHETHER EXPRESSED OR IMPLIED.

12-12-05



AIR COOLED EXCHANGERS, INC.
ELECTRIC MOTOR TEST DATA

TEST DATE 11-30-05

JOB NO. 0532202

APPROXIMATE AIR TEMP °F 60°

FAN DESCRIPTION

MODEL 1100RE-30HPAUT-LBL

ANGLE 17°

LH RH LH

	MOTOR 1	MOTOR 2	MOTOR 3	MOTOR 4
MOTOR MAKE	EMERSON			
MOTOR SERIAL NO.	J01A625MS	04015		
MOTOR HP	20			
MOTOR FULL LOAD AMPS	24.4			
ACTUAL VOLTAGE	495			
MOTOR VOLTAGE	460			
ACTUAL AMPS	23.4			
HERTZ	60			
FAN RPM (DESIGN)	389			
FAN RPM (ACTUAL)	N/A			

TESTED BY Marty Winters

AIR COOLED HEAT EXCHANGER **SUGGESTED START UP PROCEDURE**

Before any start up procedure is begun, a thorough inspection of the Air Cooled Exchanger should be made.

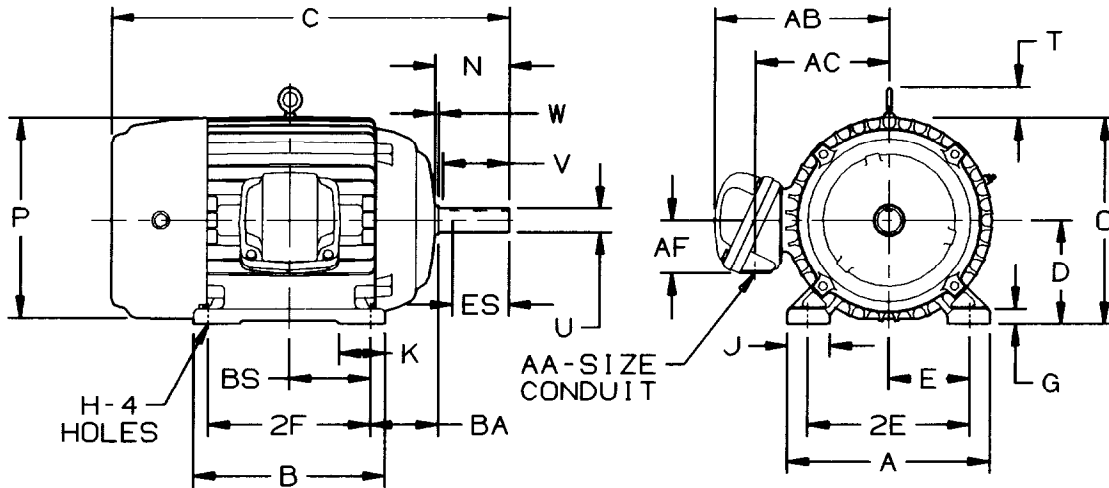
- 1.) Be sure all bolted connections are properly tightened.
- 2.) After tube bundle and piping hydrotest, remove hydrotest connections. Be sure tube bundle is properly drained, and if required, dried. Connect process piping and any auxiliary connections.
- 3.) Inspect all process connection, as well as, vent drain, temperature and pressure, or any other auxiliary connections to be sure they are plugged or connected properly.
- 4.) Check mechanical equipment before starting process through the tube bundle(s).
 - a.) Thoroughly check the plenum and fan drive area to be sure all tools and construction materials are removed.
 - b.) Rotate the fan by hand and check fan tip clearance and alignment of belts and sheaves.
 - c.) Check belt tension.
 - d.) Check all fan drive bolts to be sure they are properly tightened. This includes bearing bolts, fan and sheave bushing bolts, set screws, motor bolts and fan blades attachment bolts.
 - e.) If air operated auto-variable pitch fans are used, check for proper pitch with the air off. Fans may go to either minimum or maximum pitch at air failure. Check specifications for requirements. If fan pitch is not satisfactory, set pitch per manufacturer's instructions (see Operation and Maintenance Instructions). If fan pitch is satisfactory, cycle fan through it's range, using plant air and an air regulator.

- f.) If air operated louvers are provided, it is advisable to disconnect the air motor linkage and cycle the louvers by hand to assure there is no binding or obstruction of the louvers blades. If binding occurs, check to be sure louver frames are square. Attaching bolts may have to be loosened and frames shifted to ease binding. If louvers operate smoothly, reconnect air motor. Cycle the air motor, using plant air and an air regulator.
 - g.) If manually adjusted pitch fans are provided, check fan pitch and re-pitch per manufacturer's instructions if required.
 - h.) If manual operated louvers are provided, check for binding of the blades, as in instruction (f). Operate louvers to be sure there is no linkage obstruction or binding.
 - i.) Remove condensate drain plugs, if provided, in electric motors and other electrical components to drain any condensation that might have occurred during storage. If space heaters are furnished in electric motors, louver actuators, controls, etc., activate the space heaters and allow approximately 24 hours before starting equipment.
 - j.) After all the applicable steps previously stated are completed, the mechanical equipment may be cycled.
 - k.) Be sure all personnel and equipment are away from the fan and fan drive area. For safety reasons, equipment guards should be installed. Activate the drive motor and let it reach speed. Check for vibration and excessive noise. If vibration or excessive noise occurs, immediately shut motor down, and check for loose connections or insufficient clearance between moving parts. If the system is running smoothly, replace any guards removed and move to the next drive and repeat above steps.
- 5.) Start the process through the tube bundle(s). Open the inlet valves slowly and let the process "Warm" the bundles slowly. This will allow the components of the tube bundle to expand at the same rate and lessen the thermal shock.

HORIZONTAL MOTORS

FRAME: 250T
TYPE: LC, NC, LCE, NCE, FLC, FNC

PRINT #: 07-2109
EFFECTIVE: 17-JAN-01
SUPERSEDES 23-NOV-99



ALL DIMENSIONS ARE IN INCHES & MILLIMETERS

UNITS	A	E	G	J	K	T	N	O	P ²
INCH	12.13	5.00	.88	2.25	2.50	1.75	4.13	12.91	13.31
MM	308	127	22	57	64	44	105	328	338

UNITS	V MIN	W	AA	AB	AC	AF	BA	ES MIN	SQ KEY
INCH	3.75	.06	1-1/2 NPT	11.06	8.25	3.13	4.25	2.91	.375
MM	95	2		281	210	79	108	74	9.53

UNITS	D ⁴	2E ⁴	H ⁴	U ⁴
INCH	-.06	±.03	+.05	-.0005
MM	158.8	254.0	13.5	41.275

FRAME	UNITS	2F ⁴ ±.03	B	C	BS
254T	INCH	8.25	10.25	23.25	4.13
	MM	209.6	260	591	105
256T	INCH	10.00	12.00	25.00	5.00
	MM	254.0	305	635	127

1: ALL ROUGH CASTING DIMENSIONS MAY VARY BY .25"
DUE TO CASTING VARIATIONS.
2: LARGEST MOTOR WIDTH.

3: CONDUIT BOX MAY BE LOCATED ON EITHER SIDE
OF MOTOR. CONDUIT OPENINGS MAY BE LOCATED IN
STEPS OF 90 DEGREES REGARDLESS OF LOCATION.
STANDARD AS SHOWN WITH CONDUIT OPENING DOWN.
4: TOLERANCE UNITS ARE IN INCHES ONLY.

CERTIFIED BY: _____ DATE: _____

07-2109-B



U.S. ELECTRICAL MOTORS
DIVISION OF EMERSON ELECTRIC CO.



DO NOT USE FOR CONSTRUCTION
PURPOSES UNLESS CERTIFIED

NAMEPLATE DATA

CATALOG NUMBER: YC20E2B		NAMEPLATE PART #: 422696-009	
MODEL AG25 FR 256T	TYPE FLC ENCL TE		
SHAFT END BRG 6309-J/C3 - QTY 1		OPP END BRG 6207-J/C3 - QTY 1	
PH 3 MAX AMB 40 C	ID# _____		
INSUL CLASS F Asm. Pos. F1	DUTY CONT		
HP 20 RPM 1770	HP _____ RPM _____		
VOLTS 460 230	VOLTS _____		
FL AMPS 24.4 49.0	FL AMPS _____		
SF AMPS 28.2 56.0	SF AMPS _____		
SF 1.15 DESIGN B CODE F	SF _____ DESIGN _____ CODE _____		
NEMA NOM EFFICIENCY 91.0 NOM PF 83.8 KiloWatt 14.9	NEMA NOM EFFICIENCY _____ NOM PF _____		
GUARANTEED EFFICIENCY 89.5 MAX KVAR 5.4 HZ 60	GUARANTEED EFFICIENCY _____ MAX KVAR _____ HZ _____		

UL DATA (IF APPLICABLE):

DIVISION 1 CLASS I I GROUP I D
TEMP CODE T2B CLASS II _____ GROUP II _____

VFD DATA (IF APPLICABLE):

VOLTS _____	
AMPS _____	
TORQUE 1 _____	TORQUE 2 _____
VFD LOAD TYPE 1 _____	VFD LOAD TYPE 2 _____
VFD HERTZ RANGE 1 _____	VFD HERTZ RANGE 2 _____
VFD SPEED RANGE 1 _____	VFD SPEED RANGE 2 _____
SERVICE FACTOR _____	FL SLIP _____
NO. POLES _____	MAGNETIZING AMPS _____
VECTOR MAX RPM _____	Encoder PPR _____
Radians / Seconds _____	Encoder Volts _____

TEAO DATA (IF APPLICABLE):

HP (AIR OVER) _____	HP (AIR OVER M/S) _____	RPM (AIR OVER) _____	RPM (AIR OVER M/S) _____
FPM AIR VELOCITY _____	FPM AIR VELOCITY M/S _____	FPM AIR VELOCITY SEC _____	

ADDITIONAL NAMEPLATE DATA:

Decal / Plate	WD=159833,CP=132839	Customer PN	
Notes		Non Rev Ratchet	
Max Temp Rise	80C RISE/RES@1.00SF	OPP/Upper Oil Cap	GREASE
Thermal (WDG)		SHAFT/Lower Oil Cap	GREASE
Altitude			
EPACT Note		EPACT Compliance	CC 030A
COS		Marine Duty	
Balance		Arctic Duty	
3/4 Load Eff.	92.7	Inrush Limit	
Motor Weight	375	Direction of Rotation	
Sound Level		Special Note 1	
Vertical Thrust		Special Note 2	
Thrust Percentage		Special Note 3	
Bearing Life		Special Note 4	
Starting Method		Special Note 5	
Number of Starts		Special Note 6	
200/208V 60Hz Max Amps		SH Max. Temp.	
190V 50 hz Max Amps		SH Voltage	
380V 50 Hz Max Amps		SH Watts	
NEMA Inertia		Load Inertia	
Sumpheater Voltage		Sumpheater Wattage	
Special Accessory Note 1		Special Accessory Note 16	
Special Accessory Note 2		Special Accessory Note 17	
Special Accessory Note 3		Special Accessory Note 18	
Special Accessory Note 4		Special Accessory Note 19	
Special Accessory Note 5		Special Accessory Note 20	
Special Accessory Note 6		Special Accessory Note 21	
Special Accessory Note 7		Special Accessory Note 22	
Special Accessory Note 8		Special Accessory Note 23	
Special Accessory Note 9		Special Accessory Note 24	
Special Accessory Note 10		Special Accessory Note 25	
Special Accessory Note 11		Special Accessory Note 26	
Special Accessory Note 12		Special Accessory Note 27	
Special Accessory Note 13		Special Accessory Note 28	
Special Accessory Note 14		Special Accessory Note 29	
Special Accessory Note 15		Special Accessory Note 30	



EMERSON MOTOR COMPANY
ST. LOUIS, MO



TYPICAL NAMEPLATE DATA
ACTUAL MOTOR NAMEPLATE LAYOUT MAY VARY
SOME FIELDS MAY BE OMITTED

MOTOR PERFORMANCE

MODEL NO.	CATALOG NO.	PHASE	TYPE	FRAME
AG25	YC20E2B	3	FLC	256T
ORDER NO.		11440	LINE NO.	
MPI:		48582	48583	
HP:		20	20	
POLES:		4	4	
VOLTS:		460	230	
HZ:		60	60	
SERVICE FACTOR:		1.15	1.15	
EFFICIENCY (%):				
S.F.		90.9	90.9	
FULL		91	91	
3/4		92.7	92.7	
1/2		92.4	92.4	
1/4		88.8	88.8	
POWER FACTOR (%):				
S.F.		84.2	84.2	
FULL		83.8	83.8	
3/4		81.4	81.4	
1/2		74.2	74.2	
1/4		54.6	54.6	
NO LOAD		6.3	6.3	
LOCKED ROTOR		45.1	45.1	
AMPS:				
S.F.		28.2	56	
FULL		24.4	49	
3/4		18.6	37	
1/2		13.7	27.3	
1/4		9.7	19.3	
NO LOAD		7.9	15.8	
LOCKED ROTOR		139	278	
NEMA CODE LETTER		F	F	
NEMA DESIGN LETTER		B	B	
FULL LOAD RPM		1770	1770	
NEMA NOMINAL EFFICIENCY (%)		91	91	
GUARANTEED EFFICIENCY (%)		89.5	89.5	
MAX KVAR		5.4	5.4	
AMBIENT (°C)		40	40	
ALTITUDE (FASL)		3300	3300	
SAFE STALL TIME-HOT (SEC)		30	30	
SOUND PRESSURE (DBA @ 1M)		74	74	
TORQUES:				
BREAKDOWN{% F.L.}		227	227	
LOCKED ROTOR{% F.L.}		224	224	
FULL LOAD{LB-FT}		59.4	59.4	

The Above Data Is Typical, Sinewave Power Unless Noted Otherwise



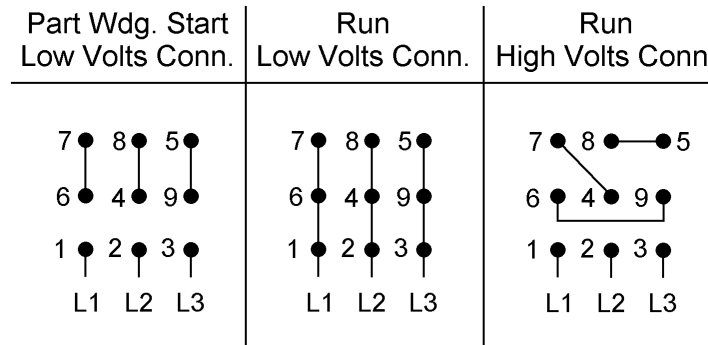
EMERSON MOTOR COMPANY
ST. LOUIS, MO



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The Emerson logo is a trademark and service mark of Emerson Electric Co.



Motor Wiring Diagram
9 Lead, Dual Voltage, Delta Connection
Part Winding Start (PWS) on Low Voltage



Motor good for across the line starting

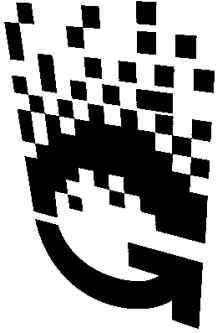
Per NEMA MG1 1998-1.75, "A Part-winding Start motor is one which certain specially designed circuits of each phase of the primary winding are initially connected to the supply line. The remaining circuit or circuits of each phase are connected to the supply in parallel with initially connected circuits, at a predetermined point in the starting operation." This is intended to limit the inrush current required to start the motor. NEMA MG1 1998-14.38 states that the motor may not accelerate to full speed in part-winding and may be noisier than when on full winding.

Motors designed by US Motors for Part-winding Start also be used for across the line starting using only the full winding connection. Damage will occur if the motor is operated with load for more than 2 seconds on Part-winding without transition to full winding.

To reverse direction of rotation, interchange leads L1 & L2.

Each lead may have one or more cables comprising that lead. In such case, each cable will be marked with the appropriate lead number.





Global Heat Transfer Ltd.
7716 – 67 Street
Edmonton, Alberta
T6B 2K4
Phone: (780) 448 – 3600
Fax: (780) 465 – 8035

INSTALLATION & MAINTENANCE INSTRUCTIONS FOR FACTORY ASSEMBLED MWC AND HC AIR COOLED HEAT EXCHANGERS

RECEIVING

INSPECTION

Inspect the unit for shipping damage (especially the core) before uncrating. Rotate the fan, which should move freely. Note that one blade is wired to the guard on some models for shipping. Remove wire before rotating fan.

HANDLING

Exercise care to avoid damage to the core.

All units are shipped with wood skid facilitating for forklift handling.

Lifting holes are provided in MWC and some HC side members. HC units have integral or removable lifting lugs (shipped unattached on some units)

STORAGE

Units normally have one coat of medium grey, semi – gloss enamel paint. A finish coat of paint should be applied to all exterior ferrous surfaces unless storage is indoors. Do not paint the core as this may impair airflow and heat transfer. All openings are sealed with appropriate pipe plugs, pipe caps, and thread protectors, flange covers and/or pressure caps at the factory. Be sure these are in place.

IMPORTANT NOTE

***Low Liquid Flow**

Improper circuitry in co-generation, load balance or prime power applications can result in too low of liquid flow through the radiator core, causing hot and cold core areas and induced stress by the way of differentials in thermal expansion.

***Thermal Shock**

Hot jacket water suddenly entering cold cores, or cold ambient air suddenly forced over hot cores, can cause severe thermal shock, conditions which can be offset by the use of thermostatically controlled shutters and fan motor controls, two speed fan motors, and heaters and pumps in bypass piping circuit to prewarm cooler core.

Inadequate liquid flow or thermal shock may result in premature failure of a flat tube soldered radiator core.

***Sidemember Bolts**

Per sticker located on radiator side members, nuts must be loosened on bolts, which secure MWC top tank or HC floating end tank to side members to permit differential thermal expansion of steel sides and nonferrous core.

***Two-Pass/One-Pass Piping**

Smaller radiators may be furnished with a pass partition in one tank, allowing for two-pass liquid flow. Connections on these models must be mainfolded to provide for proper one-pass flow.

***Long Term Storage**

Proper precautions must be taken when radiator is stored in a damp or salt-laden atmosphere, particularly with electric motors, which may have their drain holes become corroded and clogged, allowing for accumulation of moisture within the motor housing.

INSTALLATION

***Location**

Insure that no obstructions impede either discharge or inlet air flow. If the unit is wall mounted, provide ample room ventilation. MWC unites should be oriented to take advantage of prevailing winds to avoid recirculation and the resultant loss of cooling effect. Expected wind direction on hot, summer days should especially be anticipated. Duct work on housing of unit adds air flow static resistance which must be overcome with extra fan capacity. Ducting should be larger in area than heat exchanger core face and contain only straight runs and long radius turns.

***Foundation and Mounting**

Flexible connections or non-rigid plumbing (hangers and right- angle bends) should be used to allow thermal expansion of core, insulation from vibration and freedom from static loading.

Consult “cooled equipment” manufacturer for recommendations on specific plumbing system. Inlet to heat exchanger is normally at the highest connection, but this is not mandatory.

In the case of round tube cores with counter-flow passes, plumb inlet fluid to connection farthest from blower fan to avoid co-flow of the tube fluid and cooling air.

***Fan Drive System**

If fan is motor driven, check that voltage, frequency and number of phases on motor nameplate are compatible with electrical supply.

Connect motor leads so that rotation of forced draft blower fan is counter-clockwise when viewed from fan side of unit unless fan is supplied with special, left-hand blades.

If drive includes v – belts, sheave alignment and correct belt tension must be maintained to transmit sufficient power to fan and prevent excessive belt and bearing wear.

*If fan is engine driven, locate the idler sheave on the slack side of the belt drive. Engine packager as required by OSHA provides belt guards.

The assemblies of sheaves and/or fans utilizing taper lock bushings require: clean surfaces, proper alignment of bushing to sheave/fan.

Initially snug the pull-up bolts, assuring correct fit of tapered mated surfaces. With torque wrench, torque bolts in an alternating pattern to recommend torque. With a light hammer, tap between the pull-up bolts, check torque, and if necessary, re-torque to specifications.

Recommended Wrench Torque Values

Bolt Dia.	(lb. ft)	Bolt Dia	(lb. ft)	Bolt Dia	(lb. ft)	Bolt Dia	(lb. ft)
#10	5	3/8	30	5/8	135	1	450
1/4	9	1/2	60	3/4	225	1 1/8	600
5/16	15	9/16	75	7/8	300	1 1/4	750

STARTUP

***Startup**

*If tube fluid is water, fill unit from a clean and chemical free source. Use a 50% aqueous ethylene glycol solution if freezing is possible. For ambient conditions below – 25F (-32C) use a 60% solution, below –50F (-45C) consult factory.

*If Anti-freeze is not used, water should be treated with a corrosion inhibitor.

*Check unit for undue vibration resulting from fan imbalance or loose drives components.

*Check torque of tank to header bolts in accordance with values given in table above.

MAINTENANCE

***Motor**

*Ball bearings should be lubricated once per year or each nine months for severe duty motors, 10hp or larger. Consult local motor manufacturer representative for grease type specification.

*Clean ventilation openings as needed.

***Fan**

*Clean fan blades once a year. Use stiff brush or air nozzle for loose dirt and non-flammable solvent with brush for solid deposits. Care must be taken not to damage fan

blades as a resulting out-of-balance condition may cause vibration and damage to bearings of motor and/or fan bearing.

***Fan Bearings (Vee Belt & External Drive System)**

*Fan and idler bearings are provided with combination Alemite grease and relief fittings and should be lubricated once per year or more often for severe duty applications.

*Bearing temperature should never exceed 150 – 160F

***Fan Drive**

Refer to Installation – Fan Drive System – The Assembly of Sheaves and/or Fans

*Check and maintain alignment of sheaves by adjusting their location on fan shaft and idler shaft.

*Check and maintain correct tension of fan belts by adjusting idler.

*Check for frame vibration due to fan imbalance, bearing wear or loose drive components.

*Vibration switches are recommended to detect problems and are available as optional equipment.

***Core and Frame**

*Periodically checks for core or plumbing leakage.

*Inspect MWC top tank or HC system high point for correct liquid level.

*Test anti-freeze coolant for correct specific gravity before cold weather.

*Examine interior of MWC top tank through filler neck for signs of scale formation and rust. Radiator should be cleaned and flushed if necessary. When replacing water in system add a cooling system treatment as a corrosion inhibitor.

*If steel frame develops rust, clean and repaint as necessary.

*Dirt accumulation on core can be removed by brushing and blowing with compressed air. A steam jet may also be effectively used if grease deposits are on core.

Note: Be careful that fins or tubes are not damaged from rough brushing or excessive jet pressure of either steam or air.

WARRANTY PROCEDURES

Please note the following:

*If a warranty matter occurs, contact the factory service department immediately through your local representative.

*In all communications with Service Department include complete nameplate data.

*Units will not be accepted for return unless prior authorization from factory has been obtained

Global Heat Transfer

Cooling System Data Sheet

DATE: 08/31/05

PhtD05083101

CUSTOMER: Tormont
APPLICATION: Gen Set
ENGINE: CAT G3306 TA HP: 203 RPM: 1800

DESIGN CONDITIONS:

MAX AMB: 100F
MAX T.T: 210F
ALT: 2500 ft
MAX A/C: 130F

JACKET WATER RADIATOR:

JW HR: 9967 Btu/min
JW FLOW: 50 gpm 50/50 EG Calc DP: 1.5 psi
CALC TOP TANK: 209 F
CORE SIZE: 36" H X 28.13" W

After Cooler Water Rad:

HEAT LOAD: 745 Btu/min
FLOW: 35 gpm 50/50 EG Calc DP: 1.34 psi
CALC TEMPS: Temp in: 129F Temp out: 126F
CORE SIZE: 36" H X 8" W

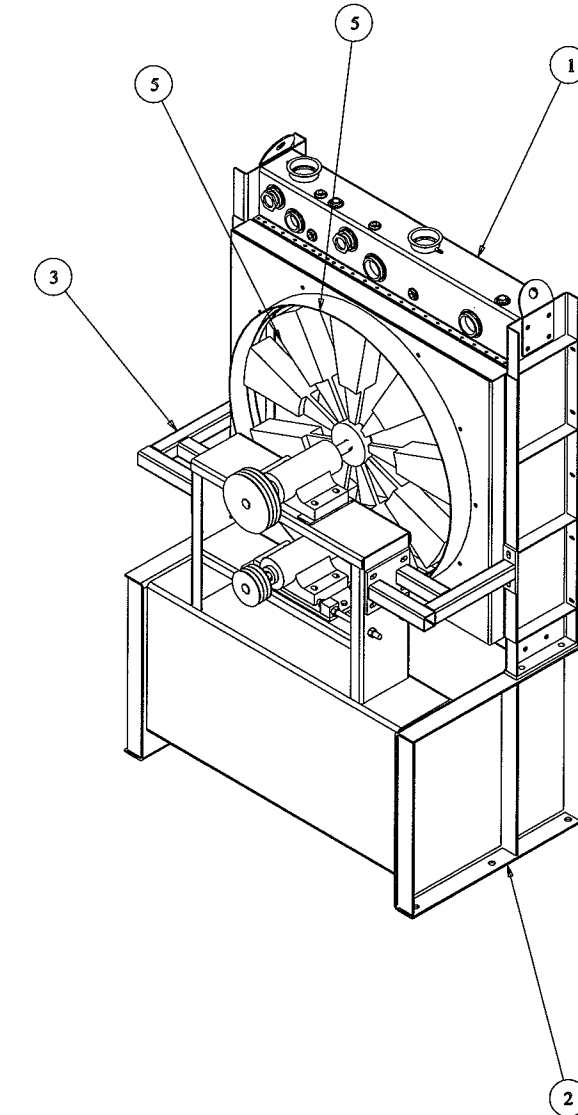
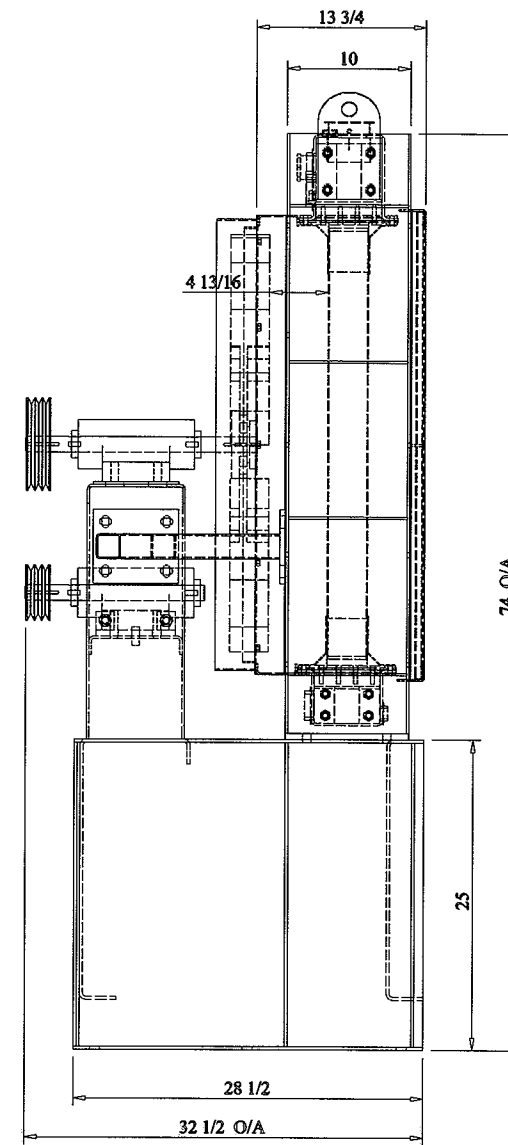
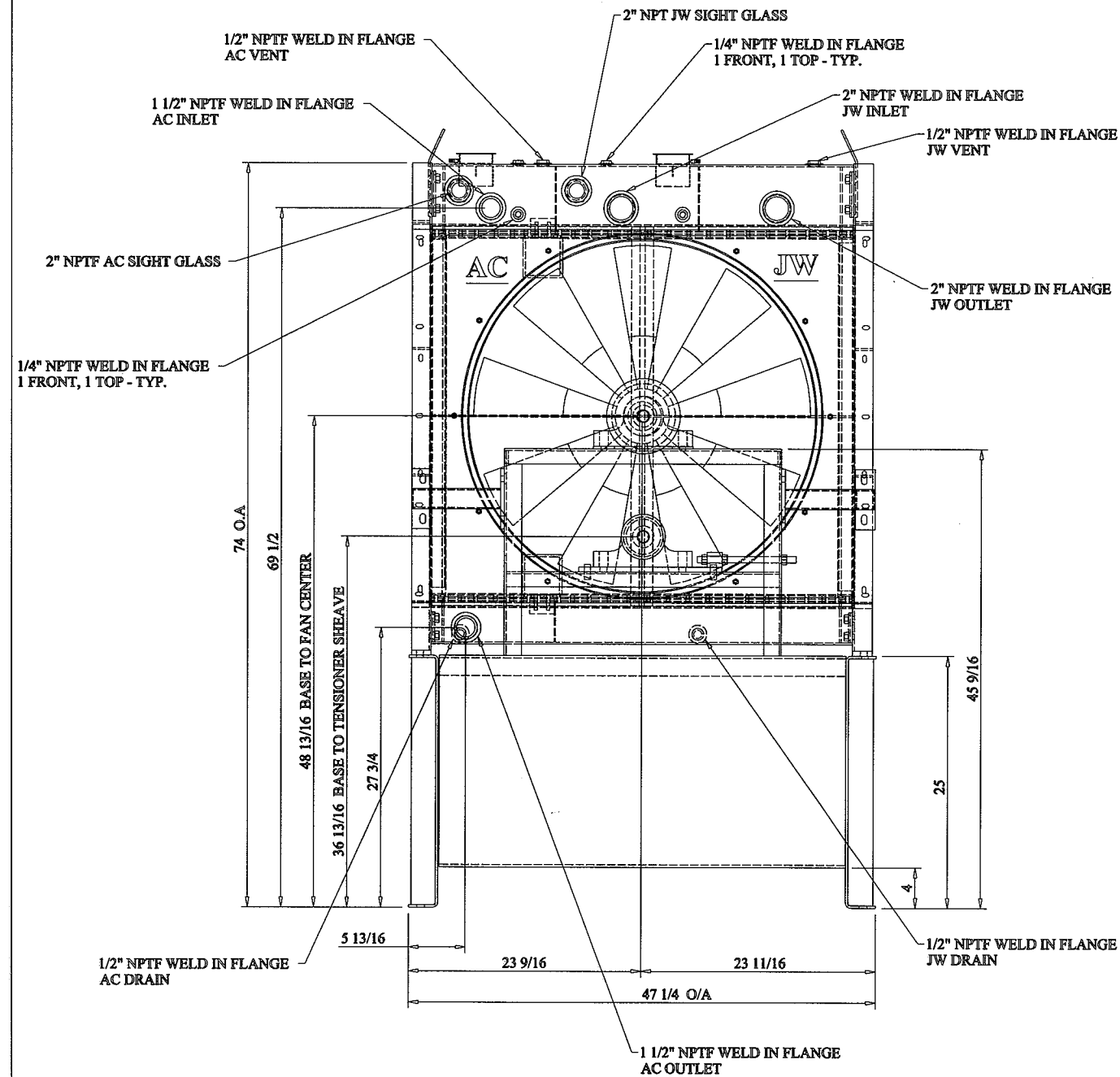
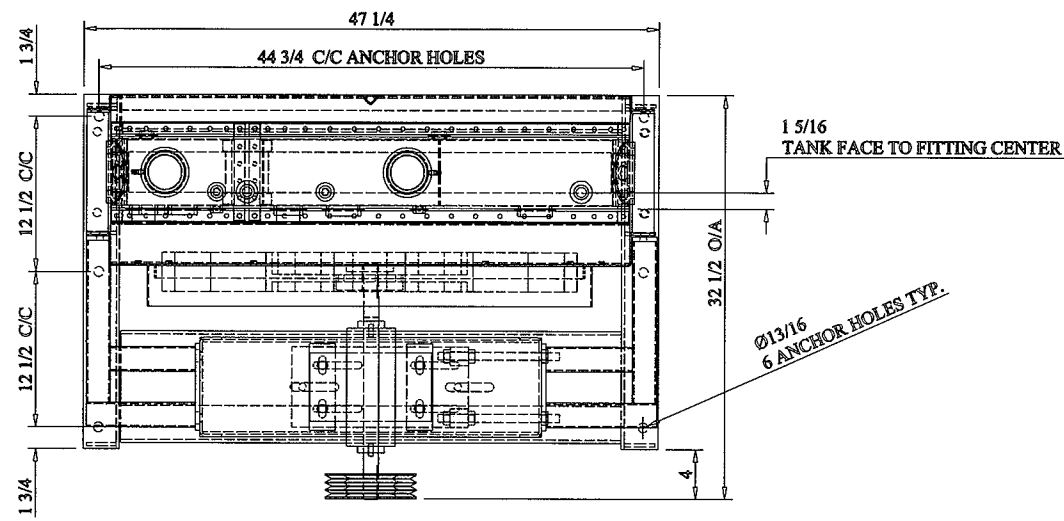
NOTE: Cores are side-by-side, both seeing coolest air.

Fan used for calculations:

Make: Crowley Diameter 34"
Type: Blower Speed: 1750 rpm Est HP: 11
Fan-Core Dist: 4" Shroud Dia: 35"
Est SPL: 90 dB(A) @ 3ft

Parts List				
ITEM	QTY	PART NUMBER	DESCRIPTION	MATERIAL
1	1	320002 (REF. 320002)	UNIT ASSEMBLY	
2	1	320013 (REF. 320013)	SKID ASSEMBLY	
3	2	320016 (REF. 320016)	FRAME SUPPORT ASSEMBLY	
4	1	320019 (REF. 320019)	FAN GUARD ASSEMBLY	
5	1	320701 (NO DWG.)	FAN (34/9-9/35/PAG/5ZR/SH/1.25/AS)	ALUM./PAG

NOTE THIS DRAWING SHOWN WITHOUT FAN GUARD FACE



NOTES:
1. ALL DIMENSIONS IN INCHES U.N.O.
2. ALL TOLERANCES ARE 1/16" OTHER THAN SPECIFIED.

TITLE		MATERIAL		PIECE(S)
MAIN ASSEMBLY				1
GLOBAL HEAT TRANSFER DESIGNING & MANUFACTURING OF HEAT EXCHANGER EDMONTON, AB, CANADA T6B 2K4 TEL: 1-(780)468-3600 FAX: 1-(780)465-8035		DWN BY/DATE SR 9/19/2005	APPR. BY/DATE RG 9/19/2005	PART/ASSEMBLY 320 001
		CHKD BY/DATE RG 9/19/2005	MNF. BY/DATE KV 9/19/2005	REF. DRAWING 320 001
		REVISION 0		