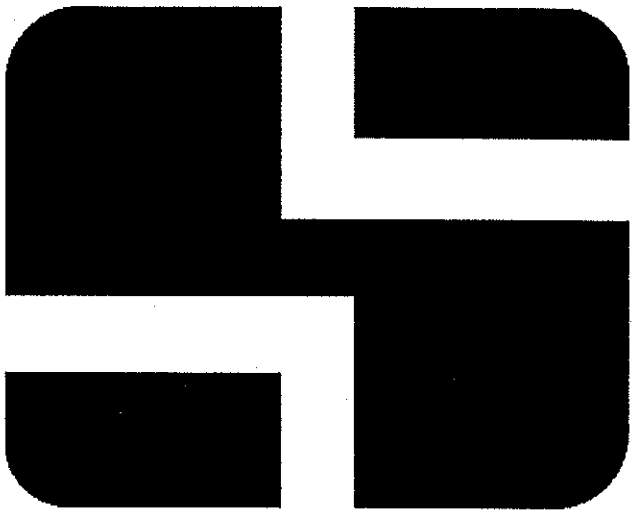

SMITHCO ENGINEERING, INC.

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

SMITHCO

SMITHCO JOB NO: 2008B554

FOR: OFD ENGINEERING

OFD CLIENT:
ENTERPRISE FIELD SERVICES

REF P.O.: O158919

PROJECT NO: 1295 - POSEIDON

ITEM: HAL-4110 & HAL-4120

6312 S. 39th West Avenue • P.O. Box 571330 • Tulsa, OK 74157-1330 • Tel: 918.446.4406 • Fax: 918.445.2857 • www.smithco-eng.com
SERVING THE INDUSTRY SINCE 1952 • MEMBER HTRI

SMITHCO

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6312 S. 39th West Avenue • P.O. Box 571330 • Tulsa, OK 74157-1330 • Tel: 918.446.4406 • Fax: 918.445.2857 • www.smithco-eng.com

SERVING THE INDUSTRY SINCE 1952 • MEMBER ITRI

RECEIVING THE EQUIPMENT

The **SMITHCO** Air Cooled Heat Exchanger should be inspected thoroughly by receiving personnel. Check the columns, fan drive support, plenum panels, fan ring and guard, and cooling sections for damage. Any damage in transit must be noted on receiving documents presented by the carrier. Prompt claim filing will expedite compensation from the carrier.

The base unit is a shop assembled cooling unit. The columns, braces, walkway supports, and walkways may be shipped disassembled due to shipping limitations. The ship loose parts will normally be secured on the trailer with the base unit or may require additional trailer(s), depending on the size and extent of these items.

Included with the shipping documents is a Shipping List. This document lists all ship loose items with the part number or piece mark number shown as the Item #. Each ship loose item should be counted and marked as received.

To enable assembly of the components, the appropriate assembly instructions will accompany the shipment.

Attached:

1. Shipping List
2. General Storage Recommendations
3. Lifting Details

SMITHCO ENGINEERING INC.

P.O. Box 571330
Tulsa, OK 74157-1330
Phone (918) 446-4406 Fax (918) 445-2857

Ship To:

Poseidon OPC
Will Advise
At time of Shipment
ATTN: POSEIDON OIL PIPELINE
CO

Date: 11/20/2008
Job #: 2008B554
Cust. PO: O158919
Shipped Via:

Item #	Qty	Description	Weight(lbs)
	2	SMITHCO Model 1 F34-140-2 Air Cooled Heat Exchanger	41500

UNIT DESCRIPTION: Size(ft)(Length x Width x Height) Weight(lbs)
35.5 x 14.0 x 9.5 18950 each

LOOSE STRUCTURE:
Note: Stubbed Columns

101	4	BOTTOM LEFT COLUMN	{ W 6.00 x 15 x 68}
106	4	BOTTOM RIGHT COLUMN	{ W 6.00 x 15 x 68}
111	4	BOTTOM CENTER COLUMN	{ W 6.00 x 15 x 68}
131	12	END COLUMN BRACE	{ L 2.50 x 0.25 x 62}
136	16	SIDE COLUMN BRACE	{ L 2.50 x 0.25 x 62}

LOOSE BOLTS:

292	122	BOLT,NUT,LOCK&(2)FLATS 5/8" X 2" A-325 GALV.
293	52	BOLT,NUT,LOCK&(2)FLATS 5/8" X 2 1/2" A-325 GALV.

LOOSE:
1 LOUVER DROP ROD AND INEX PLATE, 100" LONG

Serving the Industry Since 1952
Member of HTRI & ACHEMA

SMITHCO ENGINEERING, INC.

P.O. BOX 571330
TULSA, OK 74157
PHONE: (918) 446-4406
FAX: (918) 445-2857

GENERAL STORAGE RECOMMENDATIONS

Storage of an air cooled heat exchanger for an extended period of time can cause serious damage to some components under almost any conditions. Storage in a wet or humid atmosphere can cause condensate to damage the electric motors, bearings, and unprotected machined surfaces. Drive belts can be damaged by extended exposure to either wet or dry conditions. The terms of storage as shown below are general and based on moderate storage conditions. If the storage is on a coastal or tropical area, the conditions will require a higher level of protection for even a short storage period.

Storage Period — 1 to 6 Months (Moderate Conditions)

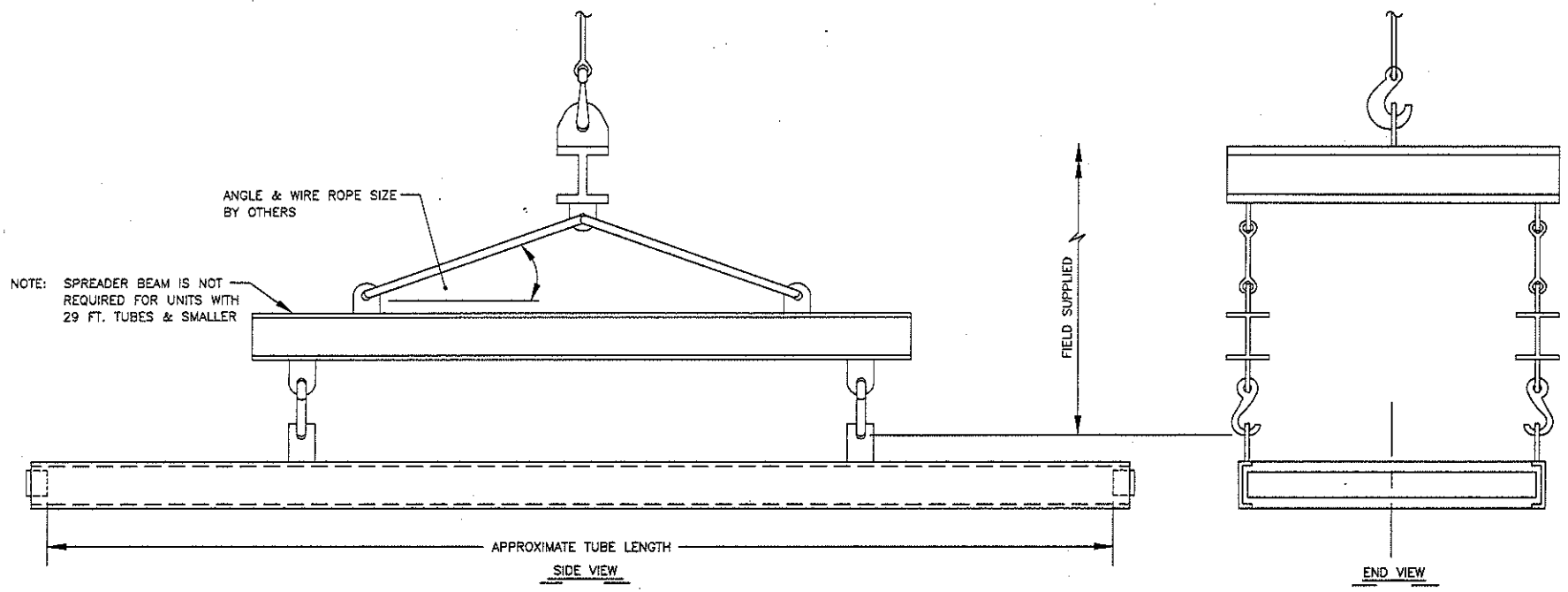
1. Nozzles covered and sealed with tape.
2. Drive belts relieved of tension.
3. Motors covered (shrink wrap and add desiccant bags) to protect against weather.
4. Plywood covers on fin tube bundle to avoid damage to the fins.
5. Coat all exposed machined surfaces with rust inhibiting preservative.
6. Rotate the fan and motor shafts by hand every 60 days (maximum) to circulate lubricant and avoid "brinelling" the bearings.
7. "Shipped loose" parts such as vibration switches, louver actuators, and all other parts boxed separately should be properly marked and stored inside a building in an area designated for that cooler.

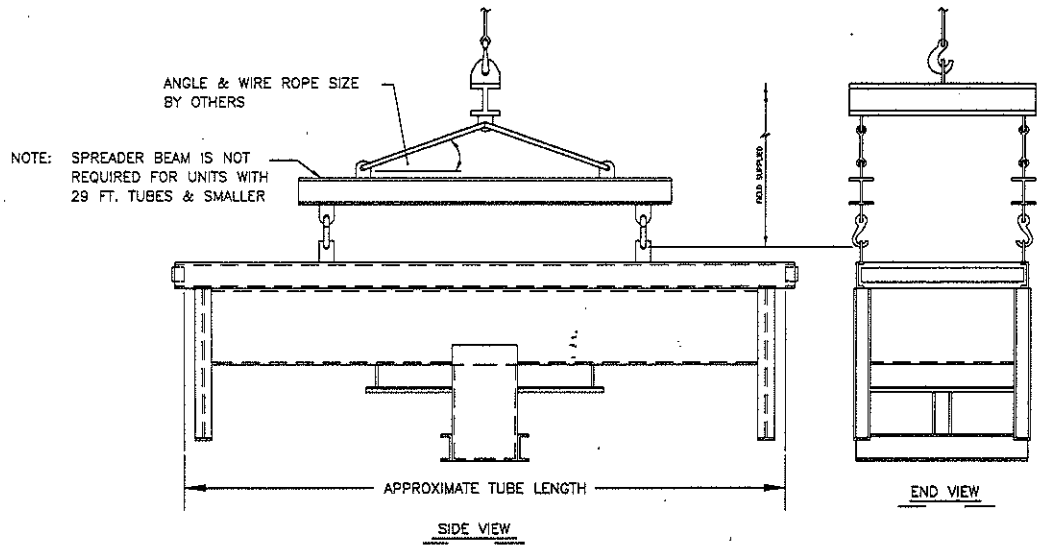
Storage Period — 6 Months or longer (Moderate Conditions)

1. Nozzles — Install gaskets and seal with metal covers or blind flanges.
2. Nitrogen purge of bundle to retard corrosion. Check the purge pressure every week and recharge as necessary to maintain 5 to 15 psi pressure.
3. Remove motors and drives from unit and store inside a humidity controlled building.
4. If the electric motors have internal space heaters, they can be connected to power continuously to avoid condensate in the motors.
5. Plywood covers on fin tube bundle to avoid damage to the fins.
6. Coat all exposed machined surfaces with rust inhibiting preservative.
7. Rotate the fan and motor shafts by hand every 60 days (maximum) to circulate lubricant and avoid "brinelling" the bearings.
8. "Shipped loose" parts such as vibration switches, louver actuators, and all other parts boxed separately should be properly marked and stored inside a building in an area designated for that cooler.

The above are recommendations only. All or part of the recommendations may be selected depending on length of storage, storage area (protected or unprotected), and weather conditions at the storage site. You are advised to document all steps taken to protect the components during storage should a warranty issue arise at a later date.

These recommendations are made with the understanding that Smithco assumes no responsibility for deterioration on any part of the equipment due to corrosion or erosion, when such deterioration occurs after leaving Smithco premises.





FOR INFORMATION ONLY
NOT FOR REVIEW

SMITHCO
ENGINEERING, INC.
Tulsa, Oklahoma

COIL SECTION & STRUCTURE
LIFTING DETAIL

DWN KIM	CKD -------	DATE 10/12/92
JOB NO. STD.		DWG NO. A-1000
REVISION	0	F

COIL SECTION & STRUCTURE LIFTING DETAIL

PREPARING FOR START UP

1. FIELD ASSEMBLED COMPONENTS

Structural components requiring field assembly are to be assembled per the drawing furnished. All parts are marked with a piece mark and the drawing shows the location of the part by piece mark number.

After Assembly:
Check all bolts (including shop assembled unit) to confirm they are tightened.
Remove any protective plywood panels from the top of the tube bundles.
Remove any restraint used to keep the fan from rotating during transport.

2. BEARINGS

Rotate the fan by hand to confirm that the shaft, bearings, speed reducer and driver turn freely.

Remote lubrication lines should be disconnected at the bearing, and then purged with grease from the fitting end. Reconnect the lube line at the bearing. This will ensure that the lube lines are full of grease and free of air and debris.

Check bearing flange bolts and set screws and tighten if necessary.

3. ELECTRIC MOTORS

Remove the condensate drain plug from each motor to drain any condensate that may have accumulated during storage. If space heaters are provided in the electric motors, activate them approximately 24 hours before starting the equipment.

4. V-BELT DRIVES

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

5. GEAR BOX

Check gearbox for oil. Some gearboxes are shipped with no oil and must be filled and serviced per the Maintenance section of this manual.

6. **LOUVERS**

Check all louvers for ease of movement prior to operation. If they do not operate freely, loosen the frame mounting bolts and adjust the frame until the louvers move freely. Retighten the bolts.

Check all mounting brackets and bolts for tightness.

Check the operation of manually operated louvers by moving the manual operator from full open to full closed several times to confirm proper linkage adjustment.

To check the operation of air motor operated (automatic) louvers, disconnect the actuator linkage and move the blades by hand. When operating correctly, retighten the bolts and reconnect the actuator. Check air supply line fittings for tightness and operate the air motor with air at the operating pressure to confirm proper linkage adjustment and the louvers operate freely with the specified air supply.

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

If the bundle has an even number of passes, bolts attaching return header(s) to sideframes must be removed. If the bundle has an odd number of passes, the bolts attaching the outlet header to the sideframes must be removed. In either case, the bolts must be removed before the unit is put into service to allow thermal expansion of the tubes.

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

8. **FANS**

The fan must be checked for adequate fan blade tip clearance. Move the blades around the inside of the fan ring and observe where blades have the least amount of clearance. The fan tip clearance should be approximately 1/2" for fans up to 9 ft. Dia., 5/8" for fans 9 ft to 11 ft. Dia., 3/4" for fans 11 ft. Dia. and larger.

Confirm the fan blade pitch setting. Looking into the end of the fan blade, the leading edge of the blade should be down and to the left. See the maintenance section for vendor instructions to set the blade pitch.

9. **HYDROSTATIC TEST**

SMITHCO tube bundles are hydrostatically tested at 1.3 times the design pressure before being released for shipment. To ensure that no damage has occurred during shipment and/or erection, it is good practice to hydrostatically test the entire system, including piping, heat exchangers, pumps, etc., prior to start-up. **Do not use water to hydrostatically test Oil Coolers. Movement during shipment and temperature fluctuations may cause minor seepage at the plug to plug-sheet joint. If this occurs, it will require tightening the plugs. Please contact the factory at the phone number below for advice on how to proceed.**

After hydrostatic test, remove the test connections. Completely drain the bundle and, if required, dry it. Connect all process piping and auxiliary connections.

Inspect all process connections as well as vent, drain, temperature and pressure connections to confirm they are plugged or connected properly.

START UP

1. Complete wiring of all electrical components including the motor(s), vibration switch(s), controls, etc. **DO NOT START MOTORS.**

2. ***WARNING! Turn off and lock out or tag power source before proceeding.***

3. Remove all hand tools and debris from the cooler plenum, drive supports, and any area containing components that will be moving when the fan is turning. Any loose debris under or around the unit may be pulled into the fan and should be removed from the area of the unit.

4. **If the unit is equipped with a fan anti windmilling device, it must be disengaged prior to applying power to the electric motors or serious damage could occur.**

5. Install all equipment guards to protect personnel from possible injury.

6. Switch on the fan driver momentarily to check for proper direction of rotation and fan blade orientation. A forced draft horizontal cooler fan should rotate counter-clockwise (left hand rotation) when looking at the air intake of the fan. The fan in an induced draft cooler should rotate clockwise looking at the air discharge of the fan.

7. Re-engage the anti windmilling device if the unit is so equipped.

8. If the starting torque trips the vibration switch turn the adjusting screw located on the right hand side of the vibration switch to the right (clockwise) for a less sensitive setting.

9. When the above steps are completed, start the fans and let then run for several minutes to warm the motors, bearings, etc. The fan should run smoothly and evenly in the fan ring. If there is noticeable vibration in the unit, stop and lock out the motor(s) and check the drive bolting for tightness. If necessary, tighten the bolts. If the vibration persists, check the fan blades for proper pitch and possible damage.

   With the unit running smoothly, the next step is to start the process through the tube bundle(s). The following methods of introducing the process fluid into the bundle should be followed.
   The process start-up should minimize thermal shock to the tube bundle(s) and avoid overcooling critical services during conditions of low ambient temperature and low heat load.

10. Low pour point and low viscosity services should have the process fluid introduced at a low rate and gradually increased to the design flow rate with the fans off. Start the fan(s) one at a time as the process fluid starts to exceed the design operating temperature. Start the fans until all fans are on or the process temperature is at the design operating temperature.

11. High viscosity fluids and fluids with a pour point above the ambient air temperature should have the process fluid introduced rapidly to prevent over cooling the first process liquid to contact the tubes. When the design process flow is reached and the process temperature begins to exceed the design temperature, start the fan(s) one at a time until the process temperature is at the design temperature or all the fans are running.

OPERATION

This section of the manual contains the applicable drawings and documents specific to this air-cooled heat exchanger. Please consult the Maintenance section of this manual for schedules of periodic maintenance.

LIST OF DOCUMENTS IN THIS SECTION (IF APPLICABLE):
(The client requirements may differ from the documents listed)

1. Smithco Warranty
2. Spare Parts List
3. Cooler Performance Data Sheet(s)
4. ASME Code U-1A FORM(s)
5. Header Design Calculations
6. Structural Calculations (if required)
7. Certified Drawings
8. Job Specific Vendor Data
   a. Fan Rating, Curves, Noise, etc.
   b. Vibration Switch Information, Wiring Diagram, etc.
   c. Motor Data Sheet, Test Reports, etc.
   d. Fan Drive Information, V-Belt, HTD, Gear, etc.
   e. Louver Information, Actuators, etc.
   f. Controllers (if furnished)

OTHER REFERENCE SOURCES:
VENDOR WEBSITES
ELECTRIC MOTORS:
www.reliance.com
www.sea.siemens.com/motors
FAN SHAFT BEARINGS
www.industry.net/dodge.rockwell.automation
V-BELTS:
www.gates.com
www.dayco.com
VIBRATION SWITCHES:
www.fwmurphy.com
www.metrix1.com
www.pmcbeta.com
www.icca.invensys.com (RobertShaw)
SPIRAL BEVEL GEAR BOXES:
www.amarillogear.com
www.hubcityinc.com
LOUVER ACTUATORS & CONTROLLERS:
www.airtechproducts.com
www.emersonprocess.com (Fisher Actuators and Controls)
LOUVERS:
www.airtechproducts.com

Serving the Industry Since 1952
Member HTRI

SMITHCO ENGINEERING, INC.
P. O. BOX 571330
TULSA, OK 74157
PHONE: (918) 446-4406
FAX: (918) 445-2857

F-260 SUPPLEMENT

FREIGHT

Freight charges represent present estimate based on existing rates. All shipments, unless dated otherwise in writing, are F.O.B. point of manufacture. Unless otherwise specified, shipments of major components will be by contract truck. Small shipments such as motors, fans, etc., may be by LTL carriers.

Actual freight charges will be for the purchaser's account, prepaid and invoiced in exact amounts to be determined at the time of shipment. Permits and other invoiced items such as dunnage required as an integral part of the carrier's tariff authority and shown on the freight bill, are part of the freight charges.

MATERIAL PURCHASES

All non-stock material will be ordered at the time of receipt of the written purchase order. Any changes in material requirements caused by revision to the certified outline drawings shall be for the purchaser's account.

SHIPMENT

The shipping date is specified in weeks from the date of receipt of the certified outline drawings marked "Approved for Construction," from the purchaser. This is an estimate based on present shop load and material deliveries.

TERMS OF PAYMENT

Unless otherwise specified, terms of payment are net thirty (30) days from date of shipment or notification that the equipment is ready for shipment.

A service charge of 1.5% per month (18% yearly interest rate) will be charged on all past due accounts. Where cash discounts are offered, they apply to equipment only and not freight or taxes.

CONDITIONS OF SALE

This proposal contains the entire contract between the parties, and it is agreed that there are no agreements, warranties, or representation expressed or implied, related to the contract except such as are specifically set forth herein, and when duly accepted and approved, it shall constitute the entire contract between the parties hereto. No modification thereof shall be binding on either party unless in writing and duly signed by the purchasers and the company.

Orders entered on our books may not be canceled except upon our consent and upon terms indemnifying us against loss. We make every effort to ship on dates promised and to maintain production schedules consistent therewith, but we are not liable for claims of damage or any other expense due to failure to meet scheduled shipping date. We are not responsible for damage to equipment in transit. Purchasers are warned against signing for equipment before making careful inspection.

PERFORMANCE GUARANTEE

All Smithco exchangers are guaranteed to have the capacity to perform according to our rating when properly installed and maintained for a period of one year from start-up, not to exceed 18 months from shipping date or notification that the exchangers are ready for shipment. The specified design conditions are those shown on the exchanger specification sheet. The purchaser shall specify the conditions under which the equipment shall be expected to function, and Smithco's guarantee shall extend to meeting said specified conditions. In the event of disagreement concerning performance, arrangement will be made for an inspection of the system of which the equipment in question is a component part and for a test of the same, in whole or in part, to the extent necessary to test our equipment. The test shall be made by Smithco Engineering, Inc., with a mutually agreeable testing procedure for determining heat load and cooling capacity. In case our equipment does not perform as rated, Smithco will bear whatever expense is incurred in making the inspection and test, and will at its option make changes necessary to obtain performance, replace F.O.B. factory the questioned equipment, or promptly refund the purchase price on return of the goods, F.O.B. factory. If the failure is due to failure of components not manufactured by Smithco, or misapplication of components, or incorrect heat load calculation, the purchaser shall bear all expense required to make necessary corrections and will reimburse Smithco for all its expense in connection with the inspection and test.

MATERIAL AND WORKMANSHIP WARRANTY

Smithco warrants each exchanger against defects in material and workmanship for a period of one year from shipping date and shall repair or replace, F.O.B. our plant, any parts proven defective within said period. Finished materials and accessories purchased from other manufacturers, including metal tubing, are warranted only to the extent of the original manufacturer's warranty to the heat exchanger fabricator. Any defective equipment or parts will be promptly replaced or repaired without charge, F.O.B. our factory, and any changes in the field by the customer will be at his expense unless authorized by Smithco.

Smithco assumes no responsibility for deterioration of any part of the equipment due to corrosion, erosion, or any other causes regardless of when such deterioration occurs after leaving our premises.

DISCLAIMER OF WARRANTIES, CONSEQUENTIAL DAMAGES

The warranty provided in this article and the obligations and liabilities of the seller thereunder are exclusive and in lieu of and buyer hereby waives all other remedies, warranties, guaranties, or liabilities, express or implied, arising by law or otherwise (including without limitation any obligations of the seller with respect to fitness, merchantability, indirect and consequential damages) or whether or not occasioned by seller's negligence. This warranty shall not be extended, altered, or varied except by a written instrument signed by seller and buyer.

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Member of HTRI & ACHEMA

SMITHCO ENGINEERING, INC.
P.O. Box 571330
Tulsa, Oklahoma 74157
Phone: (918) 446-4406
Fax: (918) 446-7439

Co: Poseidon Oil Pipeline Co.
Ref: 0158919
Item: HAL-4110/20

Date: 12/17/2008

RECOMMENDED SPARE PARTS FOR 2 YEAR OPERATION
SMITHCO JOB NO. 2008B554

Item #	QTY	Description	Net Each	Total Net
001	56	A1051838 Plugs	$6.25	$350.00
002	112	CS1813 gasket	$.50	$56.00
003	1	Cofimco Fan, 144 inch 4 Blade #3658-04-24L/B3T 2.9375 bore	$.00	$.00
004	1	2.9375 X 46.5 Shaft with 0.7500 X 0.3750 Keyway 4.2500 one end 4.8750 other end with keys	$458.72	$458.72
005	1	30 HP Electric Motor Frame 286T Chem Duty 1750 RPM TEFC-XEX Enclosure 460/3/60 Premium Eff. Insulation Class F Service Factor 1.15 Vent Drain Space Heater (120)	*	*
006	2	2.9375 SCM Flange Bearings	$307.80	$615.60
007	1	3360 -14M- 40 HTD Belt	$362.66	$362.66
008	1	P192-14M-40 Sprocket w/2.9375 bore .75 X .375 keyway	$1,112.32	$1,112.32
009	1	P28-14M-40 Sprocket w/1.8750 bore .500 X .2500 kw	$134.06	$134.06
010	1	VS-2EX Vibration Switch	$287.36	$287.36

*Provided upon request

The recommended quantities are for remote locations.

SMITHCO Engineering Inc.

P.O. Box 571330 Tulsa, OK 74157
Ph. (918) 446-4406 FAX (918) 445-2857

AIR COOLED EXCHANGER SPECIFICATION SHEET

Date	Tue*10:27 am*22-JUL-08
Proposal/Job No.	2008B-554-01
Reference	O158919
Item No.	HAL-4110/20

Customer	POSEIDON OIL PIPELINE CO					
Plant Location	Offshore GOM					
Service	Pipeline Pump Recycl					
Model	1 F34-140-2	Type	FORCED		No. of Bays	1 (2 Units)
Surface per Unit-Finned Tube	53,940			Ft²	Bare Tubes	2,548 Ft²
Heat Exchanged	2,100,000			BTU/Hr	MTD (Eff.)	15.8 (Counter Flow)°F
Transfer Rate-Finned Tube	2.46	Bare Tube, Service	52.02			BTU/Hr. Ft2 °F

PERFORMANCE DATA-TUBE SIDE

Fluid Name	CRUDE OIL			Lethal Service	Yes [ ] No [X]	IN	OUT
Total Fluid Entering	Lb/Hr 409,500			Density	Lb/Ft³	54.4	54.4
		IN	OUT	Specific Heat (Liq/Vap)	BTU/Lb°F	.510 /	.510 /
Temperature	°F	119.0	109.0	Cond. avg (Liq/Vap)	BTU/HrFt°F	.0670/	
Liquid	Lb/Hr	409,500	409,500	Pour/Freeze Point	°F		
Vapor	Lb/Hr (MW)			Bubble Point	°F		
Nocond	Lb/Hr (MW)			Latent Heat	BTU/Lb		
Steam	Lb/Hr			Pressure	Psia	200.00	
Water	Lb/Hr			Pressure Drop	Allow/Calc Psi	20.00 / 14.91	
Viscosity (Liq/Vap)	Cp	8.000 /	8.000 /	Fouling resist, Inside	ft² hr °F/BTU	0.00200	

PERFORMANCE DATA-AIR SIDE

Air Quantity	SCFM 335,900	Lb/Hr 1,512,000	Altitude	Ft	150
Air Quantity/Fan ACFM	176,700		Temperature In	°F	95.0
			Temperature Out	°F	100.8

DESIGN - MATERIAL - CONSTRUCTION

Design Pressure	2,000 Psig	Test Pressure	2,600 Psig	Design Temperature	150 / MDMT 0 °F		
TUBE BUNDLE		**HEADER,** Type	PLUG BOX	**TUBE** Material	SA-214 WLD		
Size	14.0 x 34.0	Material	SA-516 GR-70				
No. 1	No. Tube Rows 4	No. Passes 2	Slope 0.0000 In/Ft	OD 1.000 In	Min. Thick 0.0830 In		
Bays 1	In Parallel In Series	Plug	A1051826	No./Bundle 286	Length 34.0 Ft		
Bundles 1	In Parallel In Series	Gasket	CS1813	Pitch 2.3125	InΔ		
Pass Arrangement (Top to Bottom)		Corrosion Allowance	0.1250 In	FIN Type EXTRUDED			
Rows / Pass	4/ 2	Size In Nozzle	(2) 6.00 SCH 160 SA-106B In	Material ALUM			
Turbulators	YES	Size Out Nozzle	(2) 6.00 SCH 160 SA-106B In	OD 2.250 In	Stock Thick 0.183 In		
Steam Coil	NO	Rating & Facing	900 -RJ SA-105	No/In 10	Support Chan. / Staple		
Hailscreens	NO	Vent	(1) 1-6000 Drain (1) 1-6000	Code-ASME VIII,Div 1 YES	Stamp ASME		
Louvers	ALUM (1) MANUAL	TI	PI	Radiograph YES API-661	Heat Treat YES		
Frame Finish	HTC 1 Coat Galvanize	Header Finish	WMSB 1 Coat Metalize	Tube Hole Grooving	YES		

MECHANICAL EQUIPMENT

FAN Mfg & Model	Cofimco 3658-04-24L/B3T	**DRIVER** Type	ELECTRIC MOTOR	**SPEED REDUCER** Type	COG
No./Bay 2	RPM 255	S.F. 1.15	Insul/TR CLASS F / B	14M - 40 SPROCKET 33.7/4.9	
Dia. 12.0 Ft.	No. Blades 4	No./Bay 2	Frame 286T HP 30.0	No./Bay 2 Test Run Fan	
Pitch ADJUSTABLE	Angle° 11.	RPM (2)1750	Duty CHEM	HP Rating 54.0	Ratio 6.86
Matl, Blade ALUMINUM	Hub EXT ALUM	Enclosure TEFC	(H.E.) V & D V&D	Support: SUSPENDED FROM STRUCTURE	
HP/Fan, Des. 24.1	DBA 85.	V/P/C 460/3/60	Space Heater YES	Vibration Switch	MURPHY VS-2EX

STRUCTURE

Mounting	GRADE
Windload - PSF	30.0 Seismic None
Finish	HTC 1 Coat Galvanize

WALKWAYS

Inlet Header	in. None
Outlet/Return	in. None
Drive Access	in. None

NOTES

Coil Volume (ft^3): 40.

Assembled Drive, Structure & Bundles (Within Shipping Restrictions)

Plot Area	14.0 x 34.0 ft	Weight Bundle	28,940 Lbs	Total Shipping	47,690 Lbs

IMPERIAL 4/94

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 SMITHCO Engineering, Inc., 6211 S. 39th W. Avenue, Tulsa, Oklahoma 74132 (Name and address of manufacturer)
2. Manufactured for POSEIDON OIL PIPELINE CO Houston, TX 77002 (Name and address of purchaser)
3. Location of installation Poseidon OPC Offshore GOM (Name and address)
4. Type Horiz(Non-Cir) (Horiz. or vert. tank) | 2008B-5541-A/B (Mfgr's serial No.) | ---------- (CRN) | 2008B-5541 (Drawing No.) | ------ (Nat'l Bd. No.) | 2008 (Year built)
5. The chemical and physical properties of all parts meet the requirements of material specifications of the ASME BOILER AND PRESSURE VESSEL CODE.

The design, construction, and workmanship conform to ASME Rules, Section VIII, Division 1 2007 (Year)

to 2008 ADD (Addenda (Date)) | (Code Case Nos.) | -- (Special Service per UG-120(d))

6. Shell: Tube & Plug Sheets: SA-516 GR-70 N (Matl. (Spec. No., Grade)) | Fr 2.750/ Bk 2.750 (Nom. Thk. (in.)) | .1250 (Corr. Allow. (in.)) | Fr 0' 7.8750"/Bk 0' 7.8750" (Diam. I.D. (ft. & in.)) | 13' 11.8125" (Length (overall) (ft. & in.))
7. Seams: Corner Joint (Long. (Welded., Dbl., Sngl., Lap, Butt)) | ---- (R.T. (Spot or Full)) | 100 (Eff(%)) | 1150 (H.T. Temp. (°F)) | 90min. (Time (hr)) | ---- (Girth (Welded, Dbl., Spot., Lap, Butt)) | ---- (R.T. (Spot., Partial or Full)) | 1 (No. of Courses)
8. Heads: (a) Matl. (a) Covers: SA-516 GR-70 N (Spec. No., Grade) b) Matl. (b) Ends: SA-516 GR-70 N (Spec. No., Grade)

	Location (Top, Bottom, Ends	Minimum Thickness	Corrosion Allowance	Crown Radius	Knuckle Radius	Elliptical Ratio	Conical Apex Angle	Hemispherical Radius	Flat Diameter	Side to Pressure (Convex or Concave)
(a)	Fr/Bk	1.250/1.000	0.1250	--	--	--	--	--	4.3750/2.8750 x 167.8125	Flat
(b)	Fr/Bk	1.125/0.875	0.1250	--	--	--	--	--	4.3750/2.8750 x 7.3125/6.8125	Flat

If removable, bolts used (describe other fastenings) N/A (Matl., Spec. No., Gr., Size, No.)

9. MAWP 2000 (internal) ____ (external) psi at max. temp 150 (internal) ____ (external) °F

Min. design metal temp. 0 °F at 2000 psi. Hydro., ~~pneu., or comb.~~ test pressure 2600 psi

10. Nozzles, inspection and safety valve openings:

Purpose (Inlet, Outlet, Drain)	No.	Diameter or Size	Type	Material	Nominal Thickness	Reinforcement Material	How Attached	Location
Inlet/Outlet	2/2	6"900/160	RJWN	SA-105/SA-106B	0.719	Integral	UW-16.1(a)	Front Head
Vent/Drain	2	1.0	6000CPLG	SA-105		Integral	UW-16.1(a)	Back Head

11. Supports: Skirts No (Yes or No) Lugs ____ (No.) Legs 4 (No.) Other ____ (Describe) Attached Welded to covers (Where and how)
12. Remarks: Manufacturer's Partial Data Reports properly identified and signed by Commissioned Inspectors have been furnished for the following items of the report: (Name of part, item number, Mfgr's name and identifying stamp)

Impact testing exempt per: UCS-66(a), UCS-66(b), UCS-66.1, UG-20(f) & UCS-68(c) Item: HAL-4110/20 Service: PIPELINE PUMP RECYC
Tubes: SA-214 WLD- 286 x 1.00" x .083" x 34.0000'-Straight
Front: Constructed in conformance with appendix 28, Back: Constructed per UW13

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. 4175 expires February 28th, 2009.

Date 12-19-2008 Co. name SMITHCO Engineering, Inc. (Manufacturer) Signed T. Cates (Representative)

CERTIFICATE OF SHOP/FIELD INSPECTION

Vessel constructed by SMITHCO Engineering, Inc. at Tulsa, Oklahoma

I, the undersigned, holding a valid commission issued by the National Board of Boiler and Pressure Vessel Inspectors and/or the State of Province of Oklahoma and employed by Seneca Insurance Company of Texas have inspected the component described in this Manufacturer's Data Report on 1/8 20 09, 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. Futhermore, neither the Inspector nor his employer shall be liable in any manner for any personal injury or property damage or loss of any kind arising from or connected with this inspection.

Date 1/8/09 Signed ____ (Authorized Inspector) Commissions OK914 (Nat'l Board (incl. endorsements), State, Prov. and No.)

HEADER CALCULATIONS UNSTAYED

CUSTOMER: POSEIDON OIL PIPELINE Date: 10/3/2008
P.O. NO. 0158919 JOB # 2008B5541
HEADER: INLET / OUTLET
Material: SA-516 70N Allow.Stress@100deg. F: 20000 (PSI)
DESIGN TEMPERATURE (Deg. F)= 150 MDMT(Deg F) = 0
HYDROSTATIC TEST PRESSURE (PSI)= 2600

INPUT INFORMATION:

DESIGN PRESSURE	2000 PSI	Corroded	
WIDTH (H)	4.6875 inch	4.9375	inch
HEIGHT (h)	7.625 inch	7.8750	inch
COVER THICKNESS	1.25 inch	1.1250	inch
TUBE/PLUG SHT THICKNESS	2.75 inch	2.6250	inch
CORROSION ALLOWANCE	0.125 inch		
ALLOWABLE STRESS	20000 PSI		
TUBE OD	1 inch		
PLUG DIAMETER	1.125 inch		
MULTI DIAMETER HOLE DIA.	1.0709 inch		
TUBE PITCH	2.3125 inch		
LIGAMENT EFFICIENCY	0.53691		
CORNER JOINT WELD EFF.	1.0		

MEMBRANE STRESSES PSI:

COVER	7000.00
TUBE/PLUG SHEET	3503.30

BENDING STRESSES PSI:

COVER @ CTR SPAN	6314.10
COVER @ CORNER	22579.42
TUBE/PLUG @ CTR SPAN	17419.66
TUBE/PLUG @ CORNER	4147.24

COMBINED STRESSES PSI:

COVER PL @ CTR SPAN	13314.10
COVER PL @ CORNER	29579.42
TUBE/PLUG PL @ CTR SPAN	20922.97
TUBE/PLUG PL @ CORNER	7650.54

MEMBRANE STRESSES MAY NOT EXCEED ALLOWABLE STRESS.
COMBINED STRESSES MAY NOT EXCEED 1.5 TIMES ALLOWABLE STRESS= 30000 PSI

END PLATE IN ACCORDANCE WITH UG-34
MIN END PLATE THICKNESS = 1.0863 inch, USE 1.125 inch

THESE CALCULATIONS ARE IN ACCORDANCE WITH SECTION VIII, DIV 1 APPENDIX 13 OF THE ASME CODE 2007 ED, FIG. 13.2(a) SKETCH (1),

APPROVED BY: Reg D. Abramson

HEADER CALCULATIONS UNSTAYED

CUSTOMER: POSEIDON OIL PIPELINE Date: 10/3/2008
P.O. NO. 0158919 JOB # 2008B5541
HEADER: RETURN
Material: SA-516 70N Allow.Stress@100deg. F: 20000 (PSI)
DESIGN TEMPERATURE (Deg. F)= 150 MDMT(Deg F) = 0
HYDROSTATIC TEST PRESSURE (PSI)= 2600

INPUT INFORMATION:

			Corroded	
DESIGN PRESSURE	2000	PSI		
WIDTH (H)	3.1875	inch	3.4375	inch
HEIGHT (h)	7.625	inch	7.8750	inch
COVER THICKNESS	1	inch	0.8750	inch
TUBE/PLUG SHT THICKNESS	2.75	inch	2.6250	inch
CORROSION ALLOWANCE	0.125	inch		
ALLOWABLE STRESS	20000	PSI		
TUBE OD	1	inch		
PLUG DIAMETER	1.125	inch		
MULTI DIAMETER HOLE DIA.	1.0709	inch		
TUBE PITCH	2.3125	inch		
LIGAMENT EFFICIENCY	0.53691			
CORNER JOINT WELD EFF.	1.0			

MEMBRANE STRESSES PSI:

COVER	9000.00
TUBE/PLUG SHEET	2439.01

BENDING STRESSES PSI:

COVER @ CTR SPAN	2588.74
COVER @ CORNER	20561.77
TUBE/PLUG @ CTR SPAN	20888.79
TUBE/PLUG @ CORNER	2284.64

COMBINED STRESSES PSI:

COVER PL @ CTR SPAN	11588.74
COVER PL @ CORNER	29561.77
TUBE/PLUG PL @ CTR SPAN	23327.80
TUBE/PLUG PL @ CORNER	4723.65

MEMBRANE STRESSES MAY NOT EXCEED ALLOWABLE STRESS.
COMBINED STRESSES MAY NOT EXCEED 1.5 TIMES ALLOWABLE STRESS= 30000 PSI

END PLATE IN ACCORDANCE WITH UG-34
MIN END PLATE THICKNESS = 0.8706 inch, USE 0.875 inch

THESE CALCULATIONS ARE IN ACCORDANCE WITH SECTION VIII, DIV 1
APPENDIX 13 OF THE ASME CODE 2007 ED, FIG. 13.2(a) SKETCH (1)

APPROVED BY: Rex D. O'Bannon

Job No.:2008B5541 Tube wall and Nozzle Neck Calculations

Tube Wall:

Design Pressure (P): 2000. PSI
Tube OD (D): 1.00 In.
Tube stress (S): 11400. PSI

Minimum wall = P * D/2 / (.4*P + S) = 0.0820 In.
Actual wall: 0.0830 In.

Nozzle neck/Pipe wall:

Inlet nozzle/Pipe:

Pipe Matl : SA-106B
Design Pressure (P): 2000. PSI
Nozzle OD (D): 6.625 In.
Nozzle stress (S): 17100. PSI
Corrosion (C): 0.1250 In.

Calculated wall = P * D/2 / (.4*P + S) + C = 0.4951 In.
Minimum wall: 0.6291 In.

Outlet nozzle/Pipe:

Pipe Matl : SA-106B
Design Pressure (P): 2000. PSI
Nozzle OD (D): 6.625 In.
Nozzle stress (S): 17100. PSI
Corrosion (C): 0.1250 In.

Calculated wall = P * D/2 / (.4*P + S) + C = 0.4951 In.
Minimum wall: 0.6291 In.

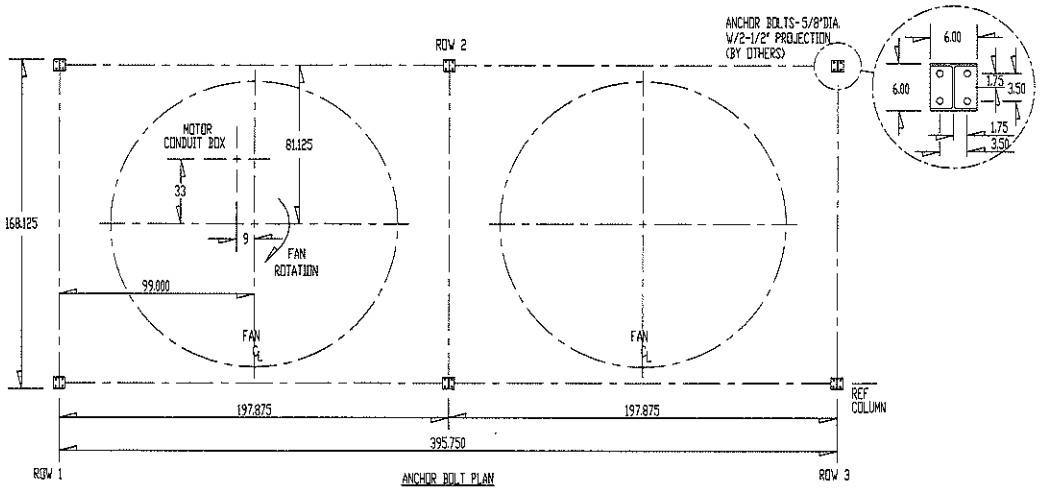
DRY WGHT 41500 WIND 30.0 PSF /100 MPH SEISMIC 0 PLATFORM 0 LBS/SQ-FT LIVE

COLUMN LOAD (KIPS)	DRY DEAD	WET DEAD	WIND VERT	WIND HORIZ	SEIS VERT	SEIS HORIZ	SNOW	PLAT	NOZZ VERT	NOZZ HORIZ	TOTAL
ROW 1 /COLUMN	5.2	5.6	1.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	6.7
ROW 2 /COLUMN	10.4	11.2	2.1	1.4	0.0	0.0	0.0	0.0	0.0	0.0	13.3
ROW 3 /COLUMN	5.2	5.6	1.0	0.7	0.0	0.0	0.0	0.0	1.1	1.1	7.8

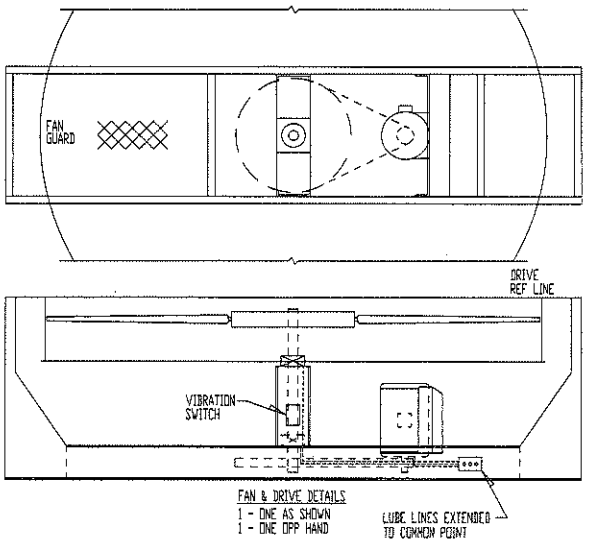
FAN COFIMCO 3658-04-24L/B3T
144 IN. DIAMETER 4 BLADE
177808 ACFM 11.1 DEG.
DRIVE REDUCER
BELTS 3360 -14M - 40
SHEAVES FAN P192 MOTOR P28
BEARINGS 2.9375 IN.
SHAFT 2.9375 IN. X 46.50 IN. LG.

MOTOR HP 30.0 RPM 1758. /0.
286T TEFC VENT & DRAIN HEATER
INSULATION CLASS F /B TEMP RISE
460 /3/60 SINGLE WINDING VARIABLE TORQUE
AMPS@102/FLA 36. LRA 218.
VIBRATION SWITCH MURPHY VS-2EX
VOLTS 480. AMPS 5.0 CONTACTS (2) SPDT

SHOP RUN IN TEST

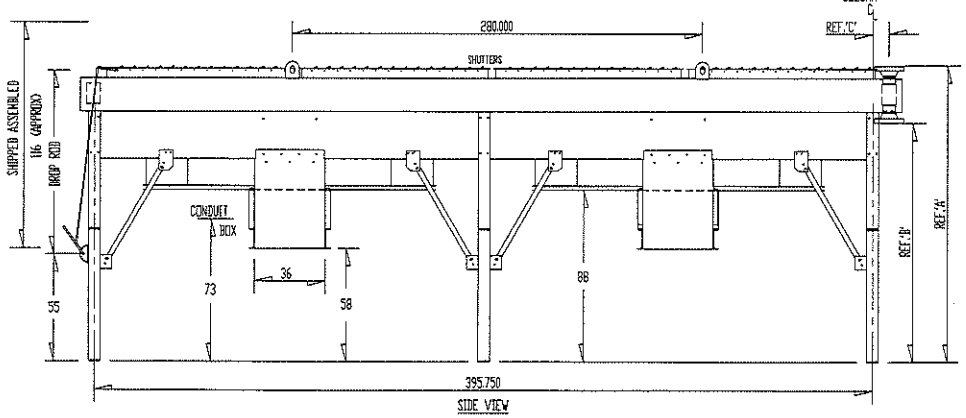


ANCHOR BOLT PLAN

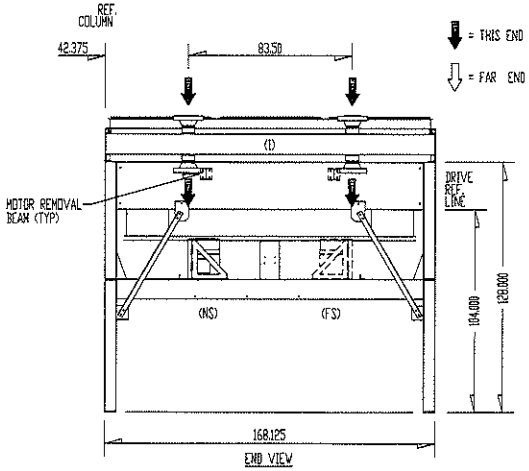


FAN & DRIVE DETAILS
1 - ONE AS SHOWN
1 - ONE OPP HAND

LUBE LINES EXTENDED TO COMMON POINT



SIDE VIEW



END VIEW

1 OF 2 UNITS PROVIDED

ITEM	SERVICE	NOZZLES INLET	NOZZLES OUTLET	REFERENCE DIMENSIONS A	B	C	D	BUNDLE WEIGHT	COUPLINGS V&D	TEMP	PRESS	SHUTTER-OPERATOR	HAIL SCRN	CODE	DESIGN PRESS.
1 HAL-410/20	PIPELINE PUMP RECYCL	(2) 6.00 - 900 # RJ SCH 160	(2) 6.00 - 900 # RJ SCH 160	152.2500	122.8750	8.250		28900	1-6000			MANUAL w/ 100' DROP ROD	NO	ASME	2000

REV 1: PER CUSTOMER COMMENTS & CERTIFIED FINAL JM 9/26/08
REV 0: SUBMITTED FOR APPROVAL JM 7/17/08

TOLERANCES: (ALL DIMENSIONS IN INCHES)
MECHANICAL EQUIPMENT ±1/8" PER 10 '-0"
NOZZLE ±1/8"
STRUCTURAL- HAND TOOL CLEAN
WITH 1 COAT GALVANIZE
FRAME- HAND TOOL CLEAN
WITH 1 COAT GALVANIZE
HEADER- WHITE METAL BLAST CLEAN
WITH 1 COAT METALIZE

CUSTOMER POSEIDON OIL PIPELINE CO
LOCATION OFFSHORE GOM
REFERENCE 0158919

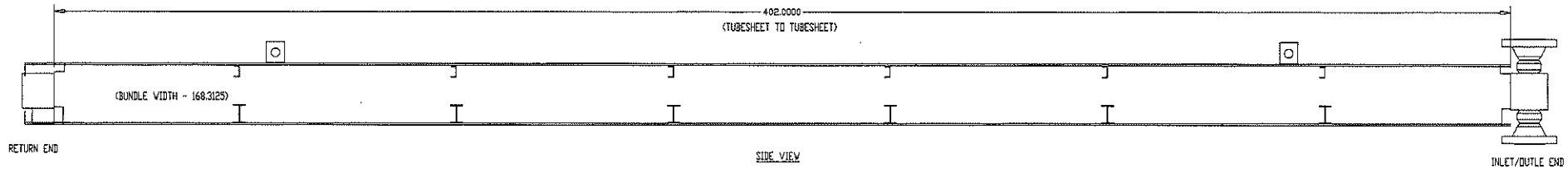
CERTIFIED BY JMCARTER DATE 9/26/08

SMITHCO
AIR COOLED DIVISION
TULSA, OKLAHOMA

PIPING, EQUIPMENT OUTLINE & ANCHOR BOLT PLAN
MODEL 1 F 34 - 140 - 2 QUANTITY 2

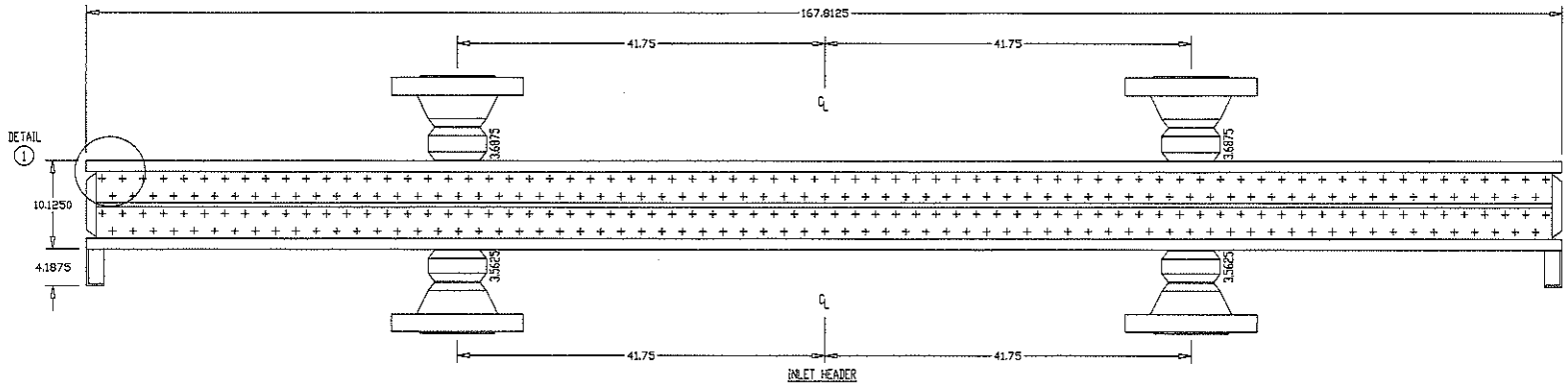
DWN JM CKD DATE 7 - 8 - 2008

REV 1 JOB 2008B 554 -A

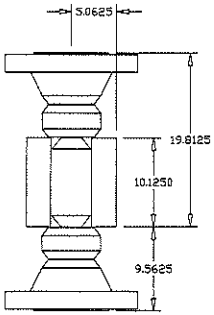


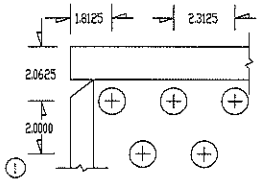
SIDE VIEW

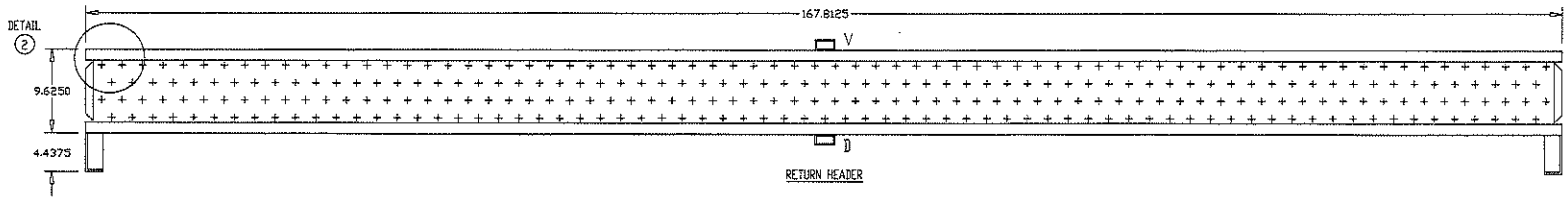
12.2500
SHOP REFERENCE



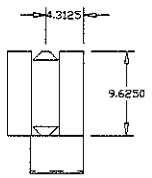
INLET HEADER



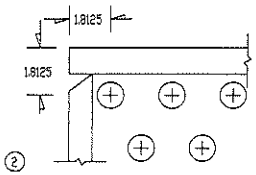




RETURN HEADER



TUBE SHEET SIDE



REV 1: CHANGED DESIGN & CERTIFIED FINAL JM 9/26/08
REV 0: SUBMITTED FOR APPROVAL JM 7/16/08

MACHINING	DRILL	REAM	SPECIAL
TUBE HOLE	0.9375	1.010 ± 0.002	DG
PLUG HOLE	1.0312	# SF 1.375	TAP 2.1875
NOZZLE IN (2)	6.00	# — 900	# RJ SCH 160
OUT (2)	6.00	# — 900	# RJ SCH 160
VENT (1) 1-6000	DRAIN (1) 1-6000		
HEAT TREAT	1150	DEG. F 90	MIN.
RADIOGRAPH -	API-661	10	INCH SHOT
WEIGHT	7800		

			THICK	LENGTH	WIDTH	BEVELS
INLET	TUBE	PLUG	2.7500	167.8125	10.1250	NONE
INLET	COVER		1.2500	167.8125	4.3750	LONG SIDES
INLET	END		1.1250	4.3750	7.3125	ALL SIDES
	PASS		0.5000	165.5625	4.6875	NONE
RETURN	TUBE	PLUG	2.7500	167.8125	9.6250	NONE
RETURN	COVER		1.0000	167.8125	2.8750	LONG SIDES
RETURN	END		0.8750	2.8750	6.8125	ALL SIDES

MATERIAL SPECIFICATIONS		
PLATE	SA-516 GR-70	NORM
FLG	SA-105	
PIPE	SA-106B	STOCK
CPLG	SA-105	STOCK

WELD PROCEDURES	
PIPE-FLG	GWP01HT/FWP01HT
FLG-HEAD	GWP01HT/SWP01HT
HAND WLD	GWP01HT/FWP01HT
AUTO WLD	AWP01HT/

PLATE TOLERANCES ± 1/16"

TUBES 286 TF 72 ROWS 4 PASS 2 LGTH 408 IN.
TUBE OD 1.000 X 0.083 MATL SA-214 WLD
FIN TYPE EXTRUDED 10.0 - 0.625 - ALUM
PLUG QTY 572 TYPE A105 -1838
GASKET CS -1813
EXPANDER 0.8340 LENGTH 16.0900
FRAME -THICK 0.2500
LENGTH 418 IN. DEPTH 17.0000 X 3
SUPPORT- 6 ,BINDER- 6 ,CLOSER- 4 167.438
SUPPORT TYPE - SCALLOPED CHANNEL
STAPLED ENDS
AGITATORS 0.774 X 409.000 SMOOTH TURBULATOR
F.FOOT: 6" X 4.1875" B.FOOT: 6" X 4.4375"

STOCK0
STOCK0
STOCK0
STOCK0
STOCK0

C

TEST PRESSURE: 2600 TIME: 60 MIN. W/ CHART
HEAD: WHITE METAL BLAST CLEAN
w/ 1 metalize
FRAME: HAND TOOL CLEAN
w/ 1 galvanize
COIL VOLUME: 40 CUBIC FEET
DESIGN TEMP: 150 F
DESIGN PRESSURE: 2000 Psig
MOMT: 0 F
CORROSION ALLOWANCE: 0.1250

CERTIFIED: JMCARTER DATE: 9/26/08

TOLERANCES LENGTH & WIDTH ± 0.125" PER 10 ' -0 "
TUBE PROJECTION API 661

AIR COOLED DIVISION

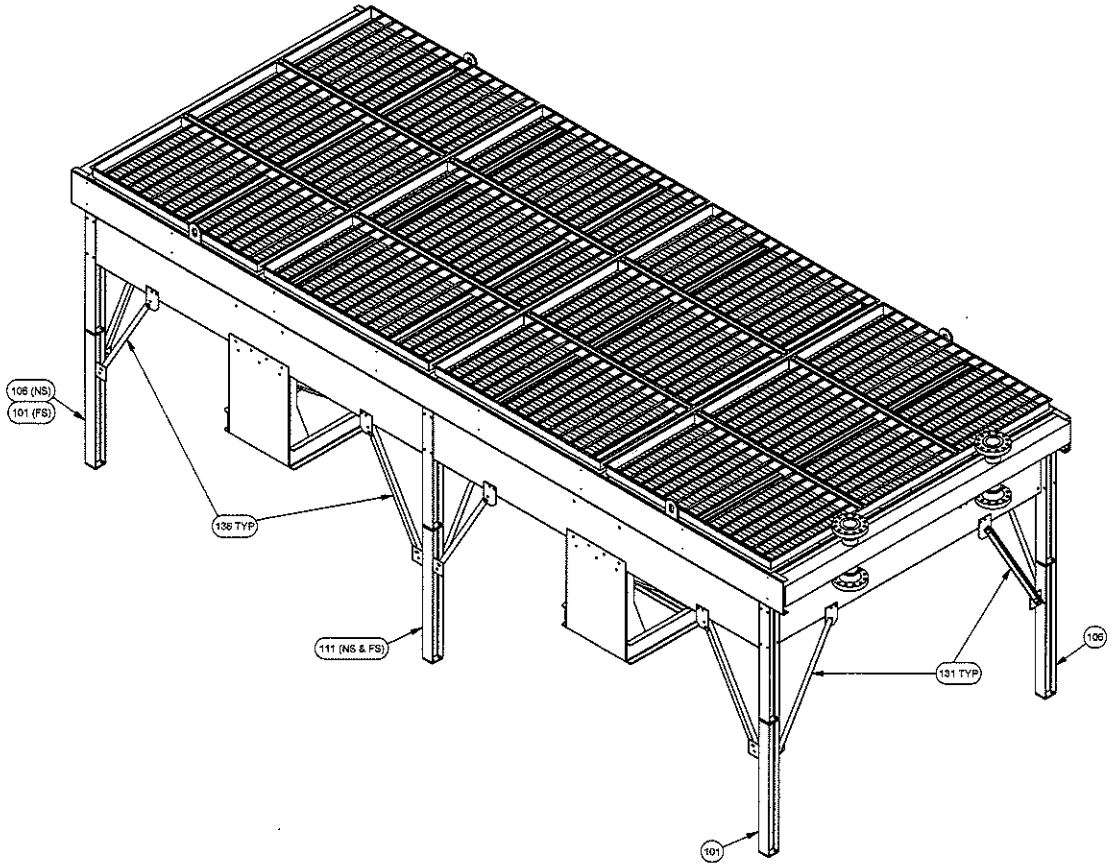
BUNDLE DETAILS

APPRV | REV 1 | 10 - 2 - 2008

SERVICE : Pipeline Pump Recycl
ITEM : HAL-4119/20

MFG	WELD	FIN	ASMBL	STRUC	INSP	CUST
1	2		2	1	1	0

QTY 2 | WEIGHT 28908 | 2008 B 554 1



NOTE:
1. USE 5/8" X 2 1/2" (A-325) BOLT, NUT, LOCKWASHER & (2) FLATWASHERS AT ALL COLUMN SPLICE CONNECTIONS.
2. USE 5/8" X 2" (A325) BOLT, NUT, LOCKWASHER & (2) FLATWASHERS AT ALL COMUMN BRACE CONNECTIONS.
3. REMOVE REAR HEADER BOLTS BEFORE START UP.

FOR INFORMATION ONLY
NOT FOR REVIEW

SMITHCO
ENGINEERING, INC.
Tulsa, Oklahoma

2 F34-140-2
FIELD ERECTION

ENGR: JM	CK'D BY: VR	DATE: 9/29/2008
JOB NO: 2008B554	DWG NO: 554B-FE	
REV: 0	SCALE:	QTY: 1

Via Gramsci, 62 - 28050 Pombia (NO) - ITALY Tel. +39.0321.968311 - Fax +39.0321.958992 - E-mail info@cofimco.com
4035 Holland Boulevard-P.O.Box 6127-Chesapeake, Virginia 23323 Tel.(757)485-5798 Fax (757)485-7021 E-mail cofimco@cofimcousa.com
Rua Severino Tescarollo, 880-CEP 13255-410 Itatiba, SP BRASIL Tel.+55-11-4534-9999 Fax +55-11-4534-1410 E-mail cofimco@cofimco.com.br

Customer Name	Smithco Engineering	Job Name	Poseidon Oil Pipeline Co.
Job Reference	2008B-554-01	Item Number	HAL-4110/20
			Date 22/07/2008

CHARACTERISTICS

Required Volume	176700.00	ACFM	Required Static Pressure	0.50	Inch H2O
Pressure recovery	0.00	Inch H2O	Fan static pressure	0.50	Inch H2O
Velocity pressure	0.14	Inch H2O	Total pressure	0.64	Inch H2O
Air Temperature	95.0	°F	Site Elevation	150	ft
Inlet Air Humidity (%)			Inlet Air Density	0.071	lb/ft³
Fan diameter	12.0	ft	Fan ring diameter	3687	mm
Blade Airfoil	24L	ALU	Rotor hub type	B3	
RPM	255.0	rpm	Blade Tip Speed	9614.3	ft/min
N° blades	4		Blade frequency +/-5%	302	cpm
Static efficiency	64.5	%	Total efficiency	82.5	%
Blade pitch angle(°)	11.1		Rotor shaft power	21.6	hp
			Rotor shaft power @ API point	29.6	hp
Pressure margin	47	%	Volume margin	15	%
Tip Clearance/D	0.004		Inlet	Flanged	
Diffuser angle (°)	0.00		Diffuser:Length/D	0.00	
Inlet Obstacle a/A	0.000		Inlet Obstacle x/D	0.000	
Outlet Obstacle a/A	0.000		Outlet Obstacle x/D	0.000	
Installation Type	Forced		Aerod axial force	171	kg
Rotor total weight	66	kg			
Rotor inertia PD²	153	kg x m²			
Max residual unbalance	1.2	kg			
Blade failure load	452	kg			
Two Blades Failure Loads	639	kg			
Xs static deflection	127	mm	Xr running deflection	138	mm

NOISE CHARACTERISTICS

Tolerance on sound values +/- 2 dB(A)

PWL 92.3 dB(A)
SPL @ 3.0 ft
Inlet / outlet 79.1 dB(A)
Side 69.6 dB(A)

Octave band [Hz]	31.5	63	125	250	500	1000	2000	4000	8000
PWL [dB]	95.3	97.3	97.3	93.3	90.3	87.3	79.3	75.3	71.3
SPL in/out [dB]	82.1	84.1	84.1	80.1	77.1	74.1	66.1	62.1	58.1
SPL side [dB]	72.6	74.6	74.6	70.6	67.6	64.6	56.6	52.6	48.6
Tolerance +/-	5	5	3	2	2	2	2	2	2

ROTOR MODEL 3658-4-24L/B3T **PAC-T**

All data must be approved by Cofimco

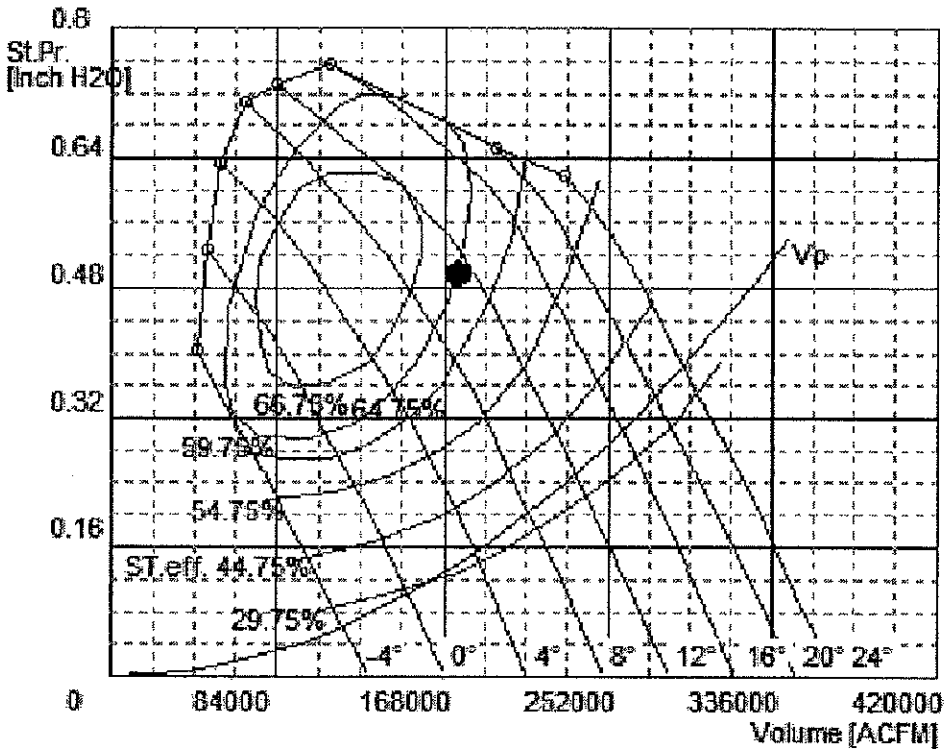
FanTastic V1R7

Via Gramsci, 62 - 28050 Pombia (NO) - ITALY Tel. +39.0321.968311 - Fax +39.0321.958992 - E-mail info@cofimco.com
4035 Holland Boulevard-P.O.Box 6127-Chesapeake, Virginia 23323 Tel.(757)485-5798 Fax (757)485-7021 E-mail cofimco@cofimcousa.com
Rua Severino Tescarollo, 880-CEP 13255-410 Itatiba, SP BRASIL Tel.+55-11-4534-9999 Fax +55-11-4534-1410 E-mail cofimco@cofimco.com.br

Customer Name	**Smithco Engineering**	Job Name	**Poseidon Oil Pipeline Co.**
Job Reference	**2008B-554-01**	Item Number	**HAL-4110/20**

Date **22/07/2008**

STATIC PRESSURE vs VOLUME CURVE



Inlet Air Density	**0.071**	lb/ft³
RPM	**255.0**	rpm
Blade Tip Speed	**9614.3**	ft/min
Pressure recovery	**0.00**	Inch H2O
Rotor shaft power	**21.6**	hp
PWL (± 2)	**92.3**	dB(A)

ROTOR MODEL **3658-4-24L/B3T**

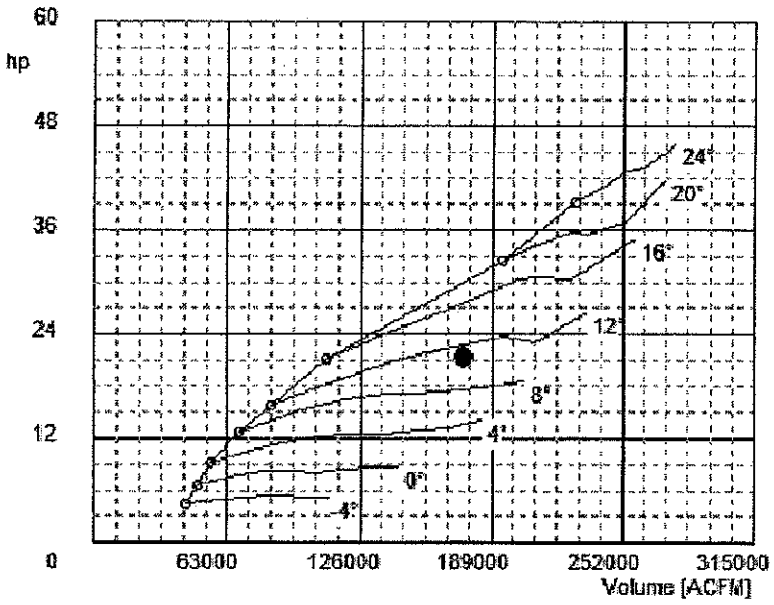
All data must be approved by Cofimco

FanTastic V1R7

Via Gramsci, 62 - 28050 Pombia (NO) - ITALY Tel. +39.0321.968311 - Fax +39.0321.958992 - E-mail info@cofimco.com
4035 Holland Boulevard-P.O.Box 6127-Chesapeake, Virginia 23323 Tel.(757)485-5798 Fax (757)485-7021 E-mail cofimco@cofimcousa.com
Rua Severino Tescarollo, 880-CEP 13255-410 Itatiba, SP BRASIL Tel.+55-11-4534-9999 Fax +55-11-4534-1410 E-mail cofimco@cofimco.com.br

Customer Name	**Smithco Engineering**	Job Name	**Poseidon Oil Pipeline Co.**
Job Reference	**2008B-554-01**	Item Number	**HAL-4110/20**
		Date	**22/07/2008**

FAN POWER vs VOLUME



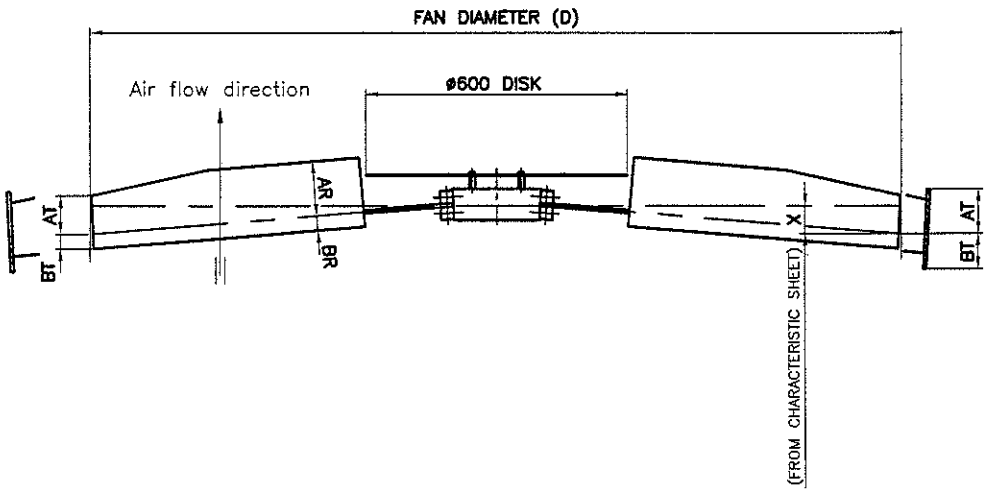
Inlet Air Density	**0.071**	lb/ft³
RPM	**255.0**	rpm
Blade Tip Speed	**9614.3**	ft/min
Pressure recovery	**0.00**	Inch H2O
Rotor shaft power	**21.6**	hp

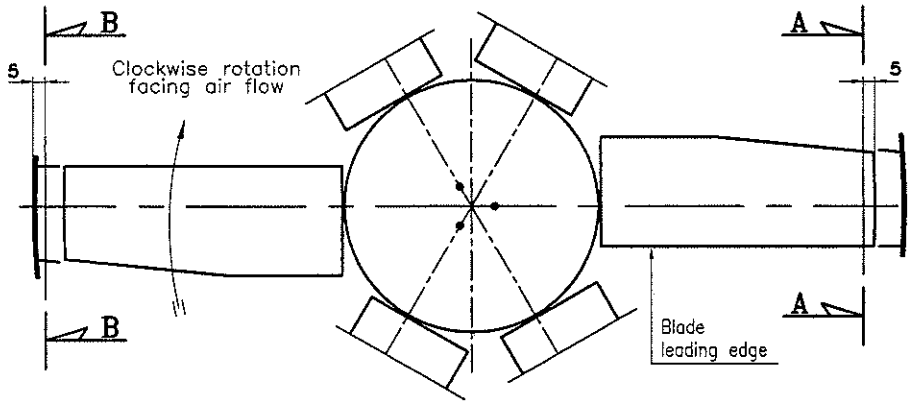
ROTOR MODEL **3658-4-24L/B3T**

All data must be approved by Cofimco

FanTastic V1R7

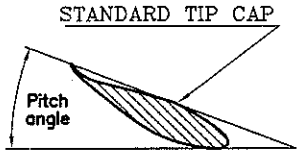
DIAMETER	3 BLADES		4 BLADES		5 BLADES		6 BLADES		7 BLADES		8 BLADES	
D	P	PD²	P	PD²	P	PD²	P	PD²	P	PD²	P	PD²
1524	36	13	42	18	49	22	55	27	–	–	–	–
1829	43	20	50	26	57	33	64	39	71	45	78	52
2134	45	27	52	35	60	46	68	55	76	64	83	73
2438	47	38	55	51	64	63	72	76	80	89	89	101
2743	49	52	58	69	67	86	76	103	85	120	94	137
3048	51	69	61	92	70	114	80	137	90	160	100	183
3353	53	90	63	119	74	149	84	179	94	208	105	238
3658	55	115	66	153	77	190	88	228	99	266	110	304
3962	57	144	69	192	80	239	92	287	104	335	116	383
4267	59	178	71	237	84	297	96	356	109	415	121	474
4572	64	224	74	290	87	362	100	435	114	507	127	579
4877	66	269	77	350	91	438	104	525	118	612	132	700





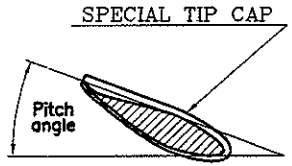
SEZ. A–A

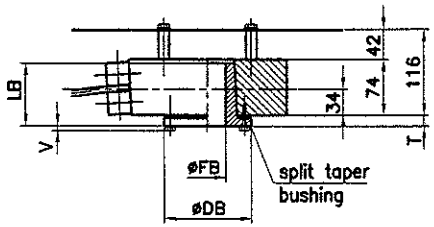
Pitch Angle	0°	5°	10°	15°	20°	25°
AR	63	86	108	129	150	170
BR	29	29	31	35	40	45
AT	29	49	72	86	104	122
BT	29	29	31	35	40	45

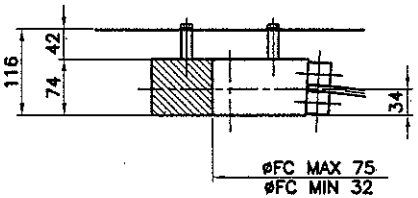


SEZ. B–B

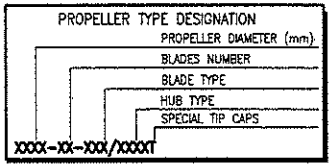
Pitch Angle	0°	5°	10°	15°	20°	25°
AR	63	86	108	129	150	170
BR	29	29	31	35	40	45
AT	34	54	77	91	109	127
BT	49	51	54	59	63	69







BUSHING	T	V	LB	DB	FB MIN	FBmax
P1	16	6.5	49	76.2	12.7	44.45
P2	16	6.5	74.5	76.2	19.05	44.45
Q1	19	7.2	63.5	105	19.05	68.26
Q2	19	7.2	89	105	25.4	66.67
R2	23	7.2	124	137	34.9	92.07



P (kg)
PD² = 4g x I (kgm²)

DESCRIZIONE–DESCRIPTION
DATA SHEET FOR COFIMCO FAN TYPE:
BLADE TYPE 24L
HUB TYPE "B3"
FAN DIAMETER FROM 5' TO 16' FEET

SCALA/SCALE —
mm [X] inches [ ]
DATA/DATE 30.08.06
APPROVED
DIS./DRAW D.R.
APPROVED
DRAWING NUMBER MAN24L/B3
REV. DIS. B

ACQUISTI: CODICI:
APPROVATO NORMALIZZAZIONE
APICE:
PEZZI N°:
POS:
ORDINE N°:

BALDOR
BALDOR • DODGE • RELIANCE

BALDOR • RELIANCE

Product Information Packet

P28G3314

30HP,1765RPM,3PH,60HZ,286T,TEFC,FOOT,

BALDOR • RELIANCE Product Information Packet: P28G3314 - 30HP,1765RPM,3PH,60HZ,286T,TEFC,FOOT,

Product Detail			
Model Number:	P28G3314	**Environment:**	Harsh / Mill & Chemical
Voltage:	460	**HP:**	30
Rpm:	1765	**Efficiency:**	Premium (XE)
Phase:	3	**Frequency:**	60
Inverter Duty:	*	**Enclosure:**	TEFC
Frame Group:	280	**Frame Size:**	286T
Features:	General Purpose	**Mounting:**	Foot Mounted
Service Factor:	1.15	**Enclosure Group:**	TEFC
List Price:	2525.00	**Price Symbol:**	RXE22
Speed Range:	1201-1800	**Insulation Class:**	F
Nema Design:	B	**Encl Enhancement:**	
Catalog Page:	M-28	**Dimension Sheet:**	611740-501
Connection Diagram:	416820-25	**Electric Design:**	E09085-B-E011
Single HP:	30	**Get Notes:**	General Purpose
Revision:		**Instruction Manual:**	B-3620
Application:	General Purpose	**Epact:**	Y
Scaled Drawing:	A83554	**Obsolete:**	N
Last Data Source:	RAG	**Bearing Type:**	
Electrical Type:	P	**Mounting Pos:**	
Ambient:	40	**Duty:**	CONT
Amps:	36.1	**Nominal Eff:**	93.6
Kva Code:	G	**Power Factor:**	83.1
Poles:	04	**Weight:**	451

611740-501-SH1

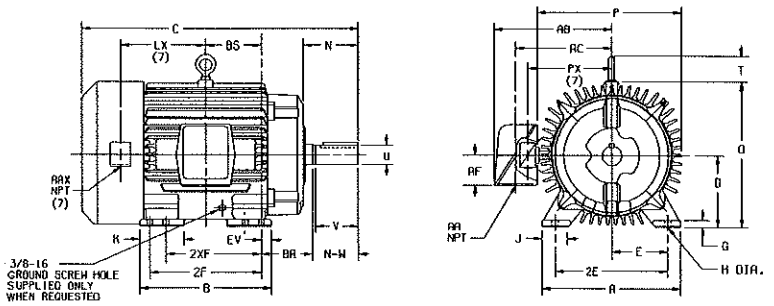
DUTY MASTER ALTERNATING CURRENT MOTORS

SQUIRREL-CAGE INDUCTION
CAST IRON CONSTRUCTION

ENCLOSURE: TOTALLY ENCLOSED
MOUNTING: FOOT

COOLING: FAN COOLED

FRAMES 250T THRU 440T



DIMENSIONS ARE IN INCHES; SEE SHEET 2 FOR DIMENSIONS IN MILLIMETERS

FRAME	A	D(2)	E	G	H	J	K	O	P	T	CAST IRON TERMINAL BOX AA	AB	AC	AF	(7) AUX. CONDUIT BOX AAX	LX (7)	PX (7)	BA	EV
254T-256T	12.50	6.25	5.00	.75	.56	2.50	--	13.25	13.25	2.44	1-1/4	10.81	8.81	2.50	3/4	6.31	9.31	4.25	1.00
284T-286TS	13.75	7.00	5.50	.75	.56	2.50	--	14.75	14.88	2.44	1-1/2	12.62	10.19	3.00	3/4	6.88	10.50	4.75	1.00
324T-326TS	15.50	8.00	6.25	.88	.69	2.75	4.50	16.69	17.00	2.44	2	15.44	11.69	3.62	3/4	8.00	10.50	5.25	1.38
364T-365TS	17.00	9.00	7.00	.88	.69	2.75	3.88	18.50	19.50	2.94	3	18.00	13.81	4.12	3/4	8.38	11.62	5.88	1.38
404T-405TS	19.00	10.00	8.00	1.12	.81	3.25	4.62	21.31	22.50	2.94	3	19.25	15.06	4.12	3/4	9.62	14.44	6.62	1.13
444T-445TS	21.00	11.00	9.00	1.12	.81	3.25	5.25	23.38	25.25	3.25	3	22.19	17.44	6.00	3/4	11.12	15.25	7.50	1.25
(1)																			

FRAME SIZE	C	BS	B	2F	(4) 2XF	N	SHAFT AND KEY N-W(6)	U(1)	V	SQ.	LGTH.	WEIGHT LBS. (5)
254T	24.56	5.00	12.00	----	8.25	4.12	4.00	1.625	3.75	.375	2.88	335
256T	24.56	5.00	12.00	10.00	----	4.12	4.00	1.625	3.75	.375	2.88	345
284T	27.44	5.50	13.00	----	9.50	5.00	4.62	1.875	4.38	.500	3.25	475
284TS	26.06	5.50	13.00	----	9.50	3.62	3.25	1.625	3.00	.375	1.88	475
286T	27.44	5.50	13.00	11.00	----	5.00	4.62	1.875	4.38	.500	3.25	490
286TS	26.06	5.50	13.00	11.00	----	3.62	3.25	1.625	3.00	.375	1.88	490
324T	30.44	6.00	14.75	----	10.50	5.62	5.25	2.125	5.00	.500	3.88	590
324TS	28.94	6.00	14.75	----	10.50	4.12	3.75	1.875	3.50	.500	2.00	590
326T	30.44	6.00	14.75	12.00	----	5.62	5.25	2.125	5.00	.500	3.88	630
326TS	28.94	6.00	14.75	12.00	----	4.12	3.75	1.875	3.50	.500	2.00	630
364T	33.44	6.12	15.00	----	11.25	6.25	5.88	2.375	5.62	.625	4.25	865
364TS	31.31	6.12	15.00	----	11.25	4.12	3.75	1.875	3.50	.500	2.00	859
365T	33.44	6.12	15.00	12.25	----	6.25	5.88	2.375	5.62	.625	4.25	890
365TS	31.31	6.12	15.00	12.25	----	4.12	3.75	1.875	3.50	.500	2.00	884
404T	38.31	6.88	16.00	----	12.25	7.50	7.25	2.875	7.00	.750	5.62	1220
404TS	35.31	6.88	16.00	----	12.25	4.50	4.25	2.125	4.00	.500	2.75	1211
405T	38.31	6.88	16.00	13.75	----	7.50	7.25	2.875	7.00	.750	5.62	1260
405TS	35.31	6.88	16.00	13.75	----	4.50	4.25	2.125	4.00	.500	2.75	1251
444T	44.82	8.25	19.00	----	14.50	8.94	8.50	3.375	8.25	.875	6.88	1670
444TS	40.88	8.25	19.00	----	14.50	5.19	4.75	2.375	4.50	.625	3.00	1654
445T	44.62	8.25	19.00	16.50	----	8.94	8.50	3.375	8.25	.875	6.88	1860
445TS	40.88	8.25	19.00	16.50	----	5.19	4.75	2.375	4.50	.625	3.00	1844
(1)												

(1) SPECIAL DIMENSIONS APPLYING TO THIS ORDER ON THIS LINE.

(2) "O" VARIES — 250T - 320T +.00, -.03. / 360T - 440T +.00, -.06.

(3) "U" VARIES — UP TO 1.625 DIA. +.0000, -.0005 / 1.625 AND LARGER +.000, -.001.

(4) ALL FRAMES HAVE EIGHT MOUNTING HOLES FOR DUAL MOUNTING.

(5) MOTOR WEIGHTS MAY VARY BY 15% DEPENDING UPON RATING.

(6) "N-W" VARIES +.00, -.25.

(7) AUXILIARY CONDUIT BOX SUPPLIED WHEN SPECIFIED

CONDUIT BOXES LOCATED ON OPPOSITE SIDE WHEN F-2,W-1, W-4,W-5,W-7, OR C-1 MOUNTING IS SPECIFIED.

IF MOUNTING CLEARANCE DETAILS ARE REQUIRED, CONSULT FACTORY.

MAXIMUM PERMISSIBLE SHAFT RUNOUT WHEN MEASURED AT END OF STD. SHAFT EXTENSION IS .002 T.I.R. UP TO AND INCLUDING 1.625 DIA. AND .003 T.I.R. 1.625 DIA. TO 5 INCH DIA.

FRAME-_____ TYPE-_____ CERTIFIED FOR-_____

ORDER-_____ ITEM-_____ HP-_____ RPM-_____ PH-_____ HZ _____ VOLTS-_____

SALES ORDER-_____ APPROVED BY-_____ DATE _____

CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT MOTOR PERFORMANCE IS SUITABLE IN THE APPLICATION.

BALDOR • DODGE • RELIANCE

DIM SHT 250T-440T TEFC FT MTG STD T & TS SGL EXT XT

REV. DESC: REMOVING TITLEBLOCK	VERSION: 01	TDR: 000030448517
REV. LTR: A	REVISED: 14:06:39 11/07/2007	BY: CONRPM
FILE: \RAG\DOD041325		
MTL: -		

611740-501-SH1

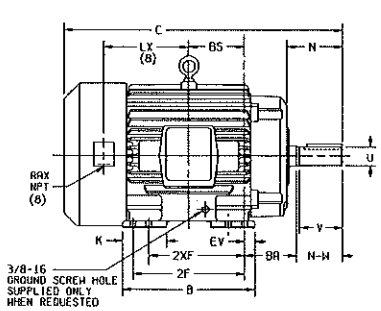
611740-501-SH2

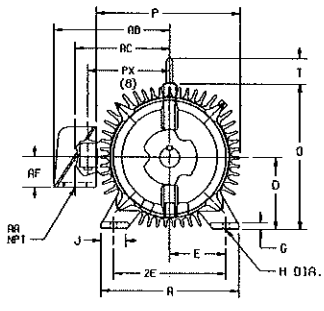
DUTY MASTER ALTERNATING CURRENT MOTORS

SQUIRREL-CAGE INDUCTION
CAST IRON CONSTRUCTION

ENCLOSURE: TOTALLY ENCLOSED — COOLING: FAN COOLED
MOUNTING: FOOT

FRAMES 250T THRU 440T





DIMENSIONS ARE IN MILLIMETERS; SEE SHEET 1 FOR DIMENSIONS IN INCHES

FRAME	A	D(2)	E	G	H	J	K	O	P	T	CAST IRON TERMINAL BOX AA(7)	AB	AC	AF	(8) AUX. CONDUIT BOX AAX(7)	LX (8)	PX (8)	BA	EV
254T-256T	317.5	158.8	127.0	19.0	14.2	63.5	---	336.5	336.5	62.0	1-1/4	274.6	223.8	63.5	3/4	160.3	236.5	108.0	25.4
284T-286TS	349.2	177.8	139.7	19.0	14.2	63.5	---	374.6	378.0	62.0	1-1/2	320.5	258.8	76.2	3/4	174.8	266.7	120.7	25.4
324T-326TS	393.7	203.2	158.8	22.4	17.5	69.9	114.3	423.9	431.8	62.0	2	392.2	296.9	91.9	3/4	203.2	266.7	133.3	35.1
364T-365TS	431.8	228.6	177.8	22.4	17.5	69.9	98.6	469.9	495.3	74.7	3	457.2	350.8	104.6	3/4	212.9	295.1	149.4	35.1
404T-405TS	482.6	254.0	203.2	28.4	20.6	82.5	117.3	541.3	571.5	74.7	3	488.9	382.5	104.6	3/4	244.3	366.8	168.1	28.7
444T-445TS	533.4	279.4	228.6	28.4	20.6	82.5	133.3	593.9	641.3	82.5	3	563.6	443.0	152.4	3/4	282.4	387.3	190.5	31.7
(1)																			

FRAME SIZE	C	BS	B	2F	(4) 2XF	N	SHAFT AND KEY N-W(6)	U(3)	V	SQ.	LGTH.	WEIGHT KGS. (5)
254T	623.8	127.0	304.8	---	209.6	104.6	101.6	41.27	95.3	9.52	73.2	151
256T	623.8	127.0	304.8	254.0	---	104.6	101.6	41.27	95.3	9.52	73.2	158
284T	697.0	139.7	330.2	---	241.3	127.0	117.3	47.63	111.3	12.70	82.5	215
284TS	661.9	139.7	330.2	---	241.3	91.9	82.5	41.27	76.2	9.52	47.8	215
286T	697.0	139.7	330.2	279.4	---	127.0	117.3	47.63	111.3	12.70	82.5	222
286TS	661.9	139.7	330.2	279.4	---	91.9	82.5	41.27	76.2	9.52	47.8	222
324T	773.2	152.4	374.6	---	266.7	142.7	133.3	53.97	127.0	12.70	98.6	267
324TS	735.1	152.4	374.6	---	266.7	104.6	95.3	47.63	88.9	12.70	50.8	267
326T	773.2	152.4	374.6	304.8	---	142.7	133.3	53.97	127.0	12.70	98.6	285
326TS	735.1	152.4	374.6	304.8	---	104.6	95.3	47.63	88.9	12.70	50.8	285
364T	849.4	155.4	381.0	---	285.7	158.8	149.4	60.33	142.7	15.88	108.0	392
364TS	795.3	155.4	381.0	---	285.7	104.6	95.3	47.63	88.9	12.70	50.8	389
365T	849.4	155.4	381.0	311.1	---	158.8	149.4	60.33	142.7	15.88	108.0	403
365TS	795.3	155.4	381.0	311.1	---	104.6	95.3	47.63	88.9	12.70	50.8	400
404T	973.1	174.8	406.4	---	311.1	190.5	184.1	73.02	177.8	19.05	142.7	553
404TS	896.9	174.8	406.4	---	311.1	114.3	108.0	53.97	101.6	12.70	69.9	549
405T	973.1	174.8	406.4	349.2	---	190.5	184.1	73.02	177.8	19.05	142.7	571
405TS	896.9	174.8	406.4	349.2	---	114.3	108.0	53.97	101.6	12.70	69.9	567
444T	1133.3	209.6	482.6	---	368.3	227.1	215.9	85.72	209.6	22.22	174.8	757
444TS	1038.4	209.6	482.6	---	368.3	131.8	120.7	60.33	114.3	15.88	76.2	750
445T	1133.3	209.6	482.6	419.1	---	227.1	215.9	85.72	209.6	22.22	174.8	843
445TS	1038.4	209.6	482.6	419.1	---	131.8	120.7	60.33	114.3	15.88	76.2	836
(1)												

(1) SPECIAL DIMENSIONS APPLYING TO THIS ORDER ON THIS LINE.

(2) "D" VARIES — 250T - 320T +.0, -.8. / 360T - 440T +.0, -1.5.

(3) "U" VARIES — UP TO 41.27 DIA. +.000, -.013 / 41.27 AND LARGER +.00, -.03.

(4) ALL FRAMES HAVE EIGHT MOUNTING HOLES FOR DUAL MOUNTING.

(5) MOTOR WEIGHTS MAY VARY BY 15% DEPENDING UPON RATING.

(6) "N-W" VARIES +.0, -6.4.

(7) DIMENSIONS ARE IN INCHES.

(8) AUXILIARY CONDUIT BOX SUPPLIED WHEN SPECIFIED.

CONDUIT BOXES LOCATED ON OPPOSITE SIDE WHEN F-2,W-1, W-4,W-5,W-7, OR C-1 MOUNTING IS SPECIFIED.

IF MOUNTING CLEARANCE DETAILS ARE REQUIRED, CONSULT FACTORY.

MAXIMUM PERMISSIBLE SHAFT RUNOUT WHEN MEASURED AT END OF STD. SHAFT EXTENSION IS .05 T.I.R. UP TO AND INCLUDING 41.27 DIA. AND .08 T.I.R. 41.27 DIA. TO 127 MILL DIA.

FRAME- _____ TYPE- _____ CERTIFIED FOR- _____

ORDER- _____ ITEM- _____ HP- _____ RPM- _____ PH- _____ HZ _____ VOLTS- _____

SALES ORDER- _____ APPROVED BY- _____ DATE _____

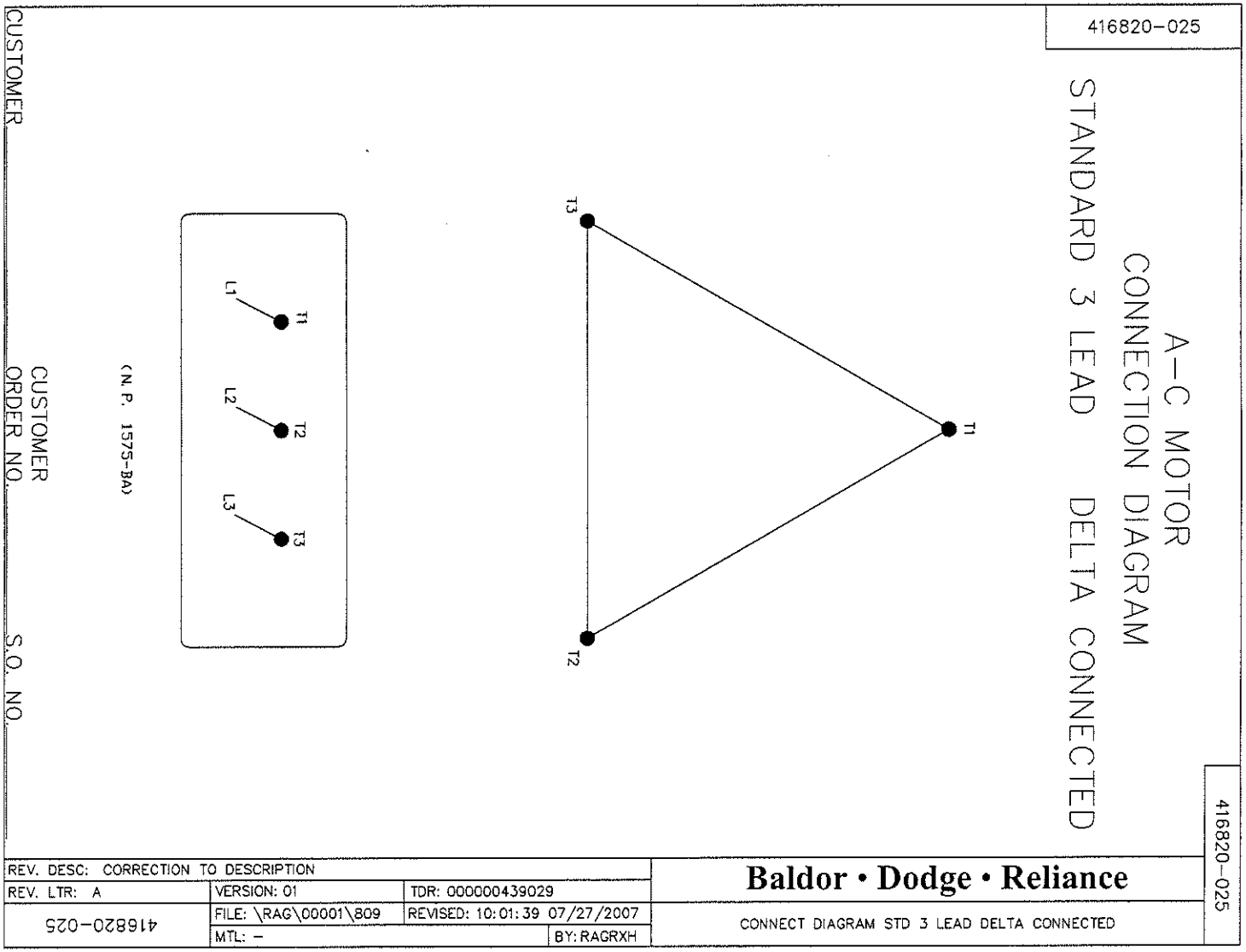
CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT MOTOR PERFORMANCE IS SUITABLE IN THE APPLICATION.

BALDOR • DODGE • RELIANCE

DIM SHT 250T-440T TEFC FT MTG STD T & TS SGL EXT XT

REV. DESC: REMOVING TITLEBLOCK	TDR: 000000448517
REV. LTR: A	VERSION: 01
FILE: \PRAG\DGDATA\526	REVISED: 14:09:46 11/07/2007
MTL: -	BY: CONBPM

611740-501-SH2


416820-025
A-C MOTOR
CONNECTION DIAGRAM
STANDARD 3 LEAD DELTA CONNECTED
T3
T1
T2
L1
L2
L3
T1
T2
T3
(N. P. 1575-BA)
CUSTOMER
CUSTOMER ORDER NO.
S.O. NO.
416820-025
REV. DESC: CORRECTION TO DESCRIPTION
REV. LTR: A
VERSION: 01
TDR: 000000439029
FILE: \RAG\00001\809
REVISED: 10:01:39 07/27/2007
MTL: -
BY: RAGRXH
Baldor • Dodge • Reliance
CONNECT DIAGRAM STD 3 LEAD DELTA CONNECTED
416820-025

REL. S.O.	FRAME	HP	TYPE	PHASE/ HERTZ	RPM	VOLTS
	286T	30	P	3/60	1765	460

AMPS	DUTY	AMB °C/ INSUL.	S.F.	NEMA DESIGN	CODE LETTER	ENCL.
36.1	CONT	40/F	1.15	B	G	FCXE

E/S	ROTOR	TEST S.O.	TEST DATE	STATOR RES.@25 °C OHMS (BETWEEN LINES)
488466	418139-37ME	---	---	.264

PERFORMANCE

LOAD	HP	AMPERES	RPM	% POWER FACTOR	% EFFICIENCY
NO LOAD	0	11.6	1800	4.89	0
1/4	7.52	14.5	1792	52.9	91.6
2/4	15.0	20.2	1785	73.9	94.1
3/4	22.5	27.6	1776	80.9	94.2
4/4	30.0	36.1	1767	83.1	93.6
5/4	37.5	45.2	1757	83.8	92.6

SPEED TORQUE

	RPM	TORQUE % FULL LOAD	TORQUE LB.-FT.	AMPERES
LOCKED ROTOR	0	208	185	217
PULL UP	720	185	165	200
BREAKDOWN	1656	258	230	123
FULL LOAD	1767	100	89.1	36.1

AMPERES SHOWN FOR 460. VOLT CONNECTION. IF OTHER VOLTAGE CONNECTIONS ARE AVAILABLE, THE AMPERES WILL VARY INVERSELY WITH THE RATED VOLTAGE

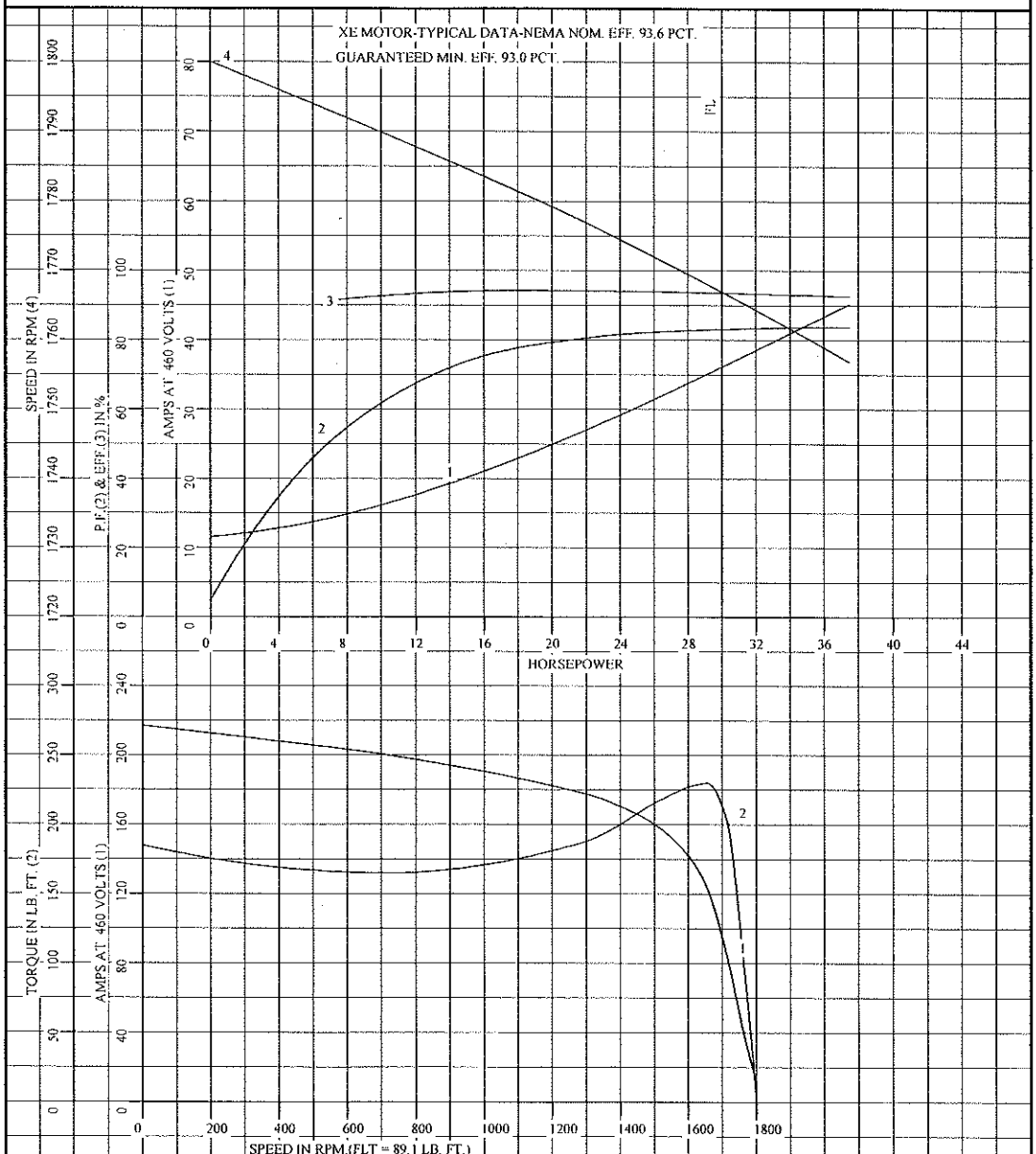
REMARKS: XE MOTOR-TYPICAL DATA-NEMA NOM. EFF. 93.6 PCT.
GUARANTEED MIN. EFF. 93.0 PCT.

BALDOR
BALDOR • DODGE • RELIANCE

DR. BY P.B. GREENE
CK. BY K.W. KANOUFF
APP. BY K.W. KANOUFF
DATE 01/17/95

A-C MOTOR PERFORMANCE DATA E09085-B-E011
ISSUE DATE 01/17/95

REL S.O.	RPM 1765	S.F. 1.15	ROTOR 418139-37ME
FRAME 286T	VOLTS 460	NEMA DESIGN B	TEST S.O. ---
HP 30	AMPS 36.1	CODE LETTER G	TEST DATE ---
TYPE P	DUTY CONT	ENCLOSURE FCXE	STATOR RES.@ 25 °C .264
PHASE/HERTZ 3/60	AMB °C/INSUL 40/F	E/S 488466	OHMS (BETWEEN LINES)



AMPERES SHOWN FOR 460 VOLT CONNECTION, IF OTHER VOLTAGE CONNECTIONS ARE AVAILABLE, THE AMPERES WILL VARY INVERSELY WITH THE RATED VOLTAGE.

BALDOR · DODGE · RELIANCE

DR. BY	P.B. GREENE
CK. BY	K.W. KANOUFF
APP. BY	K.W. KANOUFF
DATE	01/17/95

A-C MOTOR PERFORMANCE CURVES E09085-B-E011 ISSUE DATE 01/17/95

Printed on 11/15/07 12:15 @ usmghengdev1

RELIANCE ELECTRIC

Installation, Operation And Maintenance Of Reliance® Standard Industrial AC Induction Motors

- 180 – 449 Frames (NEMA)
- 112 – 280 Frames (IEC)

AC MOTORS

"Solutions You Can Trust"

Instruction Manual B-3620-25
December, 1998

Rockwell Automation

Table of Contents

⚠ DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE, AND/OR SERVICE THIS EQUIPMENT. READ AND UNDERSTAND THIS MANUAL IN ITS ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

The products described in this manual are manufactured by or for Reliance Electric Industrial Company.

RECEIVING AND HANDLING

ACCEPTANCE

Thoroughly inspect the equipment before accepting shipment from the transportation company. If any of the goods called for in the bill of lading or express receipt are damaged or the quantity is short, do not accept them until the freight or express agent makes an appropriate notation on your freight bill or express receipt. If any concealed loss or damage is discovered later, notify your freight or express agent at once and request him to make an inspection. We will be very happy to assist you in collecting claims for loss or damage in shipment; however, this willingness on our part does not remove the transportation company's responsibility in reimbursing you for collection of claims or replacement of material. Claims for loss or damage in shipment must not be deducted from the Reliance Electric invoice,nor should payment of the Reliance Electric invoice be withheld awaiting adjustment of such claims, as the carrier guarantees safe delivery.

If considerable damage has been incurred and the situation is urgent, contact the nearest Reliance Electric Sales Office for assistance. Please keep a written record of all communications.

EXTENDED STORAGE – AC MOTORS

If considerable damage has been incurred and the situation is urgent, contact the nearest Reliance Electric Sales Office for assistance. Please keep a written record of all communications.

STORAGE CONDITIONS – SHORT TERM

The following storage requirements must be followed:

1. Motors are to be kept in their original containers or provided with equivalent protection and stored in a warehouse free from extremes in temperature, humidity, and corrosive atmosphere.
2. If unusual vibrations exist at the storage location, the motor should be protected with isolation pads.
3. All breathers and drains are to be operable while in storage and/or the moisture drain plugs removed. The motors must be stored so the drain is at the lowest point.

STORAGE PREPARATION

Improper storage of electric machines will result in seriously reduced reliability of that equipment. For example, an electric motor that does not experience regular usage while being exposed to normally humid atmospheric conditions is likely to cause the bearings to rust or rust particles from surrounding surfaces to contaminate the bearings. The electrical insulation may absorb an excessive amount of moisture leading to the motor winding failing to ground. The following preparations should be followed:

1. Minimize condensation in and around the motor by use of desiccants or other humidity control methods.
2. Motor space heaters when specified are to be energized where there is a possibility that the storage ambient conditions will reach the dew point. Space heaters are an option.
3. Coat all external machined surfaces with a material to prevent corrosion. An acceptable product for this purpose is Exxon Rust Ban #392.
4. Measure and record the electrical resistance of the winding insulation with a megger or an insulation resistance meter. Minimum accepted Megohm level is the insulation kV rating +1 Megohm. If levels fall below the above, contact the nearest Reliance sales office. The recorded data will be required when removing from storage.

5. Some motors have a shipping brace attached to the shaft to prevent damage during transportation. The shipping brace, if provided, must be removed and stored for future use. The brace must be reinstalled to hold the shaft firmly in place against the bearing before the motor is moved.

6. Upon placing the motor into extended storage (greater than 3 months), the motors with regreasable bearings must be greased per Table 1 followed by the motor shaft being rotated a minimum of 15 times after greasing. Non-regreasable motors with "Do Not Lubricate" nameplate should also be rotated 15 times to redistribute grease within the bearing.

7. Remove the grease drain plug, if supplied, (opposite the grease fitting) on the bottom of each end bracket prior to lubricating the motor. Replace the plug after greasing.

Table 1. Lubrication Volume (Storage)

NEMA Frame Size (IEC)	Vol. in Cubic In. (Cm^3)
182 thru 215 (112 – 132)	0.5 (8)
254 thru 286 (160 – 180)	1.0 16)
324 thru 365 (200 – 225)	1.5 (24)
404 thru 449 (250 – 280)	2.5 (40)

8. Regreasable bearings are to be greased per Table 1 at the time of being placed into extended storage. Motor shafts are to be rotated at least 15 revolutions manually every 3 months and additional grease added every nine months per Table 1 to each bearing. Bearings are to be greased at the time of removal from storage.

   Non-regreasable motors should have their shaft rotated 15 revolutions every 3 months.

9. All breather drains should be fully operable while in storage. The motors must be stored so the drain is at the lowest point. All breathers and automatic "T" drains must be operable to allow breathing at points other than through the bearing fits.

10. The space heaters when specified are to be connected and operable while in storage.

11. Windings are to be meggered at the time equipment is put in storage. Reference Para. 4 on page 1. At the time of removal from storage, the insulation resistance reading must not have dropped more than 50% from the initial reading. Any drop below this point necessitates electrical or mechanical drying. Refer to "Motor Drying Procedure."

12. Where motors are not stored in the original containers, but are removed and mounted on other pieces of machinery, the mounting must be such that the drains and breathers and space heaters are fully operable. In this respect, the drains must be kept at the lowest point in the motor so that all condensation can automatically drain out.

FOR STORAGE OF EXTENDED PERIODS OF TIME (GREATER THAN 18 MONTHS)

All requirements of general preparation and short term storage apply with the following additional requirements.

1. Motor is to be crated in a box similar to EXPORT BOXING but that the "shell" (sides & top of box) will be LAG-BOLTED to the wooden base (not nailed as export boxes are). This design will allow for the opening and reclosing the box many times without destroying the "shell".

2. The motor will be sealed in an airtight vapor barrier bag with desiccant inside. This airtight bag will give added protection during shipment of motor to the permanent storage area.

3. After the first "Inspection" for megger reading, turning the shaft, etc., the vapor bag should be re-sealed by taping it closed with masking or similar tape. Also add new desiccant inside bag before closing. The shell should then be placed over the motor and the lag bolts replaced.

4. If a "zipper-closing" type bag is used instead of the "heat-sealed" type bag, then rezipper the bag closed instead of taping it.

5. Be sure to add new desiccant inside bag after each periodic inspection.

6. Minimize the accumulation of condensed water in and around the machine.

UNPACKING

After unpacking and inspection to see that all parts are in good condition, turn the shaft by hand to be sure there are no obstructions to free rotation. Equipment which has been in storage for some time should be tested and relubricated (regreasable type) prior to being put into service. Refer to "Test General Condition" and "Lubrication" for procedure to be performed after extended storage.

Equipment with roller bearings is shipped with a shaft block. After removing the shaft block, be sure to replace any bolts used to hold the shaft block in place during shipment that are required in service.

⚠ DANGER

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INSTALLATION

INSPECTION

After the motor is unpacked, examine the nameplate data to see that it agrees with the power circuit to which it is to be connected. The motor will operate with frequency not more than 5% and voltage not more than 10% above or below the nameplate data, or combined variation of voltage and frequency of not more than 10% above or below nameplate data. Efficiency, power factor and current may vary from nameplate data. Performance within these voltage and frequency variations will not necessarily be in accordance with the standards established for operation at rated voltage and frequency.

Typical Effect of Voltage and Frequency Variation on Induction Motor Characteristics

Variation	Starting and maximum running torque	Synchronous speed	slip %	Full-Load Speed	Efficiency			Power Factor/COS⊖			Full-load current	Starting current	Temp rise, full load	Maximum overload capacity	Magnetic noise – no-load in particular
					Full-load	3/4 load	1/2 load	Full load	3/4 load	1/2 load					
Voltage Variation:															
120% Voltage	Increase 44%	no change	decrease 30%	Increase 1.5%	6-0% decrease (1-75 HP) 0-.3% increase (100-300 HP)	decrease 1/2-2 points	decrease 1-20 points	decrease 5-15 points	decrease 10-30 points	decrease 15-40 points	Increase 12%	Increase 20%	Increase 5-6°C. (1-75 HP) Decrease 3-4°C (100-300 HP)	Increase 44%	Noticeable increase
110% voltage	Increase 21%	no change	decrease 17%	Increase 1%	slight decrease	practically no change	decrease 1-2 points	decrease 5-10 points	decrease 5 points	decrease 6-8 points	Increase 2-4%	Increase 10-12%	Increase 3-4°C.	Increase 21%	Increase slightly
Function of Voltage	(voltage)^2	constant	$\frac{1}{(\text{voltage})\ 2}$	(synchronous speed slip)								voltage		(voltage)^2	
80% Voltage	decrease 19%	no change	increase 23%	decrease 1-1/2%	decrease 2 points	practically no change	increase 1-2 points	increase 5 points	increase 2-3 points	increase 4-5 points	increase 10-11%	decrease 10-12%	increase 6-7°C	decrease 19%	decrease slightly
Frequency variation:															
105% frequency	decrease 10%	Increase 5%	practically no change	increase 5%	slight increase	slight increase	slight increase	slight increase	slight increase	slight increase	decrease slightly	decrease 5-6%	decrease slightly	decrease slightly	decrease slightly
Function of frequency	$\frac{1}{(\text{frequency})^2}$	frequency		(synchronous speed slip)								$\frac{1}{\text{frequency}}$			
95% frequency	increase 11%	decrease 5%	practically no change	decrease 5%	slight decrease	slight decrease	slight decrease	slight decrease	slight decrease	slight decrease	increase slightly	increase 5-6%	increase slightly	increase slightly	increase slightly
1 % phase unbalance	slight decrease	slight decrease		slight decrease	2% decrease			5-6% decrease			1-1/2% increase	slight decrease	2% increase		
2% phase unbalance	slight decrease	slight decrease		slight decrease	6% decrease			7% decrease			3% increase	slight decrease	8% increase		

NOTE: This table shows general effects, which will vary somewhat for specific ratings.

LOCATION

The motor should be installed in a location compatible with the motor enclosure and specific ambient.

To allow adequate air flow, the following clearances must be maintained between the motor and any obstruction:

TEFC (IC0141) Enclosures	–	
Fan Cover Air Intake	– 180 – 210T Frame	1"
	250 – 449T Frame	4"
	IEC 112 – 132	2.5 cm
	IEC 160 – 280	10 cm
Exhaust	– Envelope equal to the "P" dimension on the motor dimension sheet	
Protected Enclosures	–	
Bracket Intake	– Same as TEFC	
Frame Exhaust	– Exhaust out the sides-envelope a minimum of the "P" dimension plus 2" (5cm). Exhaust out the end-same as intake.	

LIFTING MEANS

⚠ WARNING

WHEN A LIFTING MEANS IS PROVIDED FOR HANDLING THE MOTOR, IT SHOULD NOT BE USED TO LIFT THE MOTOR PLUS ADDITIONAL EQUIPMENT SUCH AS GEARS, PUMPS, COMPRESSORS, OR OTHER DRIVEN EQUIPMENT. FAILURE TO FOLLOW THESE PRECAUTIONS COULD RESULT IN BODILY INJURY.

In the case of assemblies on a common base, any lifting means provided on the motor or generator should not be used to lift the assembly and base but, rather, the assembly should be lifted by a sling around the base or by other lifting means provided on the base. In all cases care should be taken to assure lifting in the direction intended in the design of the lifting means. Likewise, precautions should be taken to prevent hazardous overloads due to deceleration, acceleration or shock forces.

MOUNTING

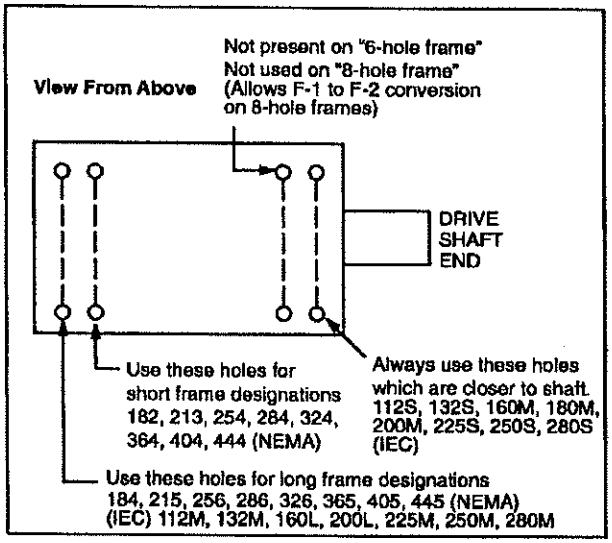
Mount the motor on a foundation sufficiently rigid to prevent excessive vibration. Roller bearing and ball-bearing motors may be mounted with the shaft at any angle. Roller bearing motors are not suitable for coupled duty applications. After carefully aligning the motor with the driven unit, bolt securely in place.

When motors, which are normally mounted with the shaft in a horizontal position, are mounted vertically, it may be necessary to provide additional guards to prevent foreign objects from falling into the motor openings and striking rotating parts. Such guards may be obtained at the time of purchase or from a local service repair center.

Explosion proof motors are shipped from the factory with the conduit box mounted. If the conduit box is removed or rotated, a minimum of five (5) full threads of engagement on the motor pipe nipple must be maintained for explosion proof integrity of the conduit box.

Some motors have standardized frames containing 6 or 8 mounting holes. 6 hole frames are not suitable for field reversal of mounting from F-1 to F-2, etc. The following diagram indicates the proper mounting holes to use.

MOUNTING OF 6 & 8 HOLE MOTOR FRAMES



DRIVE

The pulley, sprocket, or gear used in the drive should be located on the shaft as close to the shaft shoulder as possible. Heat to install. Driving a unit on the shaft will damage the bearings.

Belt Drive: Align the pulleys so that the belt will run true; tighten the belt just enough to prevent slippage, any tighter will cause premature bearing failure. If possible, the lower side of the belt should be the driving side.

Chain Drive: Mount the sprocket on the shaft as close to the bracket as possible. Align the sprockets so that the chain will run true. Avoid excessive chain tension.

Gear Drive and Direct Connection: Accurate alignment is essential. Secure the motor and driven unit rigidly to the base.

ROTATING PARTS

⚠ WARNING

ROTATING PARTS, SUCH AS COUPLINGS, PULLEYS, EXTERNAL FANS, AND UNUSED SHAFT EXTENSIONS, SHOULD BE PERMANENTLY GUARDED AGAINST ACCIDENTAL CONTACT WITH HANDS OR CLOTHING. THIS IS PARTICULARLY IMPORTANT WHERE THE PARTS HAVE SURFACE IRREGULARITIES SUCH AS KEYS, KEYWAYS OR SET SCREWS. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

SOME SATISFACTORY METHODS OF GUARDING ARE:

1. Covering the machine and associated rotating parts with structural or decorative parts of the driven equipment.
2. Providing covers for the rotating parts. Covers should be sufficiently rigid to maintain adequate guarding in normal service.

⚠ DANGER

THE USER IS RESPONSIBLE FOR CONFORMING WITH THE NATIONAL ELECTRICAL CODE AND ALL OTHER APPLICABLE LOCAL CODES. WIRING PRACTICES, GROUNDING DISCONNECTS AND OVERCURRENT PROTECTION ARE OF PARTICULAR IMPORTANCE. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

⚠ DANGER

SUBSEQUENT STEPS REQUIRE ROTATING PARTS AND/OR ELECTRICAL CIRCUITS TO BE EXPOSED. STAY CLEAR IF UNIT MUST BE RUNNING OR DISCONNECT AND LOCKOUT OR TAG POWER SOURCE IF CONTACT MUST BE MADE.

Connect the motor to the power supply according to the diagram on the motor nameplate. For most 230/460 volt motors, nine leads are brought out from the stator windings so that the motor may be connected for either 230 or 460 volts.

GROUNDING

In the USA consult the *National Electrical Code*, Article 430 for information on grounding of motors, Article 445 for grounding of generators, and Article 250 for general information on grounding. In making the ground connection, the installer should make certain that there is a solid and permanent metallic connection between the ground point, the motor or generator terminal housing, and the motor or generator frame. In non-USA locations consult the appropriate national or local code applicable.

Motors with resilient cushion rings usually must be provided with a bonding conductor across the resilient member. Some motors are supplied with the bonding conductor on the concealed side of the cushion ring to protect the bond from damage. Motors with bonded cushion rings should usually be grounded at the time of installation in accordance with the above recommendations for making ground connections. When motors with bonded cushion rings are used in multimotor installations employing group fusing or group protection, the bonding of the cushion ring should be checked to determine that it is adequate for the rating of the branch circuit overcurrent protective device being used.

There are applications where grounding the exterior parts of a motor or generator may result in greater hazard by increasing the possibility of a person in the area simultaneously contacting ground and some other nearby live electrical parts of other ungrounded electrical equipment. In portable equipment it is difficult to be sure that a positive ground connection is maintained as the equipment is moved, and providing a grounding conductor may lead to a false sense of security.

The user must select a motor starter and overcurrent protection suitable for this motor and its application. Consult motor starter application data as well as the National Electric Code and/or other applicable local codes.

⚠ DANGER

WHEN CAREFUL CONSIDERATION OF THE HAZARDS INVOLVED IN A PARTICULAR APPLICATION INDICATE THE MACHINE FRAMES SHOULD NOT BE GROUNDED OR WHEN UNUSUAL OPERATING CONDITIONS DICTATE THAT A GROUNDED FRAME CANNOT BE USED, THE INSTALLER SHOULD MAKE SURE THE MACHINE IS PERMANENTLY AND EFFECTIVELY INSULATED FROM GROUND. IN THOSE INSTALLATIONS WHERE THE MACHINE FRAME IS INSULATED FROM GROUND, IT IS RECOMMENDED THAT APPROPRIATE WARNING LABELS OR SIGNS BE PLACED ON OR IN THE AREA OF THE EQUIPMENT BY THE INSTALLER. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

STARTING

⚠ WARNING

BEFORE STARTING MOTOR, REMOVE ALL UNUSED SHAFT KEYS AND LOOSE ROTATING PARTS TO PREVENT THEM FROM FLYING OFF. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

⚠ CAUTION

Check direction of motor rotation before coupling motor to load. Failure to observe this precaution could result in damage to or destruction of the equipment.

Before starting the motor, check the following items:

1. The rotor should turn freely when disconnected from the load.
2. Driven machine should be unloaded when first starting the motor.

The motor should run smoothly with little noise. If the motor should fail to start and produces a decided hum, it may be that the load is too great for the motor or that it has been connected improperly. Shutdown immediately and investigate for trouble.

DRAIN PLUGS

If motor is totally enclosed fan-cooled or non-ventilated it is recommended that condensation drain plugs, if present, be removed. These are located in the lower portion of the end-shields. Totally enclosed fan-cooled "XT" motors are normally equipped with automatic drains which may be left in place as received.

ROTATION

To reverse the direction of rotation, disconnect from power source and interchange any two of the three line leads for the three-phase motors.

TEST FOR GENERAL CONDITION

If the motor has been in storage for an extensive period or has been subjected to adverse moisture conditions, it is best to check the insulation resistance of the stator winding with a megohmeter.

If the resistance is lower than one megohm the windings should be dried in one of the two following ways:

1. Bake in oven at temperatures not exceeding 90°C. until insulation resistance becomes constant.
2. With rotor locked, apply low voltage and gradually increase current through windings until temperature measured with thermometer reaches 194°F (90°C). Do not exceed this temperature.

INITIAL LUBRICATION

Reliance motors are shipped from the factory with the bearings properly packed with grease and ready to operate. Where the unit has been subjected to extended storage (6 months or more) the bearings should be relubricated (regreasable type) prior to starting. When motors are equipped for oil mist lubrication refer to Instruction Manual B-3654.

OPERATION

⚠ WARNING

SURFACE TEMPERATURES OF MOTOR ENCLOSURE MAY REACH TEMPERATURES WHICH CAN CAUSE DISCOMFORT OR INJURY TO PERSONNEL ACCIDENTALLY COMING INTO CONTACT WITH HOT SURFACES. WHEN INSTALLING, PROTECTION SHOULD BE PROVIDED BY USER TO PROTECT AGAINST ACCIDENTAL CONTACT WITH HOT SURFACE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

⚠ WARNING

ROTATING PARTS, SUCH AS COUPLINGS, PULLEYS, INTERNAL-EXTERNAL FANS AND UNUSED SHAFT EXTENSIONS SHOULD BE PERMANENTLY GUARDED AGAINST ACCIDENTAL CONTACT WITH HANDS OR CLOTHING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

Due to the inherent characteristics of insulating materials, abnormally high temperatures shorten the operating life of electrical apparatus. The total temperature, not the temperature rise, should be the measure of safe operation. The class of insulation determines the maximum safe operating temperature. Aging of insulation occurs at an accelerated rate at abnormally high temperatures. A general rule for gauging the effect of excessive heat is that for each 10°C. rise in temperature above the maximum limit for the insulation, the life of the insulation is halved.

Unbalanced voltage or single-phase operation of polyphase machines may cause excessive heating and ultimate failure. It requires only a slight unbalance of voltage applied to a polyphase motor to cause large unbalance currents and resultant overheating.

Periodic checks of phase voltage, frequency and power consumption of a motor while in operation are recommended; such checks assure the correctness of frequency and voltage applied to the motor and yield an indication of the load offered by the apparatus which the motor drives.

Comparisons of this data with previous no-load and full-load power demands will give an indication of the performance of the complete machine. Any serious deviations should be investigated and corrected.

Stator troubles can usually be traced to one of the following causes:

Worn bearings	Operating single-phase
Moisture	Poor insulation
Overloading	Oil and dirt

Dust and dirt are usually contributing factors. Some forms of dust are highly conductive and contribute materially to insulation breakdown. The effect of dust on the motor temperature through restriction of ventilation is a principal reason for keeping the windings clean.

Squirrel-cage rotors are rugged and, in general, give little trouble. The first symptom of a defective rotor is lack of torque. This may cause a slowing down in speed accompanied by a growling noise or perhaps failure to start the load.

This is caused by an open or high resistance joint in the rotor bar circuit. Such a condition can generally be detected by looking for evidence of localized heating.

Motors with maximum surface temperatures listed on the nameplates.

⚠ ATTENTION

THE MOTOR IS DESIGNED TO OPERATE AT OR BELOW THE MAXIMUM SURFACE TEMPERATURE STATED ON THE NAMEPLATE. FAILURE TO OPERATE THE MOTOR PROPERLY CAN CAUSE THIS MAXIMUM SURFACE TEMPERATURE TO BE EXCEEDED. IF APPLIED IN A DIVISION 2 OR ZONE 2 ENVIRONMENT THIS EXCESSIVE TEMPERATURE MAY CAUSE IGNITION OF HAZARDOUS MATERIALS. OPERATING THE MOTOR AT ANY OF THE FOLLOWING CONDITIONS CAN CAUSE THE MARKED TEMPERATURE TO BE EXCEEDED.

1. MOTOR LOAD EXCEEDING SERVICE FACTOR VALUE
2. AMBIENT TEMPERATURES ABOVE NAMEPLATE VALUE
3. VOLTAGES ABOVE OR BELOW NAMEPLATE VALUE
4. UNBALANCED VOLTAGES
5. LOSS OF PROPER VENTILATION
6. VARIABLE FREQUENCY OPERATION
7. ALTITUDE ABOVE 3000 FEET/1000 METERS
8. SEVERE DUTY CYCLES, REPEATED STARTS
9. MOTOR STALL
10. MOTOR REVERSING
11. SINGLE PHASE OPERATION

Division 2 or Zone 2 motor swith space heaters.

⚠ ATTENTION

THE SPACE HEATERS ARE DESIGNED TO OPERATE AT OR BELOW THE MAXIMUM SURFACE TEMPERATURE STATED ON THE NAEMPLATE. IF THE MARKED AMBIENT AND/OR VOLTAGE ARE EXCEEDED THIS MAXIMUM SURFACE TEMPERATURE CAN BE EXCEEDED AND CAN DAMAGE THE MOTOR WINDINGS. IF APPLIED IN A DIVISION 2 OR ZONE 2 ENVIRONMENT THIS EXCESSIVE TEMPERATURE MAY CAUSE IGNITION OF HAZARDOUS MATERIALS.

MAINTENANCE AND REPAIR

⚠ WARNING

TO INSURE THAT THE DRIVEN EQUIPMENT IS NOT UNEXPECTEDLY STARTED, TURN OFF AND LOCKOUT OR TAG POWER SOURCE BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY

The fundamental principle of electrical maintenance is KEEP THE APPARATUS CLEAN AND DRY. This requires periodic inspection of the motor, the frequency depending upon the type of motor and the service.

The following should be checked at regular intervals:

⚠ WARNING

DO NOT USE GASOLINE OR OTHER FLAMMABLE SOLVENTS WHEN CLEANING THE MOTOR. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

1. Windings should be dry and free of dust, grease, oil, and dirt. Windings may be cleaned by suction cleaners or by wiping. Nozzles on suction type cleaners should be non-metallic. Gummy deposits of dirt and grease may be removed by using a commercially available low volatile solvent.
2. Terminal connections, assembly screws, bolts and nuts should be tight. They may loosen if motor is not securely bolted and tend to vibrate.
3. Insulation resistance of motors in service should be checked periodically at approximately the same temperature and humidity conditions to determine possible deterioration of the insulation. When such measurements at regular intervals indicate a wide variation, the cause should be determined. Motor should be reconditioned if the motor has been subjected to excessive moisture by re-winding or re-insulating if necessary. Enclosed motors require very little attention. Be sure that external air chamber of fan-cooled motors does not become clogged with foreign material which will restrict passage of air.

DISASSEMBLY

If it becomes necessary to disassemble the motor, care should be taken not to damage the stator windings as the insulation may be injured by improper or rough handling.

Precautions to keep bearings clean should be exercised. Before removing either end shield:

1. Disconnect motor from power source. Tag the leads to insure proper reconnection.
2. Remove motor from mounting base. Remove fan cover and fan if present.
3. Mark end brackets relative to position on frame so they can be easily replaced.

REMOVING BRACKETS AND ROTOR

4. Remove bearing cartridge nuts or screws. (If used)
5. Remove opposite drive end bracket bolts.
6. Pull bracket.
7. Remove drive end bracket in same manner.
8. Remove rotor.

REMOVING AND REPLACING BALL BEARINGS

BEARINGS SHOULD NOT BE REMOVED UNLESS THEY ARE TO BE REPLACED. WHEN REMOVAL IS NECESSARY, USE A BEARING PULLER. A BEARING PULLER MAY BE RIGGED BY USING A METAL PLATE, WITH HOLES DRILLED TO MATCH THE TAPPED HOLES IN THE INNER CAP. USE CARE TO KEEP THE PRESSURE EQUAL TO PREVENT BREAKING THE CAP.

TO INSTALL A BEARING, HEAT THE BEARING IN AN OVEN AT 250°F (121°C). THIS WILL EXPAND THE INNER RACE, ALLOWING IT TO SLIP OVER THE BEARING SEAT. ALL BEARINGS MUST BE REPLACED WITH THE IDENTICAL PART USED BY RELIANCE. IN MANY CASES SPECIAL BEARINGS ARE USED WHICH CANNOT BE IDENTIFIED BY MARKINGS ON BEARING. IN ALL CASES, WHEN REPLACING BEARINGS, USE MARKINGS ON BEARINGS AND MOTOR IDENTIFICATION NUMBER TO OBTAIN CORRECT REPLACEMENT BEARING.

THE MAJORITY OF BEARINGS USED NOW HAVE A C3 INTERNAL FIT.

REASSEMBLY

Follow reverse procedure as outlined for Disassembly. Having marked the brackets in the original position, replace as marked.

LUBRICATION OF BEARINGS

Motors covered by this Instruction Manual are equipped with several types of bearings. This description covers regreasable anti-friction bearings only. Non-regreasable ball bearings require no periodic maintenance. See I/M B-3654 for oil mist lubricated anti-friction bearing procedures.

GREASE LUBRICATED BEARINGS

This motor has been properly lubricated at the time of manufacture and it is not necessary to lubricate at time of installation unless the motor has been in storage for a period of six months or more.

Lubrication of anti-friction bearings should be done as a part of a planned maintenance schedule. The Recommended Lubrication Interval should be used as a guide to establish this schedule.

Cleanliness is important in lubrication. Any grease used to lubricate anti-friction bearings should be fresh and free from contamination. Similarly, care should be taken to properly clean the grease inlet area of the motor to prevent grease contamination.

RECOMMENDED LUBRICANT

For motors operating in ambient temperatures shown below, use the following lubricant or its equal:

BALL BEARING MOTORS

OPERATING TEMP. –25°C (–15°F) to 50°C (120°F)

CHEVRON OIL	SRI NO. 2
EXXON	UNIREX N2
SHELL OIL CO.	DOLIUM R
TEXACO, INC.	PREMIUM RB

MINIMUM STARTING TEMPERATURE –60°C (–76°F)

SHELL OIL CO.	AEROSHELL 7

ROLLER BEARING MOTORS

OPERATING TEMP.–25°C (–1 5°F) to 50°C (120°F)

CHEVRON OIL	BLACK PEARL EP NO. 2
TEXACO, INC.	PREMIUM RB

LUBRICATION PROCEDURE

Reliance regreaseable anti-friction bearings may be lubricated with the motor running or stationary. Stationary with the motor warm is preferred.

1. Locate the grease inlet, clean the area and replace the pipe plug with a grease fitting, if the motor is not equipped with grease fittings.
2. If motor is equipped with grease drain plug, remove plug and loosen any hardened grease that may block drain.
3. Add the Recommended Volume of the Recommended Lubricant using a hand operated grease gun.
4. Run the motor for two hours.
5. Replace the pipe plug in grease drain.
6. Grease may not relieve from drain. Use only volume shown in Table 3.

LUBRICATION INSTRUCTIONS

1. Select Service Condition from Table 1.
2. Select Lubrication Frequency from Table 2.
3. Select Lubrication Volume from Table 3.
4. Lubricate the motor at the required frequency with the required lubricant volume in accordance with LUBRICATION PROCEDURE.

NOTE: Mixing lubricants is not recommended due to possible incompatibility. If it is desired to change lubricant, follow instructions for lubrication and repeat lubrication a second time after 100 hours of service. Care must be taken to look for signs of lubricant incompatibility, such as extreme soupiness visible from the grease relief drain area, or from the shaft opening.

SERVICE CONDITIONS

Table 1

Standard Conditions	Eight hours per day, normal or light loading, clean @ 40°C (100°F) maximum ambient.
Severe Conditions	Twenty-four hour per day operation or shock loading, vibration, or in dirt or dust @ 40–50°C (100–120°F) ambient
Extreme Conditions	Heavy shock or vibration, or dust.

LUBRICATION FREQUENCY

Table2

BALL BEARINGS				
Speed	**NEMA (IEC) Frame**	**Standard Conditions**	**Severe Conditions**	**Extreme Conditions**
1800 RPM and Slower	182 (112) Thru 215 (132)	3 Years	1 Year	6 Months
	254 (160) Thru 365 (200)	2 Years	6 to 12 Months	3 Months
	404 (225) Thru 449 (280)	1 Year	6 Months	1 to 3 Months
3600 RPM	ALL	6 Months	3 Months	1 Month
ROLLER BEARINGS				
For Roller Bearings divide the time periods above by 2.				

LUBRICATION VOLUME

Table3

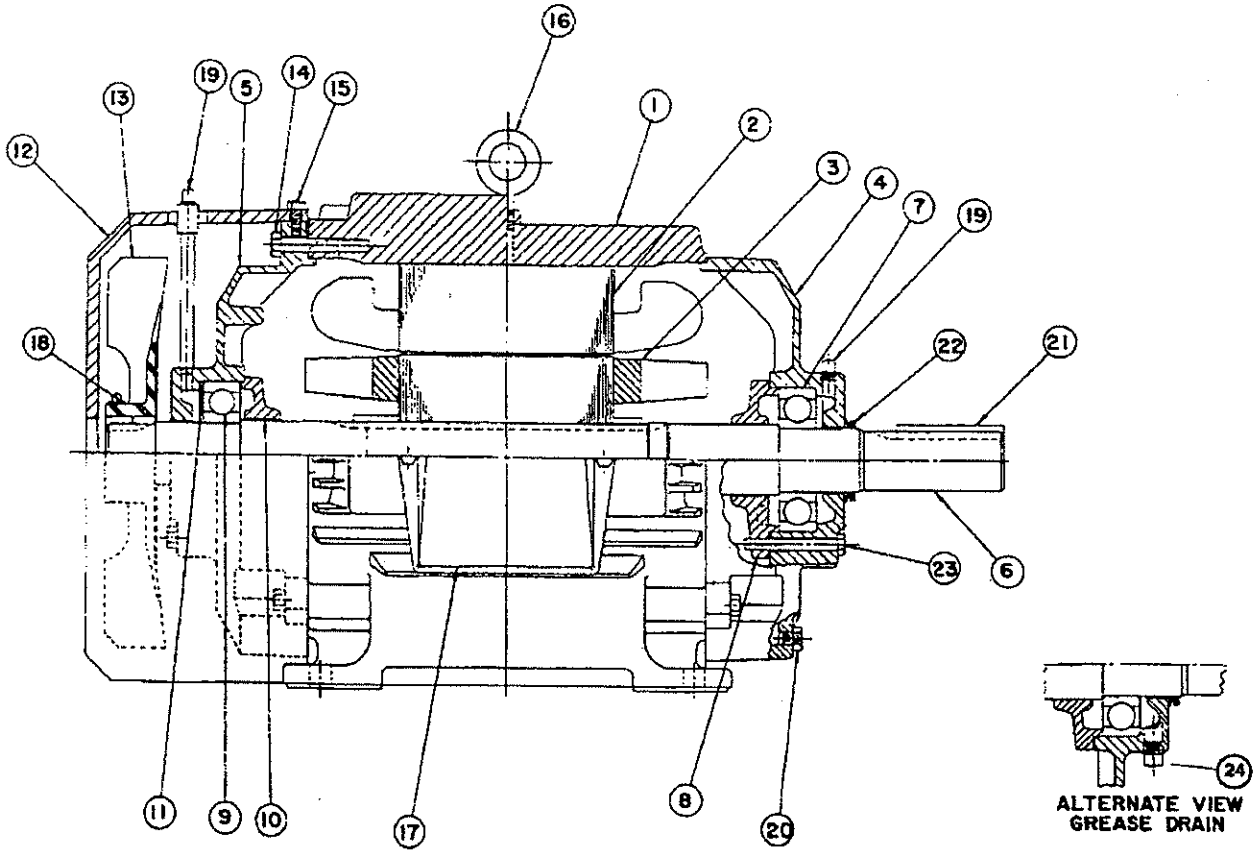
NEMA (IEC) Frame Size	Volume In Cubic Inches (cm^3)
182 Thru 215 (112 – 132)	0.5 (8)
254 Thru 286 (160 – 180)	1.0 (16)
324 Thru 365 (200 – 225)	1.5 (24)
404 Thru 449 (250 – 280)	2.5 (40)

REPLACEMENT BEARINGS

Your maintenance program will not be complete without including spare bearings. It must be remembered that the bearing is a wearable component and therefore must eventually be replaced. To insure that you are able to maintain original operation, **we recommend the purchase of spares directly from Reliance Electric.**

All bearings used in Reliance motors are subject to exact specifications and tests necessary to satisfy performance requirements. In this manner, it is possible to duplicate your present bearing. Markings on the bearing do not indicate complete specifications.

CROSS SECTIONAL AND PARTS IDENTIFICATION DRAWING



FIND NO.	PART DESCRIPTION
1	FRAME
2	STATOR
3	ROTOR/INTERNAL COOLING FAN
4	BACKEND BRACKET
5	FRONTEND BRACKET
6	SHAFT
7	BACKEND BALL BEARING
8	BACKEND INNER CAP
9	FRONTEND BALL BEARING
10	FRONTEND INNER CAP
11	WAVE WASHER, FRONTEND
12	FAN COVER
13	OUTER COOLING FAN

FIND NO.	PART DESCRIPTION
14	FRONT END BRACKET BOLTS
15	FAN COVER BOLTS
16	EYEBOLT
17	TERMINAL BOX
18	FAN CLAMP
19	GREASE ENTRY
20	CONDENSATION DRAIN
21	KEY
22	SLINGER
23	BACKEND CAP BOLTS
24	GREASE DRAIN

NOTE: Bearings shown are regreasable type. Not all items shown may be present on motor. Not all items on motor may be shown on drawing. Drawing is for general reference purposes only.

TOTAL SERVICE PROGRAMS

Reliance Electric can provide a wide range of maintenance programs to help you reduce downtime, improve productivity and increase profits. Capabilities include:

- Motor Start-Up Service
- Motor Electrical and Mechanical Preventive Maintenance
- Vibration Analysis
- Mobile Van Repair Service
- Balancing and Alignment Service
- Maintenance Schools
- 24-Hour Technical Support
- Modernization Service

For more information contact your local Reliance Electric Sales Office or write:

Attn: Motor Tech Support
Reliance Electric
Industrial Services
375 Alpha Drive
Highland Hts., Ohio 44143
USA

RENEWAL PARTS

An adequate stock of factory-made renewal parts is an integral part of a sound maintenance program to protect against costly downtime.

Parts can be obtained from your nearest Reliance Electric parts distributor, or directly from the Reliance Electric factory. When ordering parts for which a part number is not available, give complete description of part and purchase order number, serial number, model number, etc., of the equipment on which the part is used.

A detailed parts list, which gives Reliance Electric recommendations for spare parts that should be stocked for your equipment, can be ordered from:

1. Nearest Reliance Electric Sales Office
2. Nearest Reliance Electric Keyparts Distributor
3. Reliance Electric Renewal Parts, Cleveland, Ohio

Be sure to include complete nameplate data-purchase order number, serial number, rating, etc. – for your equipment when ordering the spare parts list.

For the telephone number (USA) of your local Keyparts Stocking distributor call 1-800-RELIANCE.

ADDITIONAL LITERATURE

Additional literature covering the maintenance of AC motors can be obtained from the Reliance Electric Services Division. Requests should be submitted through your nearest Reliance Electric Sales Office.

MOTOR PURCHASE RECORD

RELIANCE ELECTRIC
DUTY MASTER MOTORS

I.D. # _____ LOCAL ITEM# _____

HP/KW SPEED VOLT

P.O. #: Purchase Contact/Phone #

Date Purchased:

Comments on maintenance/maintenance log

Date	Item	Remarks	Initials

For additional information
6040 Ponders Court
Greenville, SC 29615 USA
Tel: (864) 297-4800
http://www.reliance.com/rpmac

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European Headquarters SA/NV, avenue Herrmann Debroux, 46, 1160 Brussels, Belgium, Tel: (32) 2 663 06 00, Fax: (32) 2 663 06 40
Asia Pacific Headquarters, 27/F Citicorp Centre, 18 Whitfield Road, Causeway Bay, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

Rockwell Automation

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

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.

LISTED*

Model VS2EX

Description

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

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

Models

VS2: Base mount; non hazardous locations.

VS2C: C-clamp mount; non hazardous locations.

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

VS2EXR: Explosion-proof with remote reset.

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

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

Remote Reset Feature (VS2EXR, VS2EXRB and VS94 only)

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

-R15: Remote reset for 115 VAC

-R24: Remote reset for 24 VDC

Time Delay Option (VS94 only)

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

-T15: Time delay for 115 VAC

-T24: Time delay for 24 VDC

Space Heater Options (VS94 only)

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

-H15: Space heater for 115 VAC

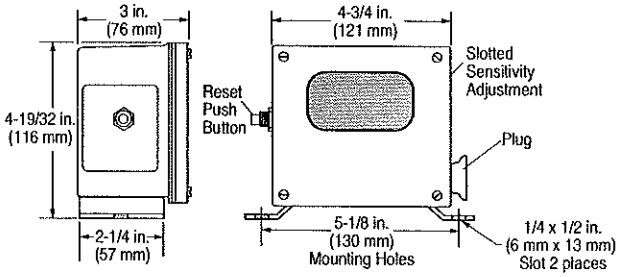
-H24: Space heater for 24 VDC

Warranty

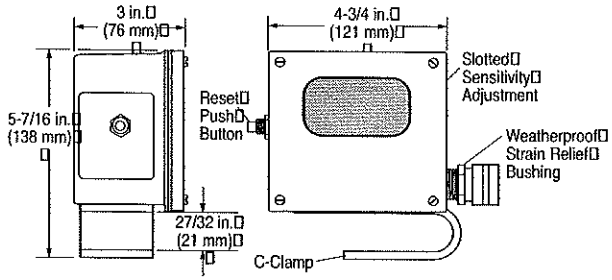
A limited warranty on materials and workmanship is given with this FW Murphy product. A copy of the warranty may be viewed or printed by going to www.fwmurphy.com/support/warranty.htm

DIMENSIONS

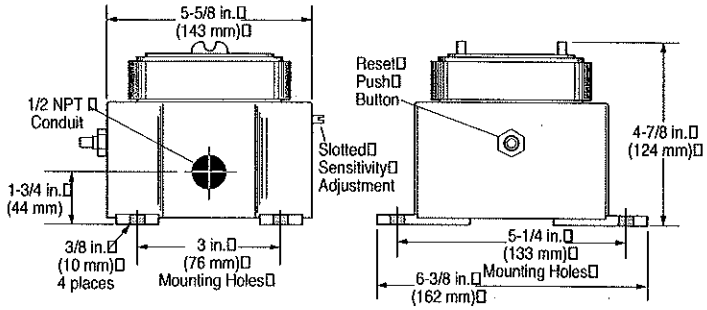
VS2



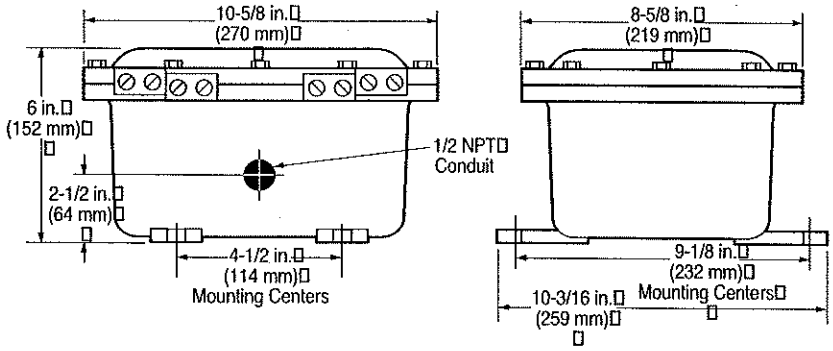
VS2C



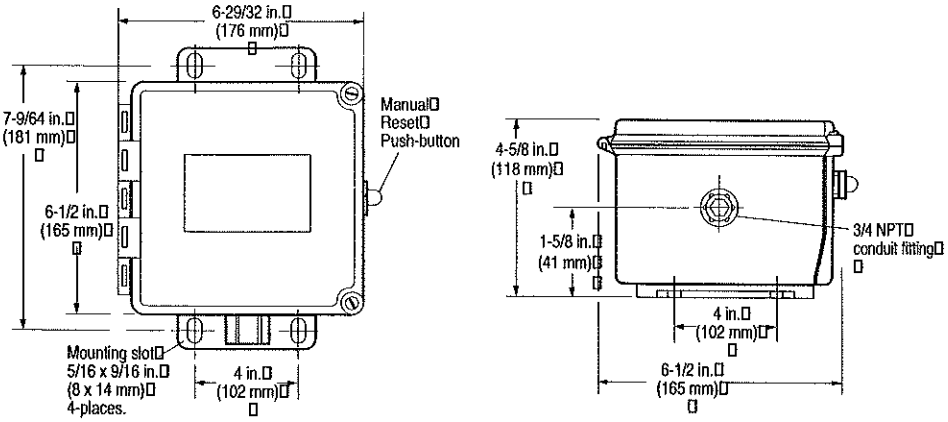
VS2EX and VS2EXR



VS2EXRB



VS94



SPECIFICATIONS

VS2 and VS2C

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

VS2EX

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

VS2EXR

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

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

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

VS2EXRB

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

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

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

VS94

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

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

- **Remote Reset (optional):**

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

- **Time Delay (optional):**

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

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

*CSA and UL listed with 480 VAC rating.

INSTALLATION

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

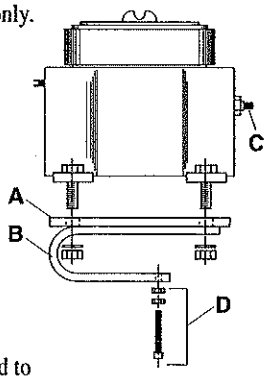
The VS2 and VS94 series shock switches are sensitive to shock and vibration in all three planes of motion - up/down, front/back and side/side. Front/back is the most sensitive (The reset pushbutton is located on the "front" of the unit). For maximum sensitivity mount the unit so that the front faces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

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

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

C-Clamp Installation (VS2C model only)

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



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

Continued on next page.

All Models

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

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

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

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

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

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

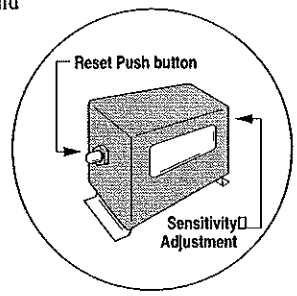
Sensitivity Adjustment

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

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

1. **REPLACE ALL COVERS, LIDS, AND ELECTRICAL ENCLOSURES.**
2. Press the reset push button to engage the magnetic latch. To be sure the magnetic latch has engaged, observe latch through the window on the VS2 and VS2C (see DETAIL "A"). On the VS2EX, VS94 series the reset button will remain depressed meaning the magnetic latch has engaged.
3. Start the machine.
4. If the instrument trips on start-up, allow the machine to stop. Turn the sensitivity adjustment 1/4 turn clockwise, (adjustment for VS94 and VS2EXRB models is located within the box, see DETAIL "B").

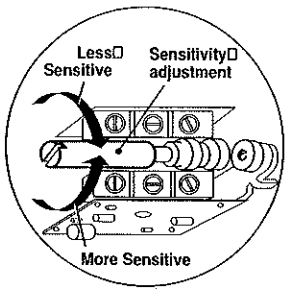
DETAIL "A"



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

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

DETAIL "B"



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

VS94 Time Delay Adjustment

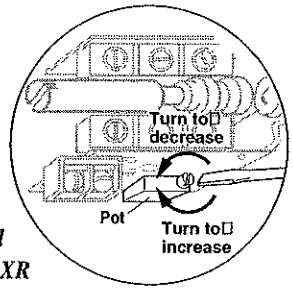
1. Apply power to the time delay circuit. (see page 7 for time delay circuit). The time delay function will be initiated.
2. Time the length of the delay with a watch. Let time delay expire. After it expires, the override circuit will de-energize the solenoid, allowing the latch arm to trip. A clicking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

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

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

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

DETAIL "C"



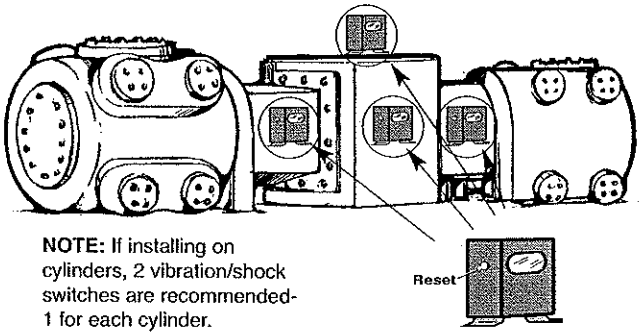
4. Locate the time adjustment pot (DETAIL "C"). The time is factory-set at the lowest setting (5 seconds approximately). To increase time, rotate the 20-turn pot clockwise as needed (5 seconds per turn approximately).
5. Repeat the above steps as necessary to obtain desired time delay.

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

TYPICAL MOUNTING LOCATIONS

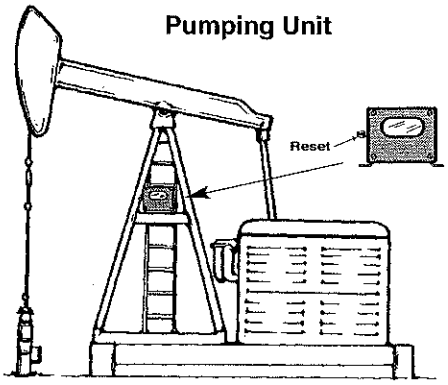
NOTE: These are typical mounting locations for best operation. Other mountings are possible. See *Installation* section on page 3.

2-Throw Balance-Opposed Compressor

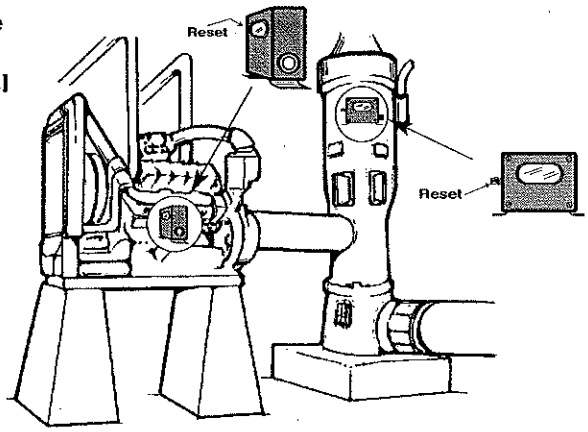


NOTE: If installing on cylinders, 2 vibration/shock switches are recommended- 1 for each cylinder.

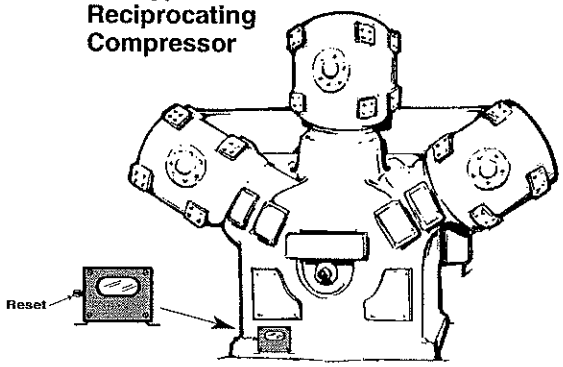
Pumping Unit



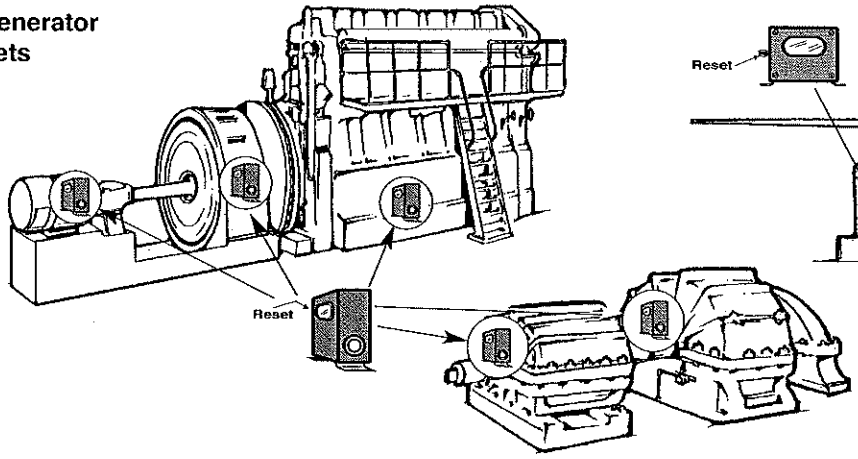
Engine and Vertical Shaft Pump



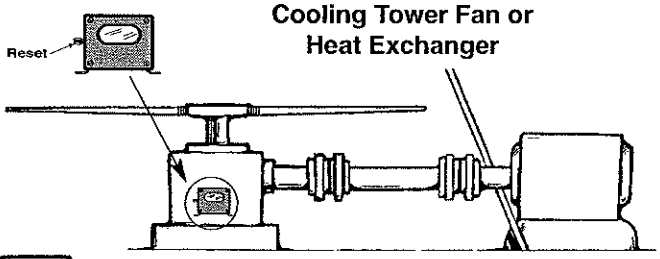
"Y" Type Reciprocating Compressor



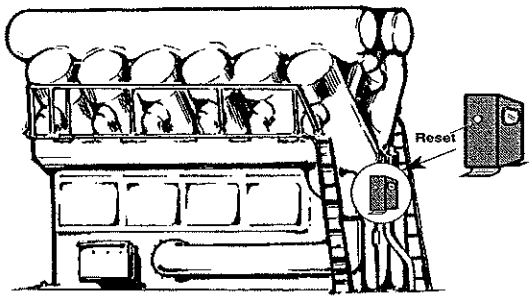
Generator Sets



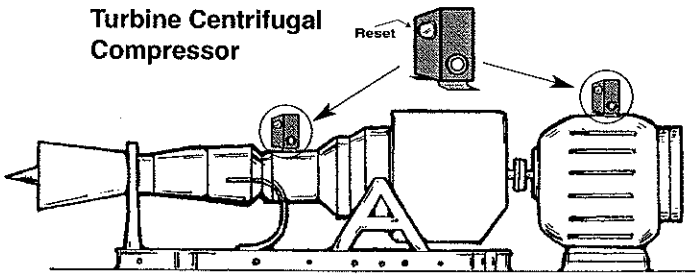
Cooling Tower Fan or Heat Exchanger



Engine Compressor

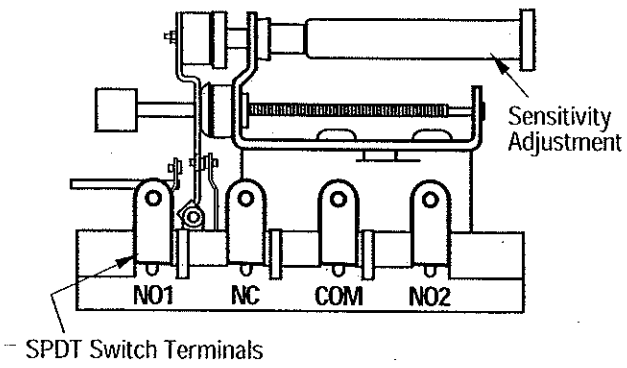


Turbine Centrifugal Compressor

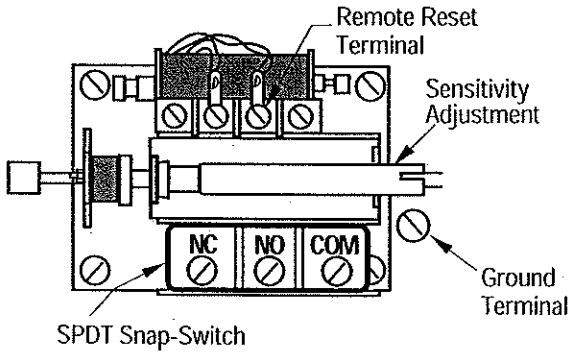


INTERNAL SWITCHES

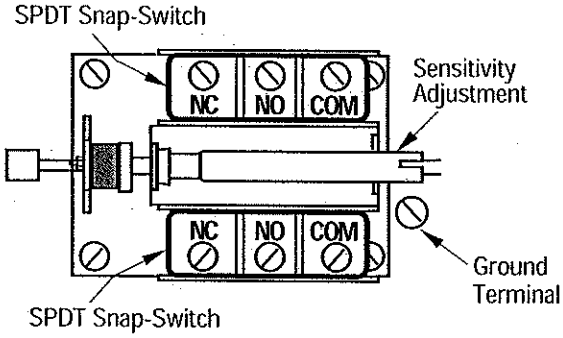
VS2 and VS2C



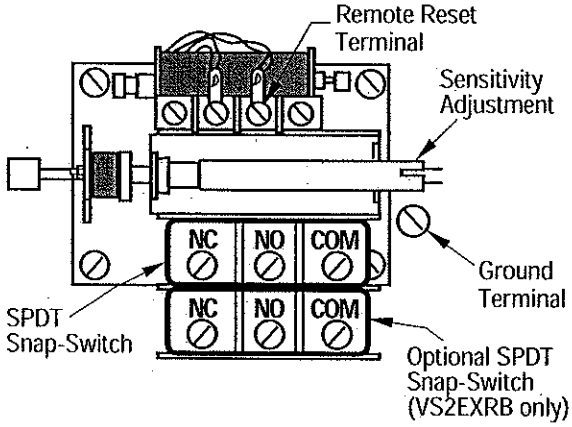
VS2EXR



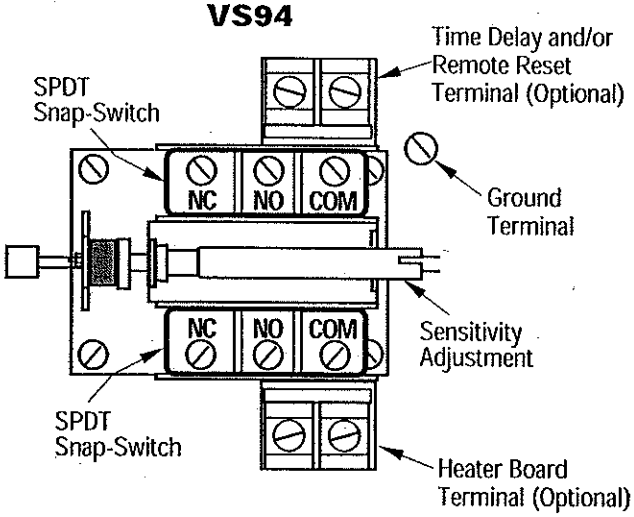
VS2EX



VS2EXB and VS2EXRB



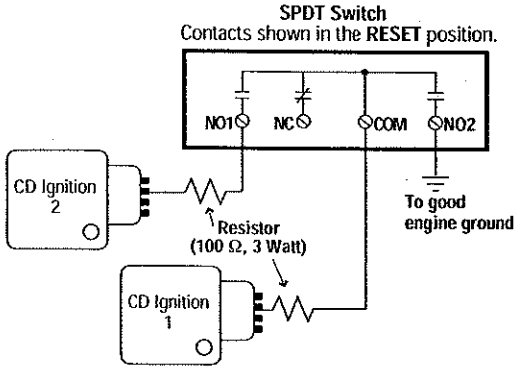
VS94



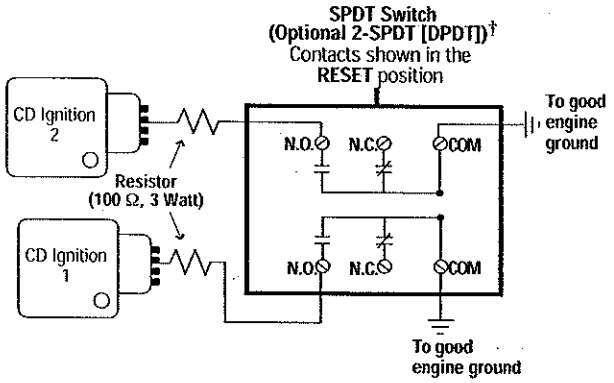
ELECTRICAL

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

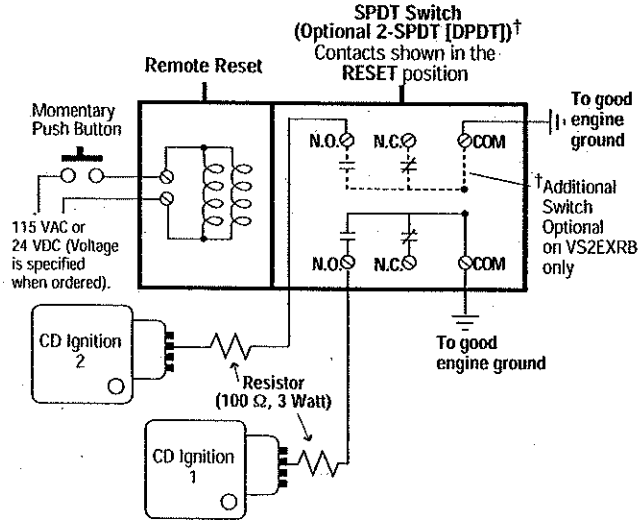
VS2 and VS2C
Typical Wiring Diagram for Single or Dual CD Ignition



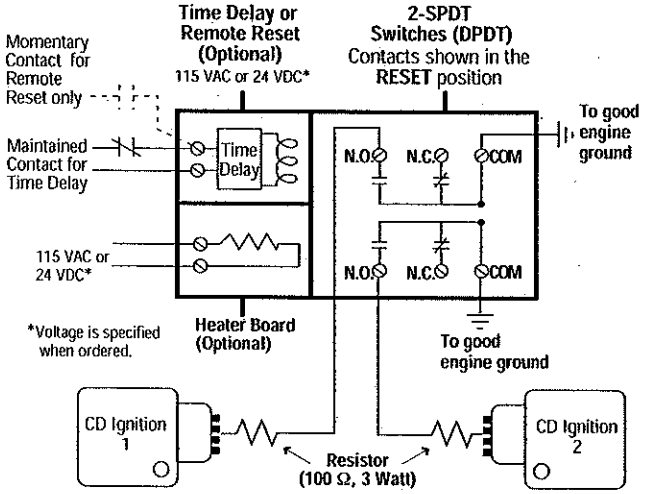
VS2EX
Typical Wiring Diagram for Single or Dual CD Ignitions



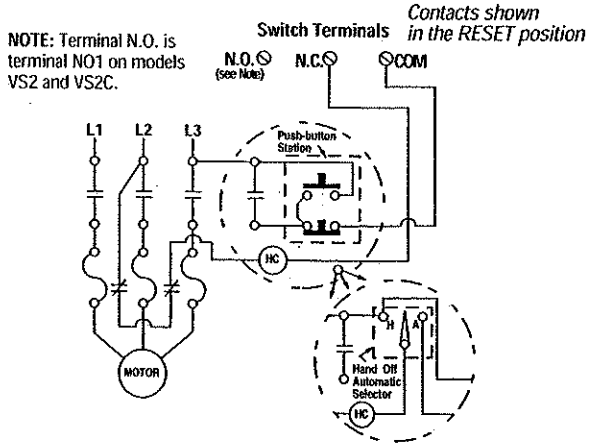
VS2EXR and VS2EXRB
Typical Wiring Diagram for Single or Dual CD Ignitions



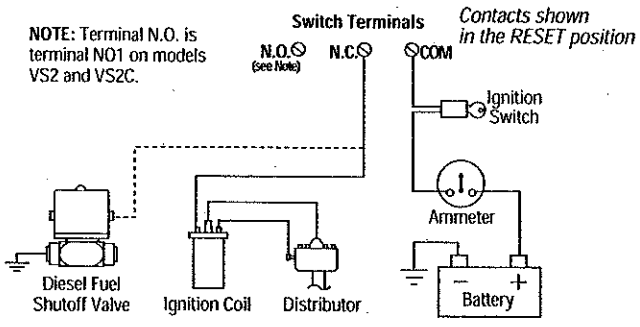
VS94
Typical Wiring Diagram for Single or Dual CD Ignitions



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



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



SERVICE PARTS

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

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

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

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

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

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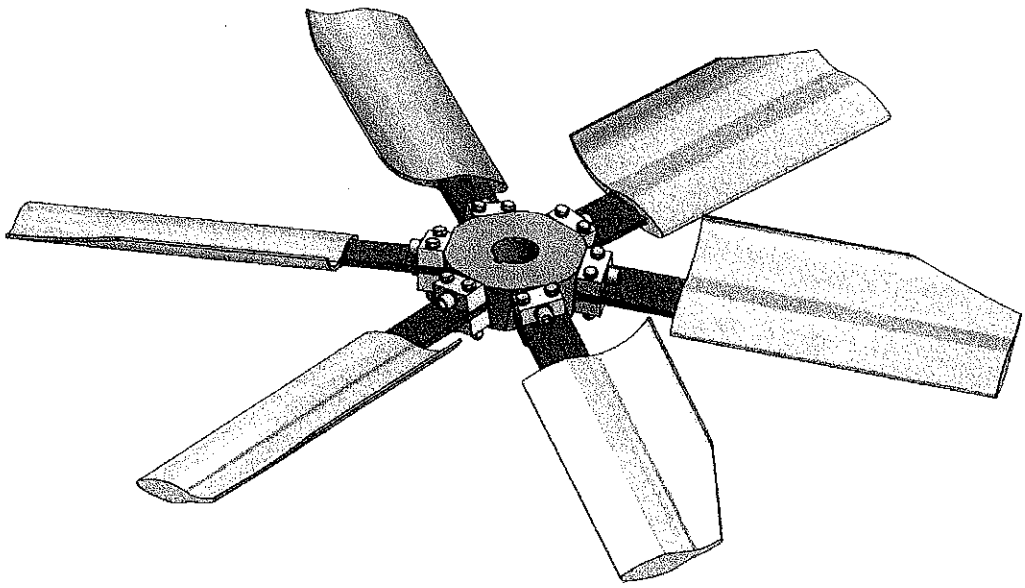
COFIMCO AXIAL FANS FOR THE WORLD	B-BR – 1.1	GB

Manual for the Installation, Maintenance and Operation of

COFIMCO B-BR series Fans



November 2006

Read carefully all the content of this manual, before starting the installation of the fan.

INDEX

1 GENERAL INFORMATIONS

1.1 Description of COFIMCO B series Fans

The Cofimco B series fans permit variable pitch adjustment at standstill and feature a simplified design: the hub is a single component made of steel. Each blade consists of an extruded aluminum alloy profile or pultruded fiberglass reinforced profile (FRP), which is fixed to a steel plate by a set of bolts. The external end of the blade plate contain a blocker system in order to facilitate the connection to the hub using some bolts.

The Cofimco B series fans are available in two different installations:

- The fan "stands" on the drive shaft: fan type B
- The fan is "hung" to the drive shaft: reverse fan type BR

Figure 1 shows the two configurations.

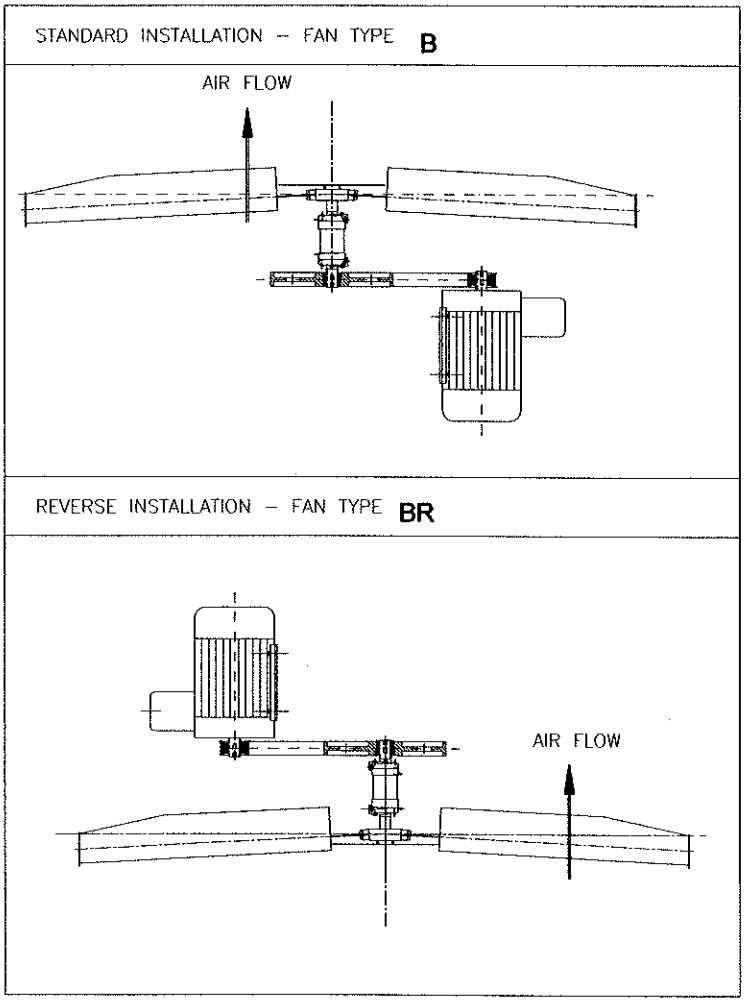


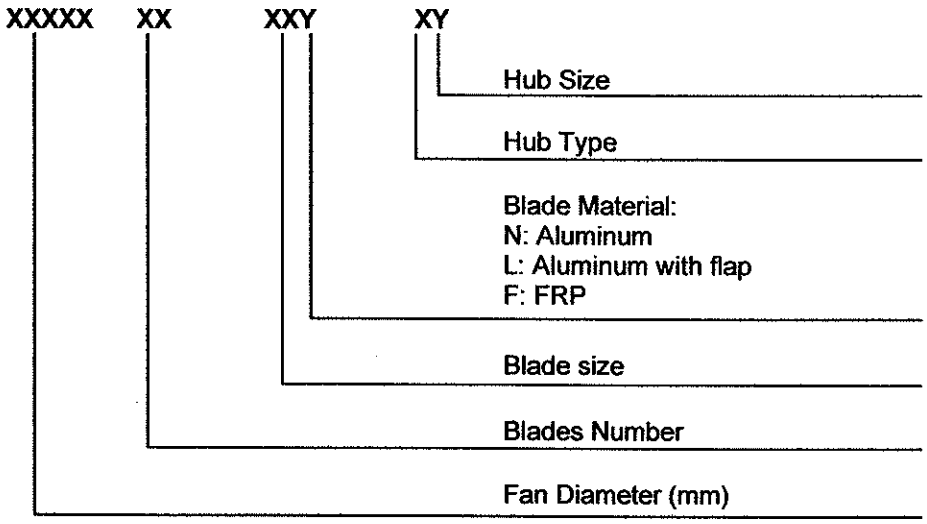
Fig.1: Installation Type

WARNING: hubs and blades of COFIMCO B series fans are patented and COFIMCO S.r.l. will take all necessary measures to protect against infringements.

1.2 Cofimco fan identification numbers

All Cofimco rotors have an identification plate attached to the hub, permitting fast and accurate identification.

On the identification plate (see example below), the following information are listed:

F/T	Fan type designation:  Following the code that identifies the hub type, the letter T appears, which stands for the special blade tip cap presence.
C/R	Refers to COFIMCO reference and is followed by an internal code number.
P.O.	Refers to the Purchase Order.
I	Refers to the fan item number in the job.
A°	Refers to the blade pitch angle and it is followed by degree of angle.

Example: F/T 4267-05-24L/B3RT

COFIMCO S.R.L. - ITALY Via A. Gramsci, 62 - 28050 POMBIA (NO)	
F/T	4267/05/24L/B3T
C/R	12345/678
P.O.	PO123456
I	E-1234
A°	10.5
BLADE PAT. N° 4618313 HUB PAT. N° 4715784	

The identification plate makes reference to a 4267mm diameter fan, having 5 blades with manual pitch adjustment at standstill, 24L airfoil type, aluminum (L) blades, special tip caps and a B3 hub; Cofimco Job 12345/678, purchase order PO123456, Item number E-1234, set at 10.5° pitch angle.

WARNING: the identification plate above, is shown as an example and do not correspond in anything to the identification plate of the purchased fan in any way.

WARNING: the data shown on the identification plate must always be transmitted to Cofimco S.r.l. when spare parts are requested.

1.3 Balancing

Unless otherwise specified, all Cofimco fans are balanced as follows:

- When the rotor is dispatched on assembled form, each unit is dynamically balanced within a degree of G = 6.3 in accordance with ISO 1940/1.
- When the fan is dispatched disassembled, the hub is dynamically balanced and the blades are statically balanced so that the reassembled unit correspond to a degree of G = 6.3 in accordance with ISO 1940/1. In this case, the blades have the same static moment, therefore can be positioned in any order on the hub; the blades of the same supply inside the same item number, are interchangeable.

NOTE: when the fan is assembled and stopped, it is possible that each blade may have slight different deflection from the other ones.

1.4 Storage

Upon unloading the Cofimco fan, inspect it for any damage. If damage occurrs, file a claim immediately against the carrier and mark the bill of lading accordingly.

After the fan delivery, check the full compliance between order and delivered goods. Shortages or discrepancies must be reported to Cofimco S.r.l. within two weeks from receipt of shipment at destination.

If not installed immediately, it is recommended to store the fan in a dry and shaded area, and do not place heavy materials of any kind upon the blades. For long-term storage, it is necessary to check the condition of the corrosion preventive coating on all machined surfaces.

2 INSTALLATION

2.1 Tools required for proper fan assembly

The following tools are required for proper fan assembly:

- Dynamometric Spanner (torque wrench, Fig.2) required tightening the hub bolts in accordance with the tables in section 2.4.
- Goniometric Level (inclinometer, Fig. 3) required setting the blade pitch to the proper angle for the desired performance in accordance with the procedure described in section 2.4. The accuracy of the inclinometer must be at least 0.5°.

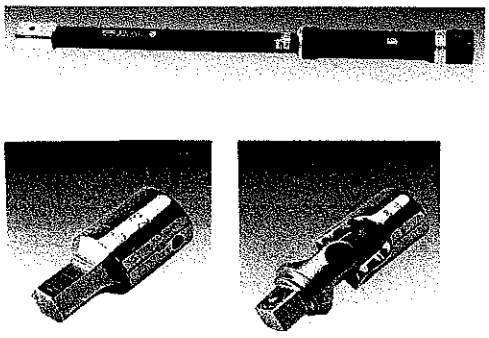


Fig.2: Torque wrench

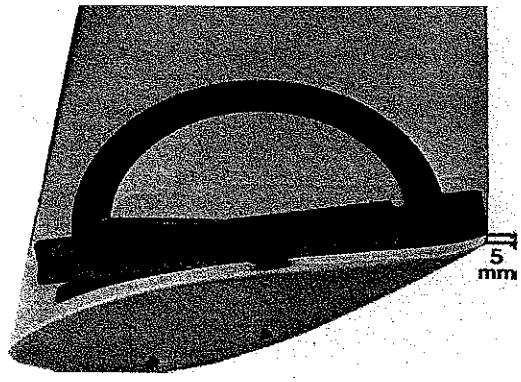


Fig.3: Inclinometer

COFIMCO S.r.l. can supply these tools on client request.

2.2 Rotation and flow direction

The rotation direction is right when the airflow moves from the convex back (suction surface) of the blade, to the concave side (pressure surface). Fig.4 shows the conventional clockwise direction of

rotation and normal direction of airflow as viewed from the discharge face of the rotor. On demand, Cofimco S.r.l. can provide fans having the same direction of airflow, but with counter clockwise rotation.

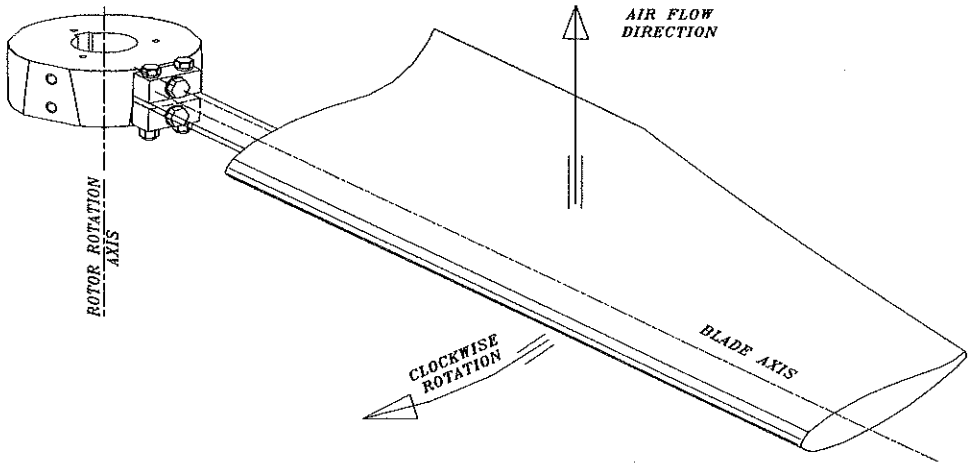


Fig.4

2.3 Inclination of blade axes

The blade axes of Cofimco fans can slope towards the direction of the air supply, creating a slight inclined angle with the normal axis of rotation (Fig.5); this fixed inclination should not be confused with the "droop". This design feature exploits the bending moment generated by centrifugal force by setting it against the opposing bending moment that results from fan traction. The centrifugal bending moment partially neutralizes the fan thrust bending moment, resulting in a considerable reduction of blade stresses. When assembling the fan, it is essential to check the blades actually slope in the direction of the air supply and away from the discharge.

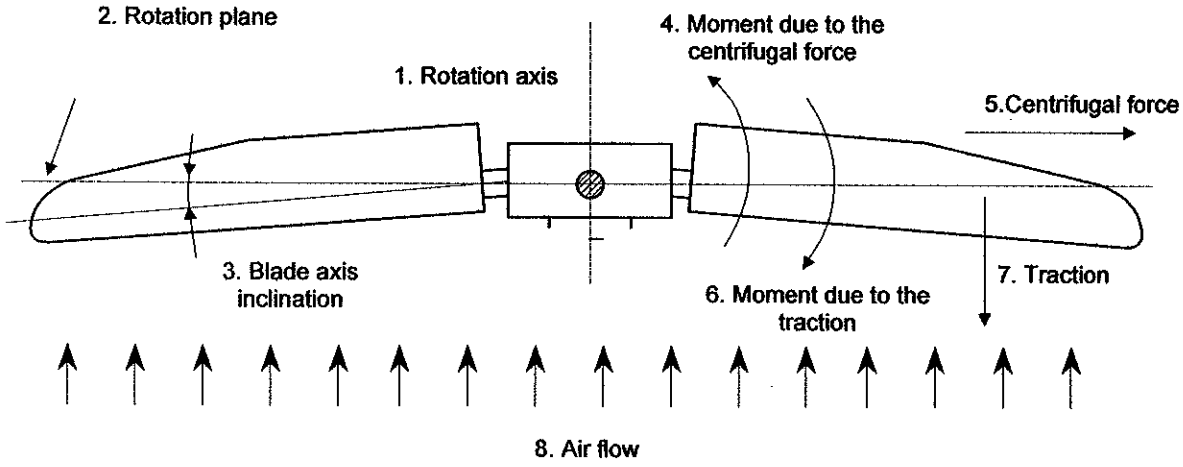


Fig.5

2.4 Installation instructions of COFIMCO B series Fans

Make sure the motor is disconnected from its power source and refer to the following instructions.

a) As for the hub with cylindrical bore, the hub is bored to attack directly to the drive shaft. In this case, making reference to Fig.6, coat the output shaft (1) with a thin layer of silicone grease;

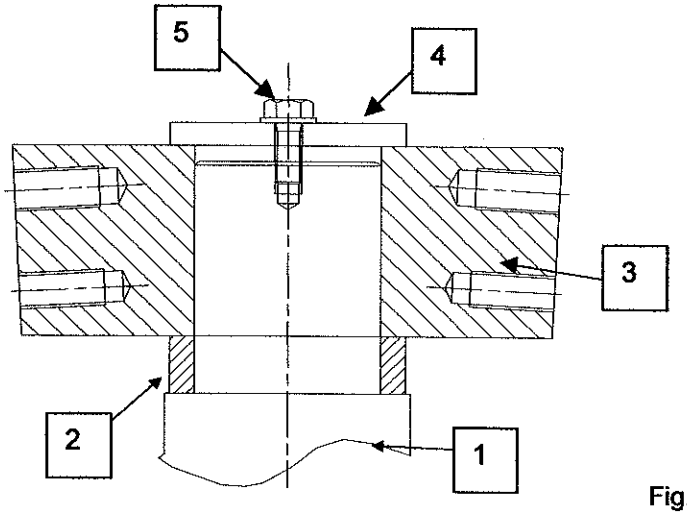


Fig.6

If supplied, install the spacer ring (2). Install the hub (3) on its drive shaft so that the coupling is seated against the shaft step; be sure the side surfaces of the hub are facing downwards. Please note the drive shaft end must remain recessed at least 2 mm in the hub hole to prevent dangerous fan vertical translation (it is advisable to keep 5 mm).

As for the hub with split taper bushing, make reference to the following Fig.7.

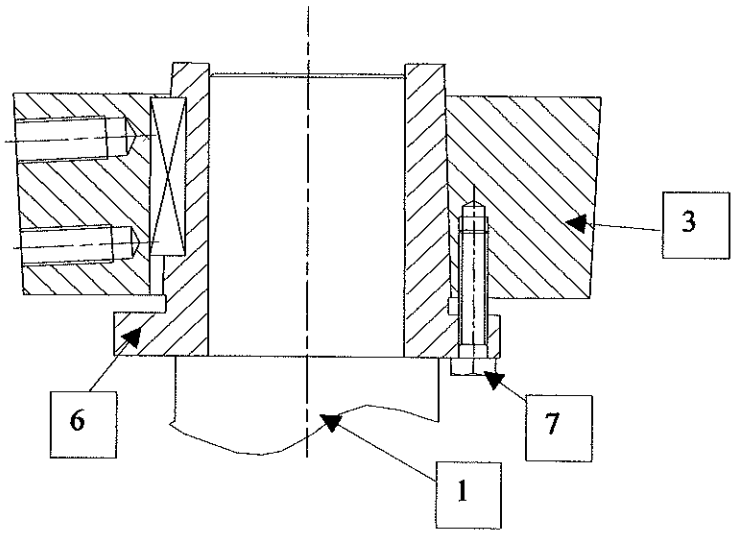


Fig. 7

Slide the bushing (6) onto the drive shaft; **in this case, the drive shaft must not be lubrificated in any way**. Then position the hub (3) over the bushing taper; be sure the side faces of the hub are facing downwards. Insert the bushing screws (7) through the bushing flange into the threaded hole in the hub coupling; torque bushing screws according to the following table.

BUSHING TYPE	SCREW TORQUE	
	N * m	Lb * ft
P2	21.0	16
Q1 and Q2	39.3	29
R1 and R2	39.3	29
S1 and S2	94.9	70

b) Only for the hub with cylindrical bore: making reference to Fig.6, attack washer (4) to the hub and insert screw (5) (not supplied by Cofimco S.r.l.), through the center of the hub and into the shaft.

c) As for the installation of blades to hub and pitch settings, clean all mating surfaces and act in the following way:

- Fit blade to hub by blade fasteners (socket heads screws (8) (10), washers (9) (11)) as indicated in Fig.8 but not tightening screws. We suggest applying on these bolts adhesive thread lock, strong grade, type Loctite 270 or equivalent (not mandatory).

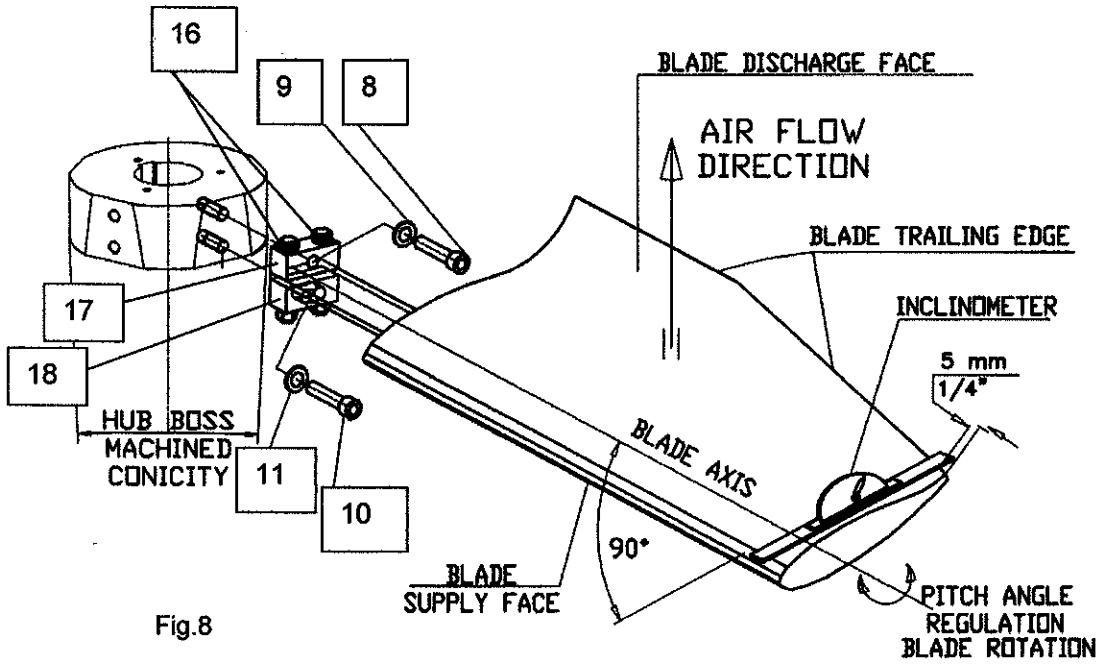


Fig.8

- Place the inclinometer perpendicular to the blade axis, on the top of the blade, 5 mm from the tip as shown in Fig.3. If the inclinometer base is too short to have a correct position, insert a rigid steel bar between inclinometer and blade.

- Rotate the blade on its axis until the required pitch angle is obtained.

- Torque screw at a torque setting according to the value indicated in the following tables.

d) Repeat for each blade steps described in point c). Before starting the pitch angle setting procedure, turn the fan till the blade to be set is at the same point in the fan ring where previous pitch angle was set. This step helps compensate for any slight departures from a vertical rotation axis.

In order to determine the torque setting of the screws, look at the following table for the screw type set for the hub type of the fan in object (this information is shown on the identification plate of the fan).

HUB	SCREW 8	SCREW 10
B1	M14	M12
B3	M16	M14
B6	M20	M20

The following tables show the listed screws torque for the screw class.

Warning: the screw class information are shown in the fan documentation part list.

Standard screws: choose torque according to 8.8 or 10.9 stamping on the bolts:

SCREW TYPE	SCREW TORQUE CLASS 8.8		SCREW TORQUE CLASS 10.9	
	N * m	Lb * ft	N * m	Lb * ft
M12	75.4	55.6		
M14	119.3	88.0	124.6	91.6
M16	179.3	132.2	194.2	143.2
M20	349.7	257.8	400.3	295.1

The blockers (17) (18), are provided by Cofimco already connected to their corresponding flexy elements, and must not be loosened. However, the following tables show the proper torque according to their corresponding bolts (16). Choose torque according to 8.8 or 10.9 stamping on the bolts

	SCREW 16	SCREW TORQUE	
		N * m	Lb * ft
B1	M10 – 10.9 Class	74.4	54.9
B3	M12 – 10.9 Class	124.3	91.7
B6	M16 – 10.9 Class	296.3	218.4
B6	M16 – 8.8 Class	241.7	178.2

For stainless steel screws, A4 –80 - AISI 316, torque previous screws 8, 10 and 16, according to the following table

SCREW TYPE	SCREW TORQUE	
	N * m	Lb * ft
M10	42.3	31.2
M12	70.8	52.2
M14	112.0	82.6
M16	168.3	124.1
M20	328.2	242.0

WARNING: in case of a structure equipped with several fans, before setting blade pitch angle to all fans as shown on the identification plate on all the fans, set the pitch on one fan only, and follow the operating instructions of chapter 3.

2.5 Installation of Seal Disk

Follow instructions below, making reference to Fig.9

a) Place seal disk spacer (12) against hub (3).

b) Place seal disk (13) atop spacers.

c) Place washers (14) against seal disk; insert seal disk screws (15) and torque to recommended 25.5 N*m (18.8 Lb*ft) for screws with 8.8 stamping; torque to 15.7 N*m (11.6 Lb*ft) for screws with A4-70 stamping. Screw class information is shown in the fan documentation part list.

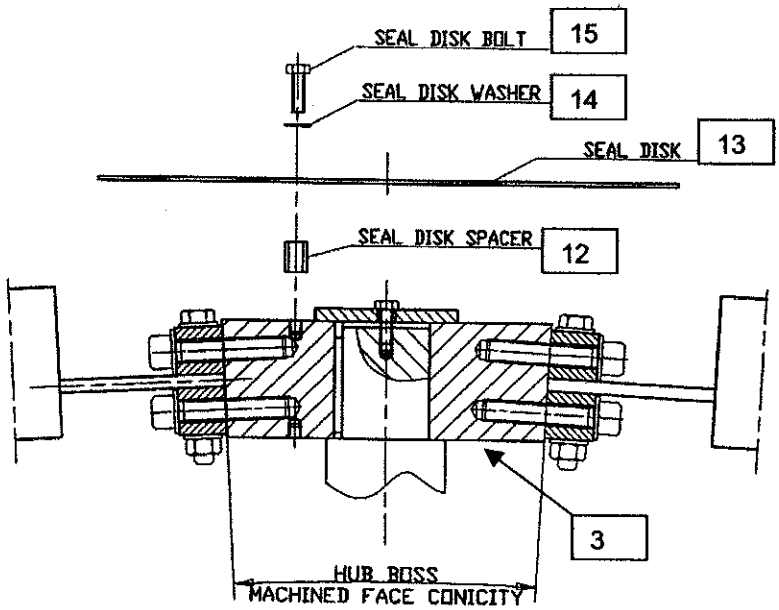


Fig. 9

3 OPERATING INSTRUCTIONS

3.1 Prior to start-up

a) Make sure all the blockers are fixed to hub boss: if any movement of the blockers is detected, do not operate the fan and check the torque of screws (8) and (10).

b) Identify blade static deflection and running deflection on the data sheet selection: if static deflection is higher than running deflection, manually rotate the fan one full turn and check that the distance of tip blades lower point to the closest surface is higher than the distance shown in the following table, according to the fan diameter; if static deflection is lower than running deflection, manually rotate the fan one full turn and check that the distance of the tip blades lower point to the closest surface is higher than [(distance shown in following table, according to fan diameter) + (running deflection - static deflection)] mm.

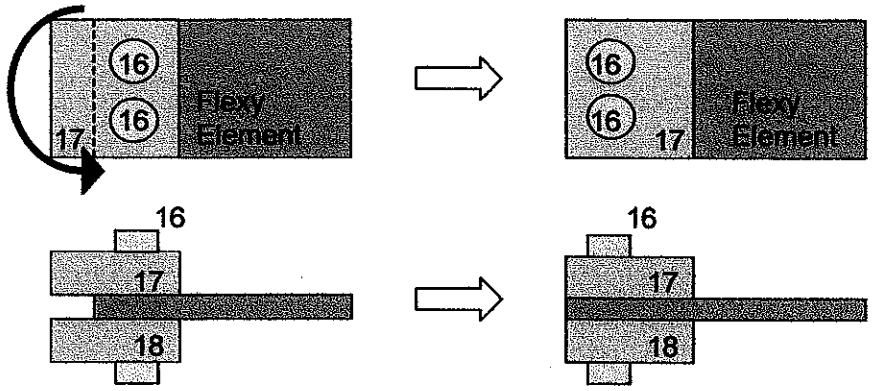
Diameter [mm]		Hub Type	Distance of the tip blades lower point to the closest surface
From	To		
0	4000	B1	150
0	3999	B3	150
4000	4881	B3	200
0	5490	B6	200
5491	6200	B6	250

WARNING: distance of the tip blades lower point to the closest surface are valid for wind speed up to 45 m/s.

c) Rotate fan to check tip clearance is in accordance with the specified value (tip clearance ratio x/D, where x = the distance from the blade tip to the fan ring and D = the rotor diameter). The gap between blade tip and fan ring must be measured along blade axis.

WARNING: the minimum distance between tip blade and fan ring must take into consideration the difference between blade static deflection and blade running deflection: especially, if blade static deflection is higher than running deflection, the blade must be kept up compared to static deflection, of a quantity equal to (static deflection - running deflection) mm; if blade static deflection is lower than running deflection, the blade must be kept down in comparison with static deflection, of a quantity equal to (running deflection - static deflection) mm. The blade static deflection and running deflection are shown on the data sheet selection.

If the distance between blade tip and fan ring is not as predicted, the fan diameter can be reduced, rotating the blockers (17) (18), as shown in following Fig.10. The blocker bolts must be tightened to the torque shown on section 2.4.



NOTE: the blocker side surfaces must lay on the same plane, as shown in following figure

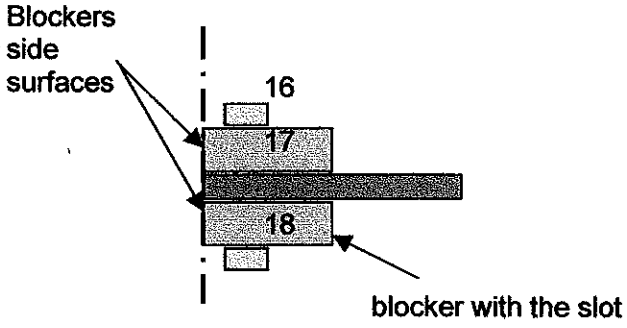


Fig.10

d) Check the blades axis for proper angle of inclination (see section 2.3).

e) Check gear box oil level or belt tension to be as indicated by the manufacturer

f) Remove all tools from area.

g) Connect motor to power supply.

h) Start fan for a few seconds, and then switch it off. While the fan is still turning, check that the direction of the blade rotation is correct (see section 2.2).

3.2 Post start-up

a) Check power aborption: if excessive, **reduce** the **blade pitch angle** until the desired power is achieved (set the new pitch on all the fans of a same structure); if lower than predicted, **increase** the **blade pitch angle** until the desired power is achieved (set the new pitch angle on all the fans of a same structure).

Warning: power absorption varies in inverse proportion to the air temperature.

b) Check that the vibration level in the position shown in Fig.11 does not exceed the most restrictive amplitude values between the limits imposed by the normative of the structure where

the fan is installed and the limits imposed by the VDI 2056 normative. In this case, shut down the unit and trace the cause of such excessive vibration by referring to section 4.3 of the following chapter.

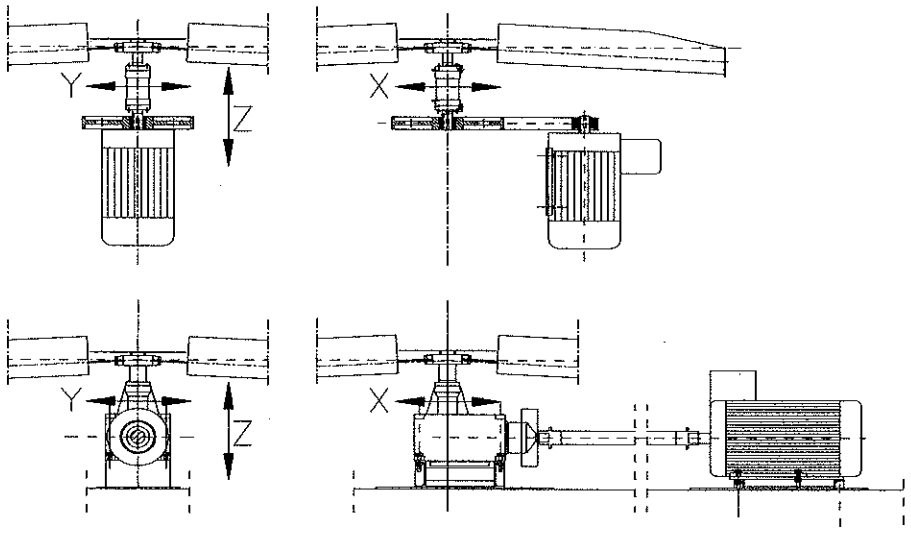


Fig.11

c) Once the rotor has been running for one hour, check the torque of the hub screws (8) and (10).

d) Repeat the verification of screws (8) and (10) after 24 hours from start-up.

4 PREVENTIVE MEASURES FOR MAINTENANCE

4.1 Maintenance and operation

a) Inspect the overall fan condition periodically.

Inspection intervals depend on fan operating conditions and may vary from a minimum of 2 weeks to a maximum of 6 months.
The following components should be specifically inspected when inspecting the overall fan conditions:

- screw torque;
- corrosion of fasteners;
- general condition of blades surface and flexible elements.

It may become necessary to clean the rotor blades in order to ensure proper balance.

b) Ice formation on the blades of operating fans must be strictly avoided.

c) If ice has formed on a stationary fan, it must be removed prior to start-up to avoid damaging the blades. Snow formed on a stationary fan must be periodically removed, according to the abundance of snow accumulated.

d) Turn-off 2-speed motor for at least 30 seconds before switching to lower speed.

e) Stop the unit completely before reversing the direction of fan.

f) Check vibration level in the position shown in Fig.11 at regular intervals.

The vibration level must not exceed the most restrictive amplitude values between the limits imposed by the normative of the structure where the fan is installed and the limits imposed by the VDI 2056 normative. In this case, shut down the unit and trace the cause of such excessive vibration by referring to section 4.3 of the following chapter.
It is advised to keep a record of the readings taken on each occasion for comparison.
Always take readings at the same positions and in the same manner.
Observe the safety precautions ensuring power supply is turned off.
The fan vibration levels constitute an invaluable indication of the state of the plant and should be frequently monitored (e.g. monthly).

4.2 Temperature range

COFIMCO fans are designed to operate at the following temperatures:

Minimum - 40 °C (-40 °F) using material standard

Maximum
Aluminum blades:
+ 105 °C (+ 221°F)
Frp blades:
+ 80°C (+ 176°F) fan in operation
+ 105°°C (+ 221°F) fan at rest

4.3 Possible causes of vibration

The actual causes of vibration may vary considerably: some of the most common are as follows:

a) Unbalance of one or more blades: the vibration caused by blade imbalance occurs on the tip path plane with a frequency equal to the fan RPM and at an amplitude which is dependent on the degree of imbalance and the square of the rotational speed.

b) Blade pitch angle not included in the ± 0.5° tolerance: this condition causes vibration outside the tip path plane at a frequency equal to the fan RPM and at an amplitude which is dependent on the square of the rotational speed.

c) Blades too close to supports (periodic aerodynamic turbulence): this condition is characterized by vibration outside the tip path plane at a frequency equal to the product of the number of fan blades and RPM. The amplitude depends upon the extent of the aerodynamic turbulence.

d) Resonance between one of the possible forcing frequencies of the fan and one or more of the vibration modes of the structure on which it is installed.
The main forcing frequencies generated by the fan, normally correspond to the following frequencies:
- Fan RPM
- The product of fan RPM and the number of blades
- The product of fan RPM and the number of structural supports capable of generating aerodynamic turbulence (if they are arranged in an axial-geometric fashion).

e) Vibration transmitted by the structure on which the fan is installed: the frequencies of such vibration depend on both the external forcing frequencies and the resonant frequencies of the structure.

f) Resonance of the blades with one of the possible forcing frequencies; in the vast majority of cases the vibration occurs outside of the tip path plane.

g) Misalignment of the drive shaft: this generates vibration with a frequency that is one or two times the RPM.

h) Loosening of blade and/or speed reducer fixing bolts. The behavior of the rotor under these circumstances is totally unpredictable, as it depends upon the extent and location of the loosening.

i) Worn output shaft bearing: this condition generates vibration on the tip path plane at a frequency equal to the rotor RPM.

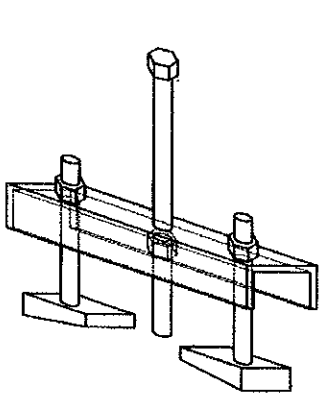
j) The fan and/of the structure bolts are not tightened: in this case all the bolts have to be tightened.

k) The draining holes of the blades are obstructed: they must be opened.

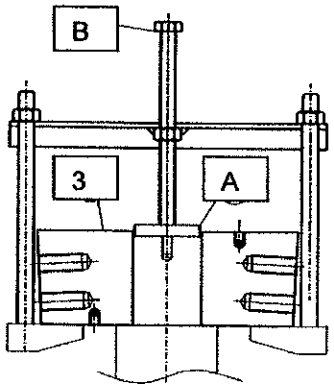
WARNING: the amplitude of the fan vibrations is determined by the rigidity of its support. Vibration that would not be critical to a fan supported by a sufficiently rigid structure is amplified by an overly flexible support. This support rigidity may also cause unexpected variations in the resonant frequencies of the blades.

5 HUB REMOVAL

A simple tool (not supplied by Cofimco S.r.l.) can be fashioned for the extraction of the fan hub from the output shaft (see Fig.12).



Tool for hub removing



(3) Hub; (A) washer; (B) bolt

Fig. 12

6 GUARANTEE

Cofimco guarantees that all materials and workmanship of Cofimco fans are of high quality and free of defects.

If, within a period of 18 months from the date of dispatch from our workshop or until the end of the first year of operation, a Cofimco fan has been determined to be defective in any way due to defective materials or manufacturing, Cofimco reserves the option to repair or replace the defective unit, without charge, whichever occurs first.
All repairs and/or replacements will be provided at Cofimco or a designated location. Freight costs to and fro Cofimco are not covered.

The Cofimco warranty shall be considered void if the fan has been altered or damaged due to improper installation and/or operation.
Cofimco will not reimburse the costs of repairs that have been performed without proper authorization.

Under no circumstances shall Cofimco be held liable for consequential or incidental damage of any kind resulting from the manufacture, sale, installation or use of any Cofimco products.

7 CONTACTS

AXIAL FANS FOR THE WORLD

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November 2006

8 TROUBLE SHOOTING

For any questions, contact COFIMCO S.r.l. specifying the purchase order number shown on the identification plate of the hub.

TROUBLE SHOOTING		
Situation	**Possible Cause**	**Possible Solution**
Low air flow Low power absorption	System congestion.	Clean the entire system.
	Obstacles to the air flow.	Check the real obstacles area and the inlet shape towards the original design.
		In dry-coolers the minimum free height of the inlet area has to be 1 times the fan diameter at least; this height has to be higher in case of multiple units in line.
	Static pressure higher than the specified one.	Increase blade pitch angle (till 3 deg. After checking the data sheet selection).
	Pitch angle lowered by blade rotation (e.g. screw (8) and (10) not tightened at the right torque)	Set the right pitch angle and refer to the operation manual to set the right torque of screws and bolts.
	Temperature higher than the designed one.	Increase blade pitch angle (till 3 deg. After checking the data sheet selection).
High power absorption	Temperature lower than the designed one.	Decrease blade pitch angle (till 3 deg. After checking the data sheet selection).
	Static Pressure lower than the designed one.	Decrease blade pitch angle (till 3 deg. After checking the data sheet selection).
Rubbing between the blades and the fan ring	Screws and bolts of the fan and/or the structure loosened.	Torque all screws and bolts.
	Fan not centered. Tip clearance too small.	Center the fan. Increase the fan ring diameter.
Scratch or little damages	...	Contact Cofimco.
Thin crack on a blade surface	...	Contact Cofimco.

Problem	Possible cause	Possible Solution
High vibration level	Unbalance of one or more blades.	Contact Cofimco.
	Blade pitch angle not included in the 0.5 deg. tolerance.	Set right blade pitch angle.
	Blades too close to supports (periodic aerodynamic turbulence).	Contact Cofimco.
	Resonance between one of the possible forcing frequencies of the fan and one or more of the vibration modes of the structure on which it is installed.	Contact Cofimco.
	Vibration transmitted by the structure on which the fan is installed.	Contact Cofimco.
	Resonance of the blades with one of the possible forcing frequencies.	Contact Cofimco.
	Misalignment of the drive shaft.	Realign the drive shaft.
	Worn output shaft bearing	Contact the supplier.
	The fan and/or the structure bolts are not tightened	Tighten screws and bolts at the right torque.
	The draining holes of the blades are obstructed	Open the draining holes.

9 PART LIST

PART LIST			
Item (Fig.13)	**Description**	**Std. Material**	**Std. Protection**
1	Drive shaft (Not supplied by Cofimco)	-	-
2	Space ring (if necessary)	Steel	Zinc plated
3	Hub boss	Steel - C40	Zinc Plated
4	Washer	Steel	Zinc Plated
5	Screw (Not supplied by Cofimco)	-	-
6	Bushing (only if required)	Melleable cast iron	Burnished
8	Blade to hub boss connecting screw	Steel - 8.8 – 10.9 class	Zinc Plated
9	Blade to hub boss connecting washer	Steel – R40	Zinc Plated
10	Blade to hub boss connecting screw	Steel - 8.8 – 10.9 class	Zinc Plated
11	Blade to hub boss connecting washer	Steel – R40	Zinc Plated
12	Seal disk spacer	Steel	Zinc plated
13	Seal disk	Steel – Fe430B	HDG
14	Seal disk washer	Steel – R40	Zinc plated
15	Seal disk screw	Steel – 8.8 class	Zinc plated
16	Blocker bolt	Steel - 8.8 – 10.9 class	HDG
17	Upper blocker component	Steel – Fe360B	Zinc plated
18	Lower blocker component	Steel – Fe360B	Zinc plated
19	Flexy element	Steel	Fusion Bonded Epoxy
20	Blade	Aluminum or FRP	-
'B-BR' SERIES FAN ASSEMBLY (Standard)			

WARNING: for special applications, materials and protective coatings could be different; in this case, make reference to the fan documentation.

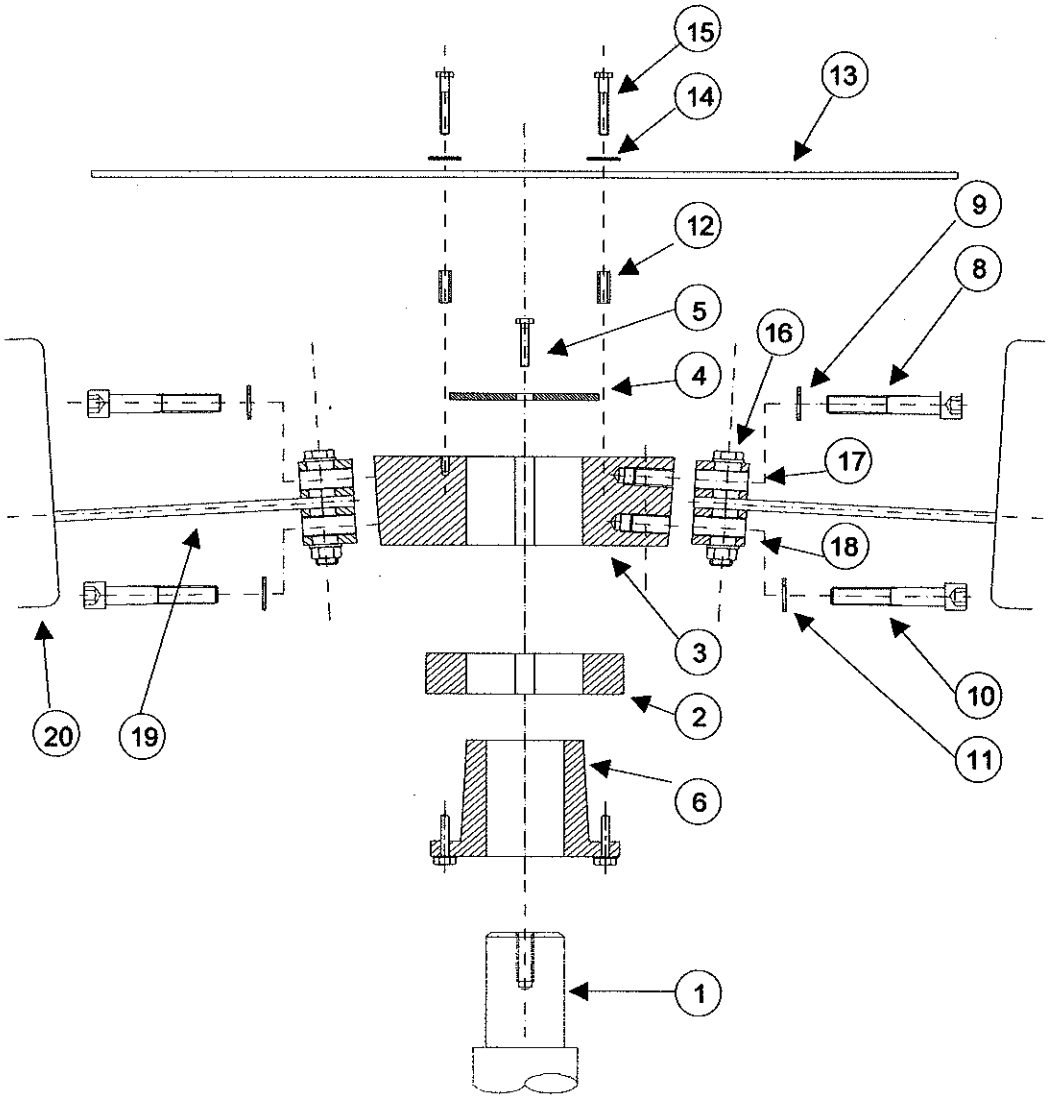

Fig.13