



 AVERY





# OPERATION & MAINTENANCE MANUAL FOR

## KOBELCO NB/GB SERIES

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<b>KOBELCO COMPRESSORS (AMERICA), INC.      ENGINEERING DEPARTMENT</b>					
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TROUBLE SHOOTING COMPRESSORS

FOREWORD

This manual contains instructions for operation and maintenance of KOBELCO screw compressors. The compressors and the auxiliary equipment have been manufactured, and undergone strict shop inspections and tests. Although we believe that all our machines function well, note that no machine can work perfectly unless operated and maintained correctly. If they are improperly installed, handled or operated, not only malfunction but also fatal damage to the machines may be brought about. Therefore, prior to starting the operation, please read through to understand the whole contents of this manual, and operate the compressor unit in the best conditions to get the most of them.

It should be understood that the information contained herein will not relieve the operators of the responsibility of exercising normal good judgment in the care and operation of the machine.

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WARNING

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A complete reading of this manual by personnel in contact with the compressor is essential to safety and proper operation.

Incorrect installation, operation, maintenance, or parts replacement can result in injury to personnel, and fatal damage to the compressor, driving machinery, and plant.

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## SAFETY PRECAUTIONS FOR COMPRESSORS AND EQUIPMENT

To be read attentively before starting the unit

### Safety Signs

Whenever you see Safety Signs in this manual it means as follows :

**WARNING** : Personal danger

Warning notes indicate any condition or practice, which if not strictly observed, could result in personal injury or possible death.

**CAUTION** : Possible damage to equipment

Caution notes indicate any condition or practice, which if not strictly observed or remedied, could result in damage or destruction of the equipment.

**NOTE** : Notes indicate an area or subject of special merit, emphasizing either the product's capabilities or common errors in operation or maintenance

### General

It is important that all personnel observe safety precautions to minimize possibility of injuries. The following should particularly be noted :

Read and understand the contents of this manual before installing, operating or maintaining this compressor.

Installation, operation, maintenance and repair shall only be performed by authorized, trained personnel.

Take care and follow appropriate procedures in handling, lifting, installing, operating and maintaining the equipment.



Operation

1. Sometimes the compressor may be provided with special parts for shipping to secure the parts during transportation. They should be removed before the operation or turning of the rotor by referring to PACKING INSTRUCTION or RUST PREVENTION PROCÉDURE.
2. KOBE STEEL, LTD. will not be responsible for any damages that may result from operation outside the design and/or stated operating conditions for which this compressor was intended. (Refer to design operating conditions included as part of this manual)
3. In the event that compressor shuts down automatically, DO NOT RESTART until cause of shut down has been determined and corrected. Severe damage to compressor and/or auxiliary equipment may result.
4. People staying in compressor rooms shall use ear protectors.
5. Never operate the equipment without protective guards such as shaft coupling guard attached.
6. The compressor casing and associated piping or accessories may become hot enough to cause skin burn on contact. Care must be taken where such surfaces are exposed.
7. Never attempt to work on machine or removal guards, covers, shields, etc. while machine is in operation.
8. Never operate the compressor for inflammable gas service on air, once it has been put into the actual gas service. This may cause a fire due to possibly remaining inflammable impurities.
9. Than air service, never fail to check the concentration of oxygen and other gases, and to secure the ventilation. If the compressor is running, be sure to wear ear protector.
10. Critical ratings (pressures, temperatures, flow, etc.) shall be durably marked and maintained.
11. Other potential hazards to safety may also be associated with operation of the equipment. All personnel working in or passing through the area should be warned by signs and trained to exercise adequate general safety precautions.

**Chapter II RECEIVING, LIFTING AND INSTALLATION****1. Receiving Inspection**

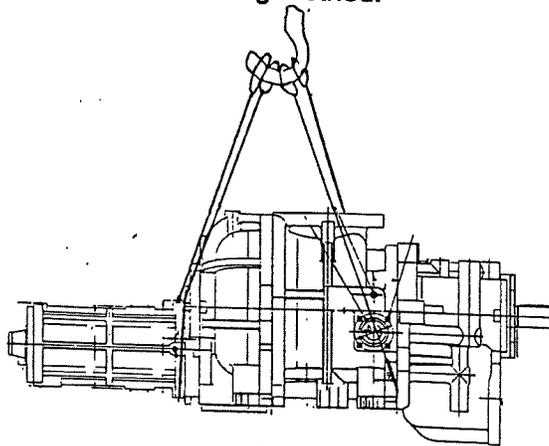
- (1) Immediately upon arrival, examine all crates, boxes, and exposed component surfaces for damage.  
Unpack all items, and check against packing slip for any shortage.  
Examine all items for damage in transit.
- (2) the compressors are pressurized with 0.5 kgf/cm<sup>2</sup>G (7PSIG) nitrogen charge.  
If the nitrogen charge is lost during transit, re-charge nitrogen. It may be necessary to check for possible leaks and repair them.
- (3) All bare steel surfaces are coated with rust preventive compound. Check the condition for all such surfaces and spray with a suitable rust preventive fluid if necessary.

2. Lifting

(1) The approximate weight is as follows;

MODEL	WEIGHT (LB)
11S	660
13S	650
13L	700
16S	950
16L	1000
19M	1980
19L	2190
19LL	2450
23M	3460
23L	3750
23LL	4000
28M	5730
28L	6170
28LL	6570
32M	8710
32L	9260
32LL	10650

(2) A crane with suitable lifting capacity is needed.  
See the sketch for correct lifting method.



**WARNING**

Never lift the compressor with lifting lugs installed on the casing.

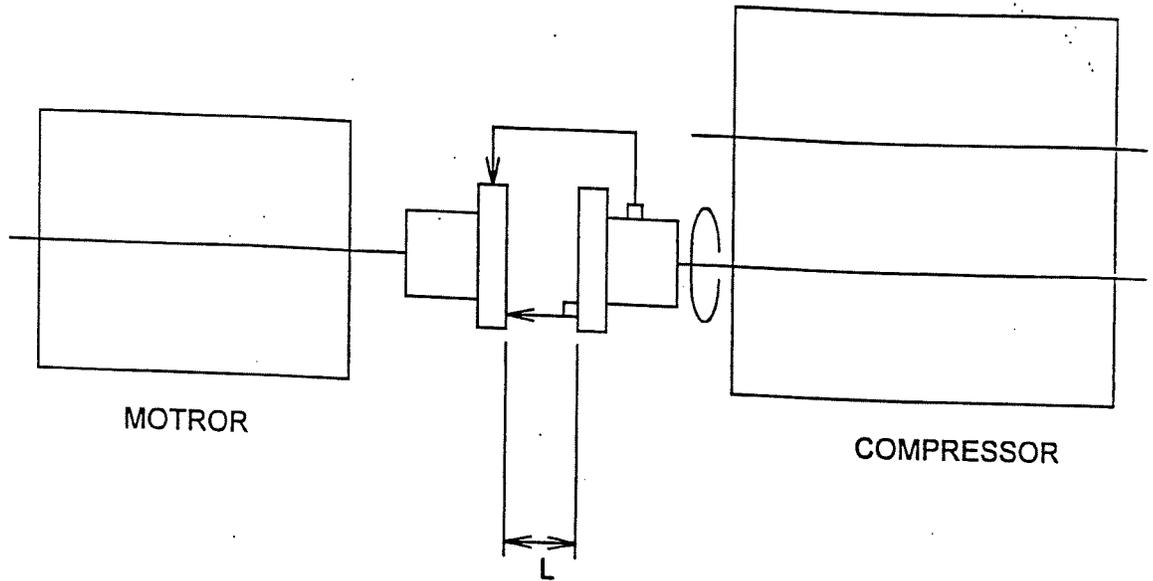
The lifting lugs of each casing is for lifting each casing.

**3. Installation**

- (1) Discharge nitrogen just before installation.
- (2) Mount the compressor on the baseplate by appropriate lifting way.  
(Refer to Chapter II)
- (3) Confirm parallel offset and angular misalignment between coupling halves and adjust them if necessary, to allowable values.  
(Refer to "Fig. 2.2 Shaft Alignment")

**Caution**

- (1) Place of packaging shall not be dusty, humid, moisture, corrosive, and high temperature circumstance.
- (2) All openings to be connected to pipes shall be protected by covers to prevent dirt from entering to the customer.



ANGULAR MISALIGNMENT	TIR	(mm)	below 0.1
PARALLEL OFFSET	TIR	(mm)	below 0.1
LENGTH	L	(mm)	As per Coupling Manufacturer

Fig. 2.2 Shaft Alignment

### 1. Preface

This manual presents minimum requirements for protecting a compressor during a long term storage (approx. 6 months).

It is intended to supplement preservation or storage by customer.

### 2. Rust prevention for shipping

- (1) After sealing the openings of compressor with blind flanges and plugs, dry nitrogen gas of 0.05MPaG (7.1PSIG) is supplied to the compressor inside.
- (2) Shipping gauge which is pressure gauge is installed at nozzle N9.
- (3) Check joint which is fitting for supplying dry nitrogen gas is installed at nozzle N8.

(NOTES) Refer to Fig. 1 for our shipping conditions.  
Refer to Fig. 2 for check joint.

### 3. Place of storage

Compressor should be stored indoors, where the following conditions are satisfied:

- (1) No exposure to weather, rain or wind
- (2) No exposure to direct sun rays
- (3) Concrete floor, free from moisture and water
- (4) Relative humidity less than 70 percent
- (5) No corrosive atmosphere
- (6) No vibration or shock
- (7) Moderate temperature (0°C - 40°C = 32 - 104° F)

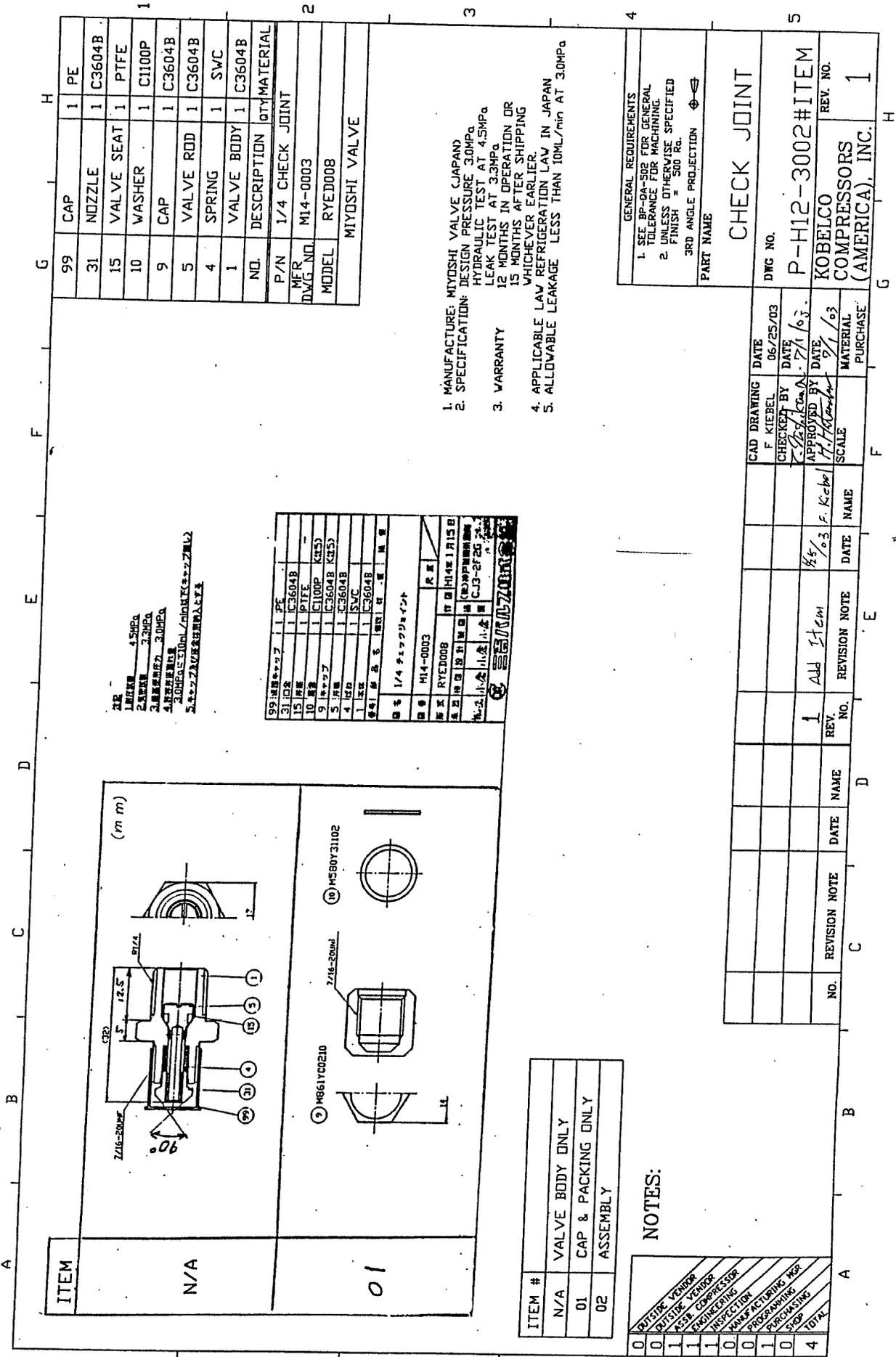
#### 4. Initial and periodical inspection, and treatment

- (1) Initial inspection after arrival of compressor and periodical inspection during storage should be made, to check the pressure of sealed nitrogen gas is above the atmosphere. Periodical inspection should be performed once per month.
- (2) When the pressure is less than 0.01MPaG (1.4 PSIG), the compressor should be pressurized to approx. 0.05MPaG (7.1PSIG) with dry nitrogen gas through check joint at nozzle N8.
- (3) When external leakage of nitrogen gas is found, check the leakage parts and repair.
- (4) Input shaft should be rotated by man 10 times per year to check internal condition. If you find any small hard turning, contact KOBELCO to check internal condition.
- (5) If the storage is exceed 4 years, disassembling and internal inspection of the compressor is needed. All o-rings, seals and gaskets should be replaced with new ones. If you find any small rust on the compressor part by the inspection, contact KOBELCO for repair procedure.  
If disassembly and reassembly were carried out, serial number of the compressor should be informed to KOBELCO.

#### IMPORTANT

- (6) Rust inhibitor should not be applied to corrosion preventive, because any rust inhibitor reacts with  $\text{NH}_3$ , and produces a sludge.

H453635



1. 12.5  
 2. 5  
 3. 12.5  
 4. 12  
 5. 14

99	1	PE
31	1	C3604B
15	1	PTFE
10	1	C1100P
9	1	C3604B
5	1	C3604B
4	1	SWC
1	1	C3604B

ITEM #	VALVE BODY ONLY
01	CAP & PACKING ONLY
02	ASSEMBLY

NOTES:

0	QUANTITY	0
0	VALVE BODY	0
1	PACKING	1
1	ENGINEERING	1
0	INSPECTION	0
0	MANUFACTURING	0
0	PROTECTIVE	0
1	PURCHASING	1
0	STOP	0
4	TOTAL	4

99	CAP	1	PE
31	NOZZLE	1	C3604B
15	VALVE SEAT	1	PTFE
10	WASHER	1	C1100P
9	CAP	1	C3604B
5	VALVE ROD	1	C3604B
4	SPRING	1	SWC
1	VALVE BODY	1	C3604B
NO.	DESCRIPTION	QTY	MATERIAL
MFR	1/4 CHECK JOINT		
DWG. NO.	M14-0003		
MODEL	RYED008		
	MIYOSHI VALVE		

- MANUFACTURE: MIYOSHI VALVE (JAPAN)
- SPECIFICATION: DESIGN PRESSURE 30MPa  
HYDRAULIC TEST AT 4.5MPa  
LEAK TEST AT 3.5MPa  
12 MONTHS IN OPERATION OR  
15 MONTHS AFTER SHIPPING  
WHICHEVER EARLIER.
- WARRANTY
- APPLICABLE LAW REFRIGERATION LAW IN JAPAN  
ALLOWABLE LEAKAGE LESS THAN 10ML/MIN AT 30MPa

GENERAL REQUIREMENTS  
 1. SEE BP-0A-503 FOR GENERAL TOLERANCE FOR MACHINING.  
 2. UNLESS OTHERWISE SPECIFIED FINISH = 500 RA.  
 3RD ANGLE PROJECTION

PART NAME  
**CHECK JOINT**

DWG NO.  
**P-H12-3002#ITEM**  
 REV. NO.  
**1**  
 KOBELCO  
 COMPRESSORS  
 (AMERICA), INC.

CAD DRAWING DATE	06/25/03
CHECKED BY	F. KIEBEL
APPROVED BY	F. KIEBEL
DATE	7/1/03
SCALE	1/0.3
MATERIAL	
PURCHASE	

NO.	REVISION NOTE	DATE	NAME
1	ADD ITEM	8/5/03	F. Kiebel

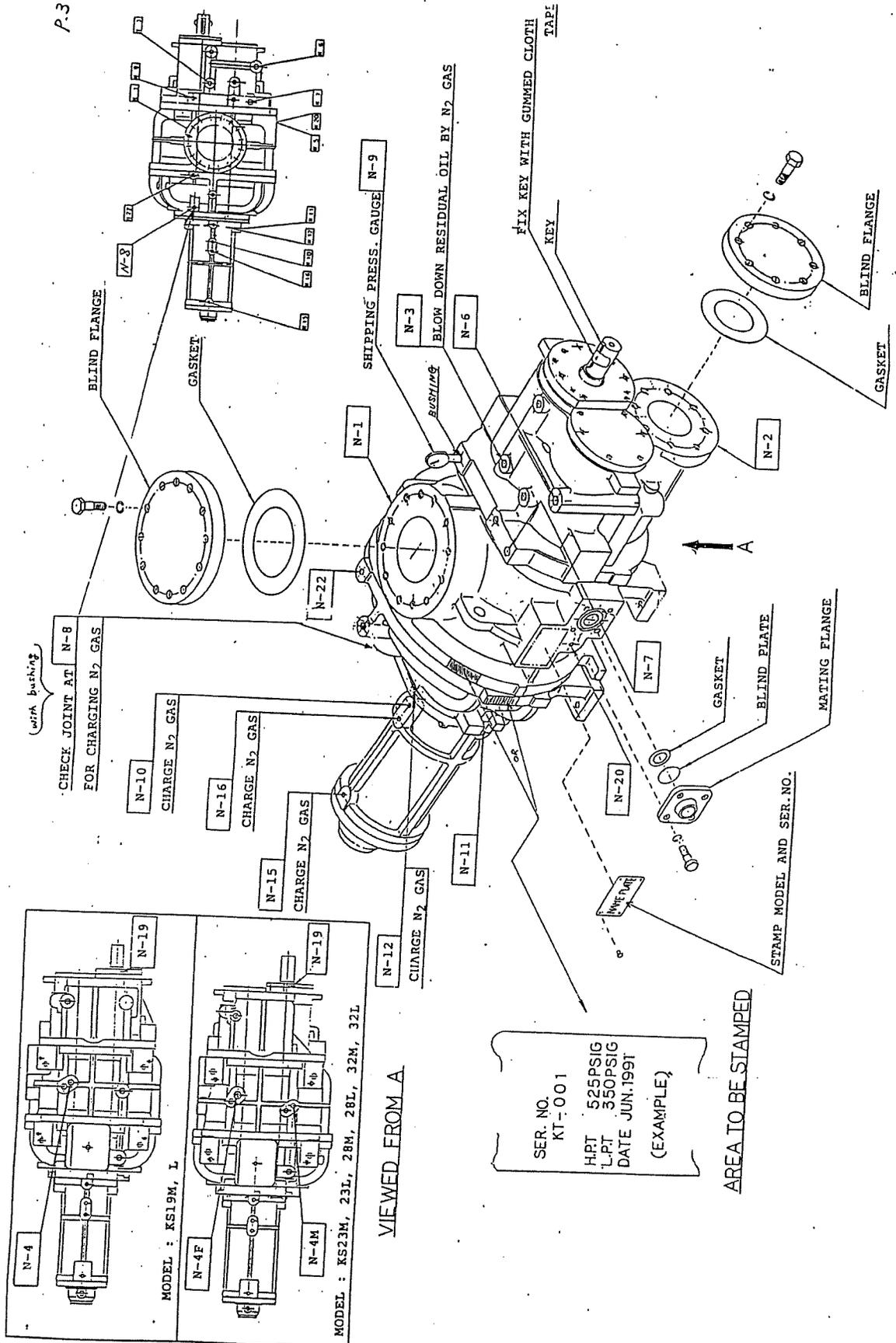


FIG.1 ILLUSTRATED DRAWING

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**Chapter IV OPERATION AND MAINTENANCE SCHEDULE****1. Pre-Start up Check Points**

The following checkpoints shall be completed before placing the compressor until in operation.

- (1) **Pre-confirmation**  
Compressor unit is completely flushed and leakage tested.
- (2) **Motor Rotating Direction**  
With compressor coupling center removed, confirm the motor will drive the compressor in correct direction.  
The direction is shown on the compressor drawing.
- (3) **Alignment**  
Confirm proper coupling alignment after replacing the coupling center.
- (4) **Piping**  
Confirm that correct piping flow is carried out and orifice with correct diameter is installed.
- (5) **Lube Oil Supply Pressure**  
Confirm that lube oil pressure is enough higher than required pressure.
- (6) **Suction and Discharge Valve**  
Confirm suction and discharge valves are open.
- (7) **Slide Valve Capacity Position Indicator**  
Activate the slide valve from 0% to 100% and confirm that slide valve position indicator indicates correct position.  
Lube Oil shall be supplied before activating the slide valve to form oil film.
- (8) **Slide Valve Position**  
Confirm that Slide Valve is in 0% position at starting.
- (9) **Lube Oil Viscosity**
  - i) **At starting**  
Confirm that viscosity is within 15~300 cSt .  
If the viscosity was too viscous, heat up lube oil by heater until lube oil viscosity was within above viscosity range.
  - ii) **At running**  
Confirm that viscosity of the lube oil in the gas dissolves is within 15~300 cSt at compressor oil supply nozzle.

(10) Cleanliness

Confirm cleanliness at lube oil inlet nozzle.

Recommended cleanliness criteria is as follows,

Recommended Cleanliness	As per API 614 4.3.3.7
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2. Running Test

- (1) When the compressor is operated with nitrogen, minimum 5 % of oxygen shall be mixed in the nitrogen.

Pure nitrogen causes rotor surface damage because of its aggressive property.

3. Lube Oil Quality

- (1) The lube oil shall be sampled regularly and change the oil whenever it exceeds the standards recommended by lube oil manufacturer regardless of the scheduled interval between oil changes.

4. Manual Turning

- (1) Turn the compressor manually before starting or long term shutdown to check whether the compressor is in good conditions or not and form oil film on the bearing area.
- (2) When emergency trip devices shut down the compressor, it is advisable to check the damage of rotors by manual turning.
- (3) At the event of shutdown, turn the compressor after 2 hours or longer to cool the compressor.
- (4) Never make a rapid or reverse turning.

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**MAINTENANCE PROCEDURE****1. General Description**

The proper inspection and maintenance servicing, if followed consistently, is the most reliable means to prevent costly repairs of refrigeration compressor and accessories. A simple record of procedures and data will help to maintain the machines. Basic requirements depend on lubrication, cleaning and periodical checking.

The unit must be operated within its specifications.

Main wearing parts are confined to the bearings, which support and locate the shafts, and mechanical seal. All are lubricated, and wear should be nominal if they are always supplied with clean, high lubricating oil. Bearing and mechanical seal subject to deterioration as well as wear. They may require replacement at varying periods. O-rings and washers should be replaced at each disassembly, and oil filter elements are routine cleaning items.

If trouble should occur during operation, and its cause cannot be readily determined, consult with the TROUBLESHOOTING.

Remedies suggested there can usually be performed by qualified mechanics, using procedures detailed in this manual. The following are suggested as general requirements and a schedule for maintenance.

The general requirements and a schedule are tabled in item 2 and 3 hereinafter.

Since unusual service conditions and environment affect equipment reliability, this schedule should be adjust in interval and content to suit any specific requirements.

At the beginning of operation, periodical check should be performed at shorter intervals.

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An accurate operational inspection system is the best means of detecting the need for maintenance work.

- 1) Operational records should be taken for future references whenever unusual situation occurs.  
For the first few weeks of operational break-in, 2 readings per 8-hour shift are recommended.  
After that, the reading could be reduced to a suggested minimum of two per day.  
Any repaid changes in consecutive readings would indicate possible malfunction and should be investigated immediately. Any gradual but consistent change not related to normal ambient or process variations should also be investigated.
- 2) Any change in the characteristic sound or increase in vibration of the unit should be investigated.
- 3) Oil and water leaks from piping, etc. should be repaired when first observed.
- 4) Make all checks recommended in driver instruction manual.
- 5) All of checking results, any abnormality, if observed, shall be recorded for future reference.

Daily

Once per 4 — 8 hours

1) Check operation data

While the compressor is in operation, measure and record all the following items and check whether they are in normal condition or not:

- Suction pressure and temperature
- Discharge pressure and temperature
- Oil level in the oil separator
- Lube oil supply pressure and temperature
- Cooling water temperature
- Power consumption (voltage and current)

2) Routine maintenance

Refer to item 2 : Routine Maintenance

2. Routine Maintenance

Part name	Check items	Place to check	Time for check	Check frequency
Mechanical seal	Oil leakage	Mechanical seal drain	At running	Once a day
Rotor casing	Noise	Surface of casing	At running	Once a day
Oil separator	Oil level	Oil separator	At running	Once a day
Lubrication oil pressure	Differential pressure	Lubrication system	At running	Once a day

Acceptance criteria

1) Mechanical seal

The oil coming out of compressor should be checked visually and replace mechanical seal if worn-out.

If oil leakage is more than a drop per every three seconds, check and replace if mechanical seal is worn-out.

Expected life of mechanical seal operated under normal conditions is approximately 25,000hrs.

Mechanical seal must be replaced with new one once per 25,000hrs, even if it is in good conditions.

2) Oil level

Oil level should be checked visually.

If oil comes to the lowest level, charge oil.

3) Rotor casing

Noise

During normal operation, there should not be abnormal sound at any place.

4) Lubrication oil pressure

Check differential pressure between compressor discharge and oil line, and clean the filter element, if it comes to 1 kg/cm<sup>2</sup> (=15PSI) or more.

3. Periodical Maintenance

3.1 Vibration Analysis

Part name	Check items	Place to check	Time for check	Check frequency
Discharge casing & Inlet casing	Vibration	Casing flange	At running	Every 1 month

Acceptance criteria

Vibration	Criteria
Velocity	Less than 1.2 cm/sec (= 0.5 inches/sec)

When vibration exceeds the criteria, check the compressor and test conditions in accordance with the following procedure.

- a) Check the fundamental frequency F(HZ).
- b) If F is equal to 60/50 Hz (power source), check misalignment between compressor and motor.
- c) Pay careful attention to compressor inside noise whether abnormal condition or not.
- d) If the compressor is considered not be satisfactory, with taking account of operating data and vibration reading at initial start-up, the compressor shall be check in details such as dismantling.

NOTES

1. Refer to TROUBLESHOOTING.
2. It is highly recommended to take vibration readings at initial start-up for observation of vibration increase tendency.
3. Take vibration reading at the same locations and the same operating conditions in order to evaluate vibration tendency.

3.2 Cleaning of Oil Cooler and Condenser

Part name	Check items	Place to check	Time for check	Check frequency
Oil cooler and condenser	Internal condition (corrosion and soiled things)	Water side of oil cooler and condenser	At stop	Every 1 year

Acceptance criteria

If the efficiency of heat exchanger is found to be lower, clean the waterside of tubes.

3.3 Clamping Bolt and Plug

Part name	Check items	Place to check	Time for check	Check frequency
Clamping bolts, plug	condition of looseness	Each fastening part, and coupling	At stop	Every 3 months

3.4 Check Misalignment

Part name	Check items	Place to check	Time for check	Check frequency
Compressor and motor	Misalignment	Compressor and motor	At stop	Every 6 months

3.5 Oil Analysis

Part name	Check items	Place to check	Time for check	Check frequency
Oil system	Oil analysis	Oil separator	At stop	Every 6 months

Acceptance criteria

Refer to item "Lubricant derailed" hereinafter.

3.6 Check instrument and calibrate them if necessary once per year.

3.7 Overhauling Compressor

- 1) Schedule : Make an overhaul of compressor according to bearing life B10 (hrs) of specific operating conditions, even if it is seemed relatively in good conditions.
- 2) The following parts must be replaced :
  - Bearings
  - Mechanical seals (per 25,000hrs max.)
  - O-rings, washers, gaskets and other wearing parts

Notes

1. The compressor shall be overhauled to check the compressor and to determine a suitable overhaul interval for specific operating conditions, after the first overhauling interval.
2. All of checking results shall be recorded for future reference.

**TROUBLESHOOTING COMPRESSOR**

TROUBLES	POSSIBLE	REMEDY
<p>1. EXCESSIVE VIRBRATION</p> <p>- If serious vibration occurs, spectrum analysis should be done.</p>	<p>a. Misalignment between motor and compressor</p> <p>b. Resonance with compressor base frame</p> <p>c. Loosing of mounting bolts and foundation bolts</p> <p>d. Bearing damage</p>	<ul style="list-style-type: none"> <li>• Realign correctly</li> <li>• Check if natural frequency of base frame is almost equal to compressor fundamental frequency.</li> <li>• Reinforce base frame if necessary.</li> <li>• Tighten bolts</li> <li>• Replace if necessary.</li> </ul>
<p>2. ABNORMAL NOISE</p>	<p>a. Bearing damage</p> <p>b. Misalignment between motor and compressor</p> <p>c. Rotor contact surface damage</p> <p>g. Refrigerant flood back</p>	<ul style="list-style-type: none"> <li>• Replace if necessary.</li> <li>• Realign correctly.</li> <li>• Amend rotor surface precisely, if necessary.</li> <li>• Correct system problem.</li> </ul>

TROUBLES	POSSIBLE	REMEDY
<b>3. SLIDE VALVE NOT MOVE</b>		
( i ) WHEN OIL PUMP RUNNING, SLIDE VALVE CAN MOVE	a. Low oil pressure due to oil filter clogged	<ul style="list-style-type: none"> <li>• Confirm oil pressure.</li> <li>• Clean oil filter element.</li> <li>• Change operating limit of oil pump, if necessary.</li> </ul>
( ii ) WHENEVER OIL PUMP RUNNING, SLIDE VALVE CAN NOT MOVE	<p>a. Pin and spiral groove of slide valve spindle jammed.</p> <p>b. Oil pump failure</p> <p>c. Hydraulic cylinder piston seal worn or damaged</p> <p>d. Solenoid valves failure</p> <p>e. Pointer of capacity indicator loosen</p>	<ul style="list-style-type: none"> <li>• Repair or replace</li> <li>• Repair or replace</li> <li>• Check and replace</li> <li>• Check if mechanical or electrical problems. Replace if necessary.</li> <li>• Tighten bolt for pointer</li> </ul>
<b>4. SLIDE STOP NOT MOVE</b>		
	<p>a. Slide stop contacts slide valve when changing Low V1 to M or H1 V1</p> <p>b. Hydraulic cylinder piston seal worn or damage</p> <p>c. Solenoid valves failure</p>	<ul style="list-style-type: none"> <li>• Unload slide valve prior to moving slide stop.</li> <li>• Check and replace</li> <li>• Check if mechanical or electrical problems. Replace if necessary.</li> </ul>
<b>5. OIL LEAKAGE OF MECHANICAL SEAL</b>		
	<p>a. Sealing face damaged</p> <p>b. O-ring damage</p>	<ul style="list-style-type: none"> <li>• Replace</li> <li>• Replace</li> </ul>

TROUBLES	POSSIBLE	REMEDY	
6. EXCESSIVE POWER	<ul style="list-style-type: none"> <li>a. High discharge pressure</li> <li>b. Improper setting of PIC or TIC for capacity control system or system failure</li> <li>c. Excessive load</li> </ul>	<ul style="list-style-type: none"> <li>• See 10</li> <li>• See correctly</li> <li>• Reduce load</li> </ul>	
7. HIGH DISCHARGE TEMPERATURE	<ul style="list-style-type: none"> <li>a. High discharge pressure</li> <li>b. Insufficient injected oil quantity</li> <li>c. High lube oil temperature</li> <li>d. High suction temp.</li> </ul>	<ul style="list-style-type: none"> <li>• See 10</li> <li>• Adjust valve for rotor chamber injection</li> <li>• See 8</li> <li>• See 13</li> </ul>	
8. HIGH OIL TEMPERATURE	( i ) WATER COOLED OIL COOLER	<ul style="list-style-type: none"> <li>a. High cooling water temperature</li> <li>b. Oil cooler cooling efficiency reduced due to scale accumulation</li> <li>c. Low cooling water flow rate</li> </ul>	<ul style="list-style-type: none"> <li>• Check cooling water supply system.</li> <li>• Clean water side of tubes.</li> <li>• Increase water flow rate</li> </ul>
	( ii ) AIR COOLED OR COOLER	<ul style="list-style-type: none"> <li>a. Oil cooler cooling efficiency reduced due to scale accumulation</li> <li>b. Low cooling air flow rate</li> </ul>	<ul style="list-style-type: none"> <li>• Clean air side of fins</li> <li>• Increase air flow rate</li> </ul>

TROUBLES	POSSIBLE	REMEDY
9. LOW DISCHARGE TEMPERATURE	a. Low load conditions	• Adjust valve to decrease rotor chamber oil quantity
	b. Low oil temperature	• Adjust thermostat to increase oil temperature
10. High DISCHARGE PRESSURE	a. Oil separator element clogged	• Replace elements
	b. Improper minimum pressure valve adjustment	• Check minimum pressure valve • Correct if wrong
	c. Improper setting of PIC for capacity control system or system failure	• Set correctly • Repair or replace if necessary
	d. Excessive load	• Reduce load
11. LOW SUCTION PRESSURE	a. Clogged or frozen suction filter	• Clean suction filter element.
	b. Improper valve adjustment	• Check suction valve • Correct if wrong
	c. Low load less than compressor min. load	• Perform low load operation with bypass valve. • Stop compressor
	d. Improper setting of PIC or TIC for capacity control system or system failure	• Set correctly • Repair or replace if necessary

TROUBLES	POSSIBLE	REMEDY
12. HIGH SUCTION PRESSURE	a. Excessive load b. Improper setting of PIC or TIC for capacity control system or system failure	• Reduce load • Set correctly. Repair or replace if necessary
13 HIGH SUCTION TEMPERATURE	a. Hot gas bypass valve opened or leaked	• Adjust bypass valve



KS23LNB SPECIFICATIONS

TYPE	SINGLE		INPUT SHAFT DIAMETER		φ 75 mm	SPARE PARTS LIST	
DM, L/DM	278.5, 1.55		BALANCE PISTON DIAMETER	M	FIX... φ 190 mm ADD... φ 100 mm	TOOL LIST	
Vi	VARIABLE (2.2~5.0)			F		SECTIONAL ASS'Y DWG	M31800317 (0C21025)
ROTATION	REVERSE		THRUST BEARING	M	QJ320N2	OUTSIDE VIEW DWG	M31800102 (1431028)
INPUT SHAFT POSITION	DIS.			F	QJ318N2	MECH.SEAL ASS'Y DWG	M31840007 (3369377)
SLIDE VALVE STROKE	283 mm		RADIAL BEARING	M	SUC. NU2316 DIS. NU2320	MECH.SEAL MODEL	T-9B 3 1/2"
SLIDE STOP STROKE	112 mm			F	SUC. NU2316 DIS. NU2310	O-RING	CR
PISTON DIAMETER	φ 200 mm						
REMARKS	<p>-本構成表を FES, SOS 向可変 Vi 標準本体とする。                      ・標準化のため、銘板・開度計目盛板、警告板(バネの警告板)を別途手配とする。                      ・J01 ボルト材質を SUS304 とする。</p> <p>M318P0296(H921926)より下記を変更した。(O.No.01—51056-0 より適用)</p> <p>1. アンロードバネ(D36)を追加した。</p>						

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**SPARE PARTS CONTROL**

Spare parts classification is made on parts no. as follows:

○ :replaced on every overhaul.  
ordinary spares are required.

△ :replaced according to their conditions.  
ordinary spares are not required.

On ordinary spare parts, the following items should be informed of:

- (1) Compressor Model :
- (2) Machine Number :
- (3) Part Name :
- (4) Quantity required :

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KS23LNB 形 KOBELCO-SCREW 圧縮機部品構成表 (2/11)  
 PARTS LIST OF KOBELCO-SCREW COMPRESSOR MODEL KS23LNB

符号 SEQ.No.	部 品 名 称 PART NAME	部 品 番 号 PART CODE	個 数 REQ.D	材 料 MATERIAL	備 考 REMARKS	整理番号 T.No.
B01	入 口 蓋 INLET CASING	M31820211	1	FC300		0127018
B02	ロ ー タ ケ ー シ ン グ ROTOR CASING	M31820209	1	FC300		0127012
B03	吐 出 ケ ー シ ン グ DISCHARGE CASING	M31820210	1	FC300		0127017
B04	吸 込 側 蓋 ( M S ) BLIND PLATE (MS)	M31820038	1	SS400		3410633
B05	吸 込 側 蓋 ( F S ) BLIND PLATE (FS)	M31820039	1	SS400		3410634
B06	シ リ ン ダ ー 取 付 板 CYLINDER FIXTURE	M31820017	1	FC300		2366540
B07	軸 受 抑 工 蓋 ( F D ) THRUST BRG COVER (FD)	M31820051	1	S35C		3410721
B08	ピ ス ト ン リ ン グ PISTON RING	M31820049	1	FC200		3410719
B09	ピ ス ト ン リ ン グ ス ペ ー サ PISTON RING SPACER	M31820050	1	SS400		3410720
B10	注 油 ノ ズ ル ( M S ) OIL NOZZLE PLATE (MS)	M31830053	1	SS400		3410723
B11	注 油 ノ ズ ル ( F S ) OIL NOZZLE PLATE (FS)	M31830052	1	SS400		3410722
B13	" O " リ ン グ "O"RING	M31720517#03	1	CR	(J0870)	4C17401
B14	" O " リ ン グ "O"RING	M31720517#04	1	CR	(J0870)	4C17401
B15	ラ ビ リ ン ス ( M D ) LABYRINTH (MD)	M31820098	1	S25C		3411870
B16	ラ ビ リ ン ス ( F D ) LABYRINTH (FD)	M31820099	1	S25C		3411871
B17	滑 り 弁 ガ イ ド SLIDE VALVE GUIDE	M31820016	1	FC300		3410325
B18	閉 止 蓋 END COVER	M31820046	1	S35C		4345100
B19	パ ッ キ ン PACKING FOR B18	M31820045	1	V#6501		4345099
B22	閉 止 プ ラ グ BLIND PLUG	M31800151	1	FC250		3427159
B23	ガ ス ケ ッ ト GASKET	M31720345#14	1	V#6501		4347961
B25	隙 間 調 整 シ ム SHIMS	M31820204	1	SUS304		4386801
B30	銘 板 NAME PLATE		1	A1060-14H		

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**KS23LNB 形 KOBELCO-SCREW 圧縮機部品構成表 (3/11)**  
**PARTS LIST OF KOBELCO-SCREW COMPRESSOR MODEL KS23LNB**

符号 SEQ.No.	部 品 名 称 PART NAME	部 品 番 号 PART CODE	個 数 REQ.D	材 料 MATERIAL	備 考 REMARKS	整理番号 T.No.
(C01)	M S 軸 受 MS.ROLLER BEARING	M31730084(SKF)	1	BEARING STEEL	NU2316E	3410234
(C02)	F S 軸 受 FS.ROLLER BEARING	M31730084(SKF)	1	BEARING STEEL	NU2316E	3410234
(C03)	M D 軸 受 MD.BEARING	M31830067(SKF)	1S	BEARING STEEL	NU320E+ QJ320N2	2367137
(C04)	F D 軸 受 FD.BEARING	M31830086(SKF)	1S	BEARING STEEL	NU2318+ QJ318N2	2367136
C07	軸 受 抑 工 ( M D ) BEARING GLAND (MD)	M31830169	1	FCD450		3C05230
C08	軸 受 抑 工 ( F D ) BRG. HOLDER (FD)	M31830238	1	FC250		3C18228
C09	軸 受 抑 工 ネ ジ LOCK NUT	M31830054	1	FCD450		3410724
C10	吐 出 側 蓋 BLIND PLATE	M31820237	1	SS400		3C18227
C12	皿 ば ね CONED DISK SPRING	P-AF01-502#28	2	SUP-10		3234064
(C13)	鎖 止 メ 座 金 LOCK WASHER	M31830190	1	SS400		4348290
下記 FAG 製軸受は上記 SKF 製軸受と互換性有り Following FAG bearings have interchangeability with above SKF bearings.						
(C01)	M S 軸 受 MS.ROLLER BEARING	M31730052(FAG)	1	BEARING STEEL	NU2316E	3369893
(C02)	F S 軸 受 FS.ROLLER BEARING	M31730052(FAG)	1	BEARING STEEL	NU2316E	3369893
(C03)	M D 軸 受 MD.BEARING	M31830064(FAG)	1S	BEARING STEEL	NU320E+ QJ320N2	2367134
(C04)	F D 軸 受 FD.BEARING	M31830085(FAG)	1S	BEARING STEEL	NU2318+ QJ318N2	2367135

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KS23LNB 形 KOBELCO-SCREW 圧縮機部品構成表 (4/11)  
 PARTS LIST OF KOBELCO-SCREW COMPRESSOR MODEL KS23LNB

符号 SEQ.No.	部 品 名 称 PART NAME	部 品 番 号 PART CODE	個 数 REQ.D	材 料 MATERIAL	備 考 REMARKS	整理番号 T.No.
D01	V 可 変 弁 SLIDE STOP	M31850207	1	FCD450		2423157
D02	滑 り 弁 SLIDE VALVE	M31850208	1	FC300		2423160
D03	駆 動 軸 SLIDE VALVE ROD	M31850032	1	S45C-N		2366893
D04	固 定 弁 用 ピ ス ト ン PISTON (SLIDE STOP)	M31850041	1	S35C-N		3410636
D05	滑 り 弁 用 ピ ス ト ン PISTON (SLIDE VALVE)	M31850040	1	S35C-N		3410635
D06	固 定 弁 ス ト ッ パ ー PISTON STOPPER	M31850058	1	FC250		3410728
D09	ピ ス ト ン 止 メ ナ ッ ト NUT	P-AA12-005#07	2	S25C-N		3242729
D10	ピ ン PIN	M31850035#01	1	SCM435		4345033
D21	ピ ン PIN	M31850255#01	1	S45C-N		4C22664
D22	止 メ ネ ジ SET SCREW	P-AA11-074#02	1	SUS304		3449728
D31	油 圧 シ リ ン ダ ー CYLINDER	M31850242	1	FC300		1476319
D32	シ リ ン ダ ー 蓋 CYLINDER HEAD	M31850173	1	S35C		2C05283
D33	シ リ ン ダ ー 止 切 板 STOPPER	M31850042	1	S35C		3410637
D34	開 度 指 示 計 軸 SPINDLE	M31850172	1	S45C-N		2C05282
D35	深 ミ ソ 玉 軸 受 BALL BEARING	M21850143	1	BEARING STEEL	6206	4179539
D36	ア ン ロ ード バ ネ SPRING	M31850308	1	PURCHASE		3C66860
D41	ピ ス ト ン シ ール PISTON SEAL	P-GA04-032#39	2	2NO	ST-200	2382039
D42	ピ ス ト ン シ ール PISTON SEAL	P-GA04-031#03	2	2NO		3428351
D43	ピ ス ト ン シ ール PISTON SEAL	P-GA04-031#04	1	2NO		3428351

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KS23LNB 形 KOBELCO-SCREW 圧縮機部品構成表

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PARTS LIST OF KOBELCO-SCREW COMPRESSOR MODEL KS23LNB

符号 SEQ.No.	部 品 名 称 PART NAME	部 品 番 号 PART CODE	個 数 REQ.D	材 料 MATERIAL	備 考 REMARKS	整理番号 T.No.
J01	六角穴付ボルト SOCKET HEAD BOLT	BBSA-RA-M027-065	1	SUS304	M27X65	
J02	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M024-150	2	SCM435-Q	M24X150	
J03	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M024-110	4	SCM435-Q	M24X110	
J04	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M024-080	26	SCM435-Q	M24X80	
J05	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M020-060	5	SCM435-Q	M20X60	
J06	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M020-070	5	SCM435-Q	M20X70	
J07	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M016-110	6	SCM435-Q	M16X110	
J08	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M016-065	2	SCM435-Q	M16X65	
J09	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M016-060	7	SCM435-Q	M16X60	
J10	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M016-055	8	SCM435-Q	M16X55	
J11	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M016-050	9	SCM435-Q	M16X50	
J12	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M016-045	8	SCM435-Q	M16X45	
J13	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M012-045	4	SCM435-Q	M12X45	
J14	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M006-050	3	SCM435-Q	M6X50	
J15	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M006-016	4	SCM435-Q	M6X16	
J17	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M003-008	4	SCM435-Q	M3X0.5X8	
J19	六角穴付ボルト SOCKET HEAD BOLT	BBLK-RA-M006-012	2	SCM435-Q	M6X12	

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**KS23LNB 形 KOBELCO-SCREW 圧縮機部品構成表** (9/11)  
**PARTS LIST OF KOBELCO-SCREW COMPRESSOR MODEL KS23LNB**

符号 SEQ.No.	部 品 名 称 PART NAME	部 品 番 号 PART CODE	個 数 REQ.D	材 料 MATERIAL	備 考 REMARKS	整理番号 T.No.
K01	方 形 バ ネ 座 金 SQ SPRING WASHER	BWWC-BD-024	32	SWRH62B	24,W31	
K02	方 形 バ ネ 座 金 SQ SPRING WASHER	BWWC-BD-020	5	SWRH62B	20,W31	
K03	方 形 バ ネ 座 金 SQ SPRING WASHER	BWWC-BD-016	25	SWRH62B	16,W31	
K04	方 形 バ ネ 座 金 SQ SPRING WASHER	BWWC-BD-012	4	SWRH62B	12,W31	
K06	方 形 バ ネ 座 金 SQ SPRING WASHER	BWWC-BD-009	3	SWRH62B	3,W31	
K07	方 形 バ ネ 座 金 SQ SPRING WASHER	BWWC-BD-008	9	SWRH62B	6,W31	
K11	バ ネ 座 金 SPRING WASHER	BWWC-BA-027	1	SWRH62B	27,2号	
K12	バ ネ 座 金 SPRING WASHER	BWWC-BA-020	5	SWRH62B	20,2号	
K13	バ ネ 座 金 SPRING WASHER	BWWC-BA-016	15	SWRH62B	16,2号	
K20	平 座 金 PLAIN WASHER	BWME-FB-004	2	SS400	4	
△K31	コ ロ ガ リ 軸 受 用 ナ ッ ト LOCK NUT	BRLD-NM-020	1	S25C-N	AN20	
△K32	コ ロ ガ リ 軸 受 用 ナ ッ ト LOCK NUT	BRLD-NM-017	1	S25C-N	AN17	
○K33	コ ロ ガ リ 軸 受 用 座 金 LOCK WASHER	BRMC-AW-017	1	SS400	AW17	
K41	片 丸 平 行 キ ー KEY	M31010019#52	1	S45C-Q	20X12X130	3413444
K51	雌 ネ ジ 付 平 行 ピ ン DOWEL PIN	P-AA01-001#08	4	S45C	16X63m6A 相当 (EQ)	
K52	雌 ネ ジ 付 平 行 ピ ン DOWEL PIN	P-AA01-001#05	2	S45C	16X45m6A	

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KS23LNB 形 KOBELCO-SCREW 圧縮機部品構成表

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PARTS LIST OF KOBELCO-SCREW COMPRESSOR MODEL KS23LNB

符号 SEQ.No.	部 品 名 称 PART NAME	部 品 番 号 PART CODE	個 数 REQ.D	材 料 MATERIAL	備 考 REMARKS	整理番号 T.No.
L01	軸用 C 型 止メ 輪 RETAINING RING	BRUB-CA-070	1	SK5M	70	
L02	軸用 C 型 止メ 輪 RETAINING RING	BRUB-CA-030	1	SK5M	30	
L11	穴用 C 型 止メ 輪 RETAINING RING	BRUB-CB-200	2	SK5M	200	
L12	穴用 C 型 止メ 輪 RETAINING RING	BRUB-CB-170	2	SK5M	170	
L13	穴用 C 型 止メ 輪 RETAINING RING	BRUB-CB-150	1	SK5M	150	
L14	穴用 C 型 止メ 輪 RETAINING RING	BRUB-CB-062	1	SK5M	62	
L21	コロガリ軸受用座金 BRG.LOCK WASHER	BRMC-AW-009	2	SS400	AW09	
L22	コロガリ軸受用座金 BRG.LOCK WASHER	BRMC-AW-020	1	SS400	AW20	
L31	" O " リン グ "O"RING	P-GA02-019#39	1	CR (J0870)	G230	2C16661
L32	" O " リン グ "O"RING	P-GA02-019#36	2	CR (J0870)	G200	2C16661
L33	" O " リン グ "O"RING	P-GA02-019#32	3	CR (J0870)	G180	2C16661
L34	" O " リン グ "O"RING	P-GA02-019#25	1	CR (J0870)	G145	2C16661
L35	" O " リン グ "O"RING	P-GA02-019#23	1	CR (J0870)	G135	2C16661
L36	" O " リン グ "O"RING	P-GA02-019#22	1	CR (J0870)	G130	2C16661
L51	" O " リン グ "O"RING	P-GA02-020#92	1	CR (J0870)	P200	2C16662
L52	" O " リン グ "O"RING	P-GA02-020#88	2	CR (J0870)	P180	2C16662
L53	" O " リン グ "O"RING	P-GA02-020#71	1	CR (J0870)	P110	2C16662
L54	" O " リン グ "O"RING	P-GA02-020#70	1	CR (J0870)	P105	2C16662
L55	" O " リン グ "O"RING	P-GA02-020#56	2	CR (J0870)	P60	2C16662
L56	" O " リン グ "O"RING	P-GA02-020#24	2	CR (J0870)	P25	2C16662

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## SECTION 1.05

### SAFETY

#### SAFETY INTRODUCTION

The following safety precautions are published for your information. Waukesha Engine, Dresser, Inc., does not, by the publication of these precautions, imply or in any way represent that they are the sum of all dangers present near industrial engines or fuel rating test units. If you are installing, operating or servicing a Waukesha product, it is your responsibility to ensure full compliance with all applicable safety codes and requirements. All requirements of the Federal Occupational Safety and Health Act must be met when Waukesha products are operated in areas that are under the jurisdiction of the United States of America. Waukesha products operated in other countries must be installed, operated and serviced in compliance with any and all applicable safety requirements of that country.

For details on safety rules and regulations in the United States, contact your local office of the Occupational Safety and Health Administration (OSHA).

The words "danger", "warning", "caution" and "note" are used throughout this manual to highlight important information. Be certain that the meanings of these alerts are known to all who work on or near the equipment.

**NOTE:** This symbol identifies information which is NECESSARY TO THE PROPER OPERATION, MAINTENANCE OR REPAIR OF THE EQUIPMENT.

 **CAUTION** This symbol identifies information about hazards or unsafe practices. Disregarding this information could result in **PRODUCT DAMAGE AND/OR PERSONAL INJURY**.

 **WARNING**  
This symbol identifies information about hazards or unsafe practices. Disregarding this information could result in **SEVERE PERSONAL INJURY OR DEATH**.

#### **DANGER**

This symbol identifies information about immediate hazards. Disregarding this information *will* result in **SEVERE PERSONAL INJURY OR DEATH**.

#### SAFETY TAGS AND DECALS

#### **WARNING**

To avoid severe personal injury or death, all warning tags and decals must be visible and legible to the operator while the equipment is operating.

#### EQUIPMENT REPAIR AND SERVICE

Proper maintenance, service and repair are important to the safe, reliable operation of the unit and related equipment. Do not use any procedure not recommended in the Waukesha Engine manuals for this equipment.

#### **WARNING**

To prevent severe personal injury or death, always stop the unit before cleaning, servicing or repairing the unit or any driven equipment.

Place all controls in the OFF position and disconnect or lock out starters to prevent accidental restarting. If possible, lock all controls in the OFF position and take the key. Put a sign on the control panel warning that the unit is being serviced.

Close all manual control valves, disconnect and lock out all energy sources to the unit, including all fuel, electric, hydraulic, and pneumatic connections.

Disconnect or lock out driven equipment to prevent the possibility of the driven equipment rotating the disabled engine.

## SAFETY

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### **WARNING**

To avoid severe personal injury or death, ensure that all tools and other objects are removed from the unit and any driven equipment before restarting the unit.

### **WARNING**

Allow the engine to cool to room temperature before cleaning, servicing or repairing the unit. Hot components or fluids can cause severe personal injury or death.

Some engine components and fluids are extremely hot even after the engine has been shut down. Allow sufficient time for all engine components and fluids to cool to room temperature before attempting any service procedure.

## ACIDS

### **WARNING**

Comply with the acid manufacturer's recommendations for proper use and handling of acids. Improper handling or misuse could result in severe personal injury or death.

## BATTERIES

### **WARNING**

Comply with the battery manufacturer's recommendations for procedures concerning proper battery use and maintenance. Improper maintenance or misuse could result in severe personal injury or death.

## BODY PROTECTION

### **WARNING**

Always wear OSHA approved body, sight, hearing and respiratory system protection. Never wear loose clothing, jewelry or long hair around an engine. The use of improper attire or failure to use protective equipment may result in severe personal injury or death.

## CHEMICALS

### GENERAL

### **WARNING**

Always read and comply with safety labels on all containers. Do not remove or deface the container labels. Improper handling or misuse could result in severe personal injury or death.

### CLEANING SOLVENTS

### **WARNING**

Comply with the solvent manufacturer's recommendations for proper use and handling of solvents. Improper handling or misuse could result in severe personal injury or death. Do not use gasoline, paint thinners or other highly volatile fluids for cleaning.

### LIQUID NITROGEN/DRY ICE

### **WARNING**

Comply with the liquid nitrogen/dry ice manufacturer's recommendations for proper use and handling of liquid Nitrogen/Dry Ice. Improper handling or use could result in severe personal injury or death.

## COMPONENTS

### HEATED OR FROZEN

### **WARNING**

Always wear protective equipment when installing or removing heated or frozen components. Some components are heated or cooled to extreme temperatures for proper installation or removal. Direct contact with these parts could cause severe personal injury or death.

### INTERFERENCE FIT

### **WARNING**

Always wear protective equipment when installing or removing components with an interference fit. Installation or removal of interference components may cause flying debris. Failure to use protective equipment may result in severe personal injury or death.

**COOLING SYSTEM****⚠ WARNING**

Always wear protective clothing when venting, flushing or blowing down the cooling system. Operational coolant temperatures can range from 180 – 250° F (82 – 121° C). Contact with hot coolant or coolant vapor can cause severe personal injury or death.

**⚠ WARNING**

Do not service the cooling system while the engine is operating or when the coolant is hot. Operational coolant temperatures can range from 180 – 250° F (82 – 121° C). Contact with hot coolant or vapor can cause severe personal injury or death.

**ELECTRICAL****GENERAL****⚠ WARNING**

Do not install, set up, maintain or operate any electrical components unless you are a technically qualified individual who is familiar with the electrical elements involved. Electrical shock can cause severe personal injury or death.

**⚠ WARNING**

Disconnect all electrical power supplies before making any connections or servicing any part of the electrical system. Electrical shock can cause severe personal injury or death.

**IGNITION****⚠ WARNING**

Avoid contact with ignition units and wiring. Ignition system components can store electrical energy and if contacted can cause electrical shock. Electrical shock can cause severe personal injury or death.

**⚠ WARNING**

Properly discharge any electrical component that has the capability to store electrical energy before connecting or servicing that component. Electrical shock can cause severe personal injury or death.

**EXHAUST****⚠ WARNING**

Do not inhale engine exhaust gases. Exhaust gases are highly toxic and could cause severe personal injury or death.

Ensure exhaust systems are leak free and that all exhaust gases are properly vented.

**⚠ WARNING**

Do not touch or service any heated exhaust components. Allow sufficient time for exhaust components to cool to room temperature before attempting any service procedure. Contact with hot exhaust system components can cause severe personal injury or death.

**FIRE PROTECTION****⚠ WARNING**

Refer to local and federal fire regulations for guidelines for proper site fire protection. Fires can cause severe personal injury or death.

**FUELS****GENERAL****⚠ WARNING**

Ensure that there are no leaks in the fuel supply. Engine fuels are highly combustible and can ignite or explode causing severe personal injury or death.

**GASEOUS****⚠ WARNING**

Do not inhale gaseous fuels. Some components of fuel gas are odorless, tasteless, and highly toxic. Inhalation of gaseous fuels can cause severe personal injury or death.

**⚠ WARNING**

Shut off the fuel supply if a gaseous engine has been cranked excessively without starting. Crank the engine to purge the cylinders and exhaust system of accumulated unburned fuel. Failure to purge accumulated unburned fuel in the engine and exhaust system can result in an explosion resulting in severe personal injury or death.

## SAFETY

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### LIQUID

#### **WARNING**

Do not ingest liquid fuels or breathe in their vapors. Liquid fuels may be highly toxic and can result in severe personal injury or death.

#### **WARNING**

Use protective equipment when working with liquid fuels and related components. Liquid fuel can be absorbed into the body resulting in severe personal injury or death.

### INTOXICANTS AND NARCOTICS

#### **WARNING**

Do not allow anyone under the influence of intoxicants and/or narcotics to work on or around industrial engines. Workers under the influence of intoxicants and/or narcotics are a hazard both to themselves and other employees and can cause severe personal injury or death to themselves or others.

### PRESSURIZED FLUIDS/GAS/AIR

#### **WARNING**

Never use pressurized fluids/gas/air to clean clothing or body parts. Never use body parts to check for leaks or flow rates. Pressurized fluids/gas/air injected into the body can cause severe personal injury or death.

Observe all applicable local and federal regulations relating to pressurized fluid/gas/air.

### PROTECTIVE GUARDS

#### **WARNING**

Provide guarding to protect persons or structures from rotating or heated parts. Contact with rotating or heated parts can result in severe personal injury or death.

It is the responsibility of the engine owner to specify and provide guarding. Refer to OSHA standards on "machine guarding" for details on safety rules and regulations concerning guarding techniques.

### SPRINGS

#### **WARNING**

Use appropriate equipment and protective gear when servicing or using products that contain springs. Springs, under tension or compression, can eject if improper equipment or procedures are used. Failure to take adequate precautions can result in serious personal injury or death.

### TOOLS

#### ELECTRICAL

#### **WARNING**

Do not install, set up, maintain or operate any electrical tools unless you are a technically qualified individual who is familiar with them. Electrical tools use electricity and if used improperly could cause severe personal injury or death.

#### HYDRAULIC

#### **WARNING**

Do not install, set up, maintain or operate any hydraulic tools unless you are a technically qualified individual who is familiar with them. Hydraulic tools use extremely high hydraulic pressure and if used improperly could cause severe personal injury or death.

#### **CAUTION**

Always follow recommended procedures when using hydraulic tensioning devices. Improper use of hydraulic tensioning tools can cause severe engine damage.

## PNEUMATIC

 **WARNING**

Do not install, set up, maintain or operate any pneumatic tools unless you are a technically qualified individual who is familiar with them. Pneumatic tools use pressurized air and if used improperly could cause severe personal injury or death.

## WEIGHT

 **WARNING**

Always consider the weight of the item being lifted and use only properly rated lifting equipment and approved lifting methods. Failure to take adequate precautions can result in serious personal injury or death.

 **WARNING**

Never walk or stand under an engine or component while it is suspended. Failure to adhere to this could result in severe personal injury or death.

## WELDING

## GENERAL

 **WARNING**

Comply with the welder manufacturer's recommendations for procedures concerning proper use of the welder. Improper welder use can result in severe personal injury or death.

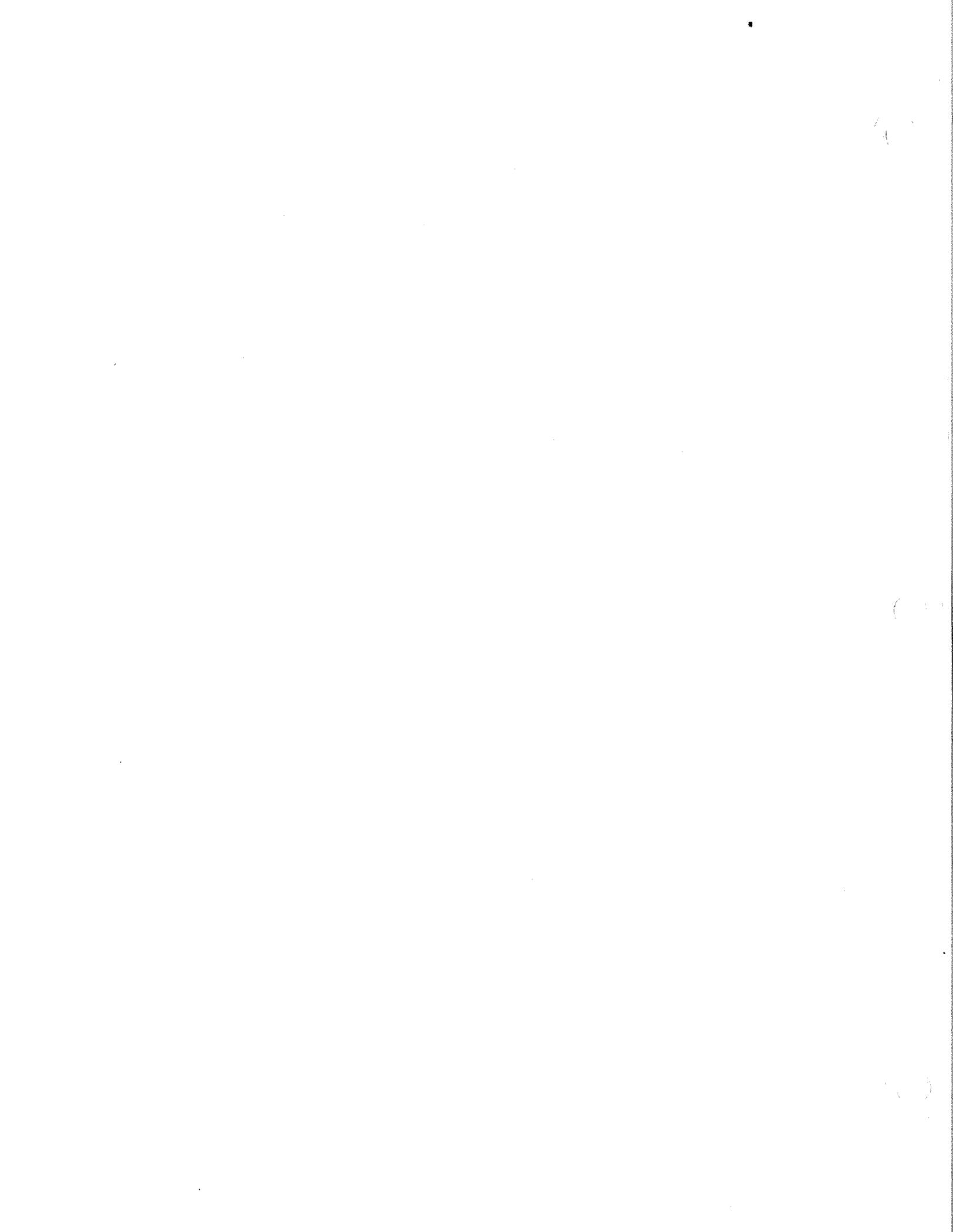
## ON ENGINE

 **CAUTION**

Ensure that the welder is properly grounded before attempting to weld on or near an engine. Failure to properly ground the welder could result in severe engine damage.

 **CAUTION**

Disconnect the ignition harness and electronically controlled devices before welding with an electric arc welder on or near an engine. Failure to disconnect the harnesses and electronically controlled devices could result in severe engine damage.



# CATA-DYNE™ QUALITY

CATA-DYNE products have an unbeatable track record for area heating applications. They can be used in all indoor locations where a source of infrared radiant heat is required. Providing adequate ventilation is available. This makes the CATA-DYNE flameless explosion-proof catalytic gas infrared heater the leading choice for many industries including:

*Oil and gas production*

*Oil and gas exploration*

*Petrochemical storage and distribution*

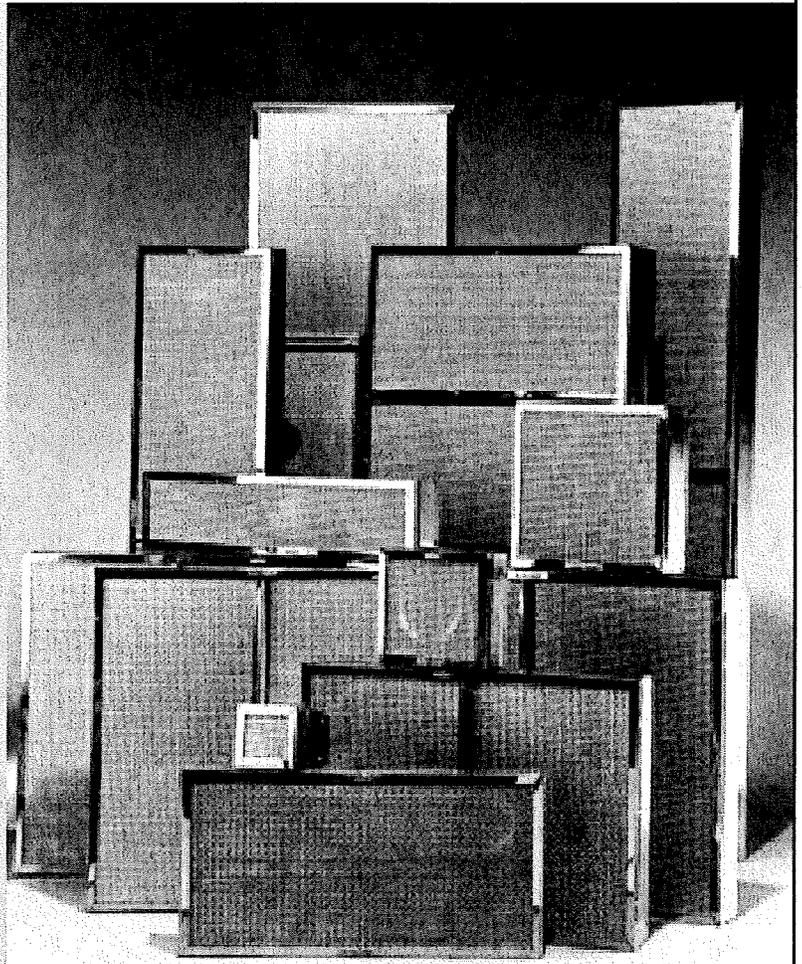
*Separators and dehydrators*

*Meter runs*

*Compressed Natural Gas (CNG) facilities*

*Liquid Propane Gas (LPG) facilities*

*General industrial areas*



CATA-DYNE explosion-proof heaters are available in 19 different models with BTU ratings ranging from 3,500 to 72,000 BTU/hr (1 - 21 kW). In addition, these heaters can be banked together to obtain any BTU (kW) rating desired.

Ciscan's CATA-DYNE heaters are moderately priced, simple to install

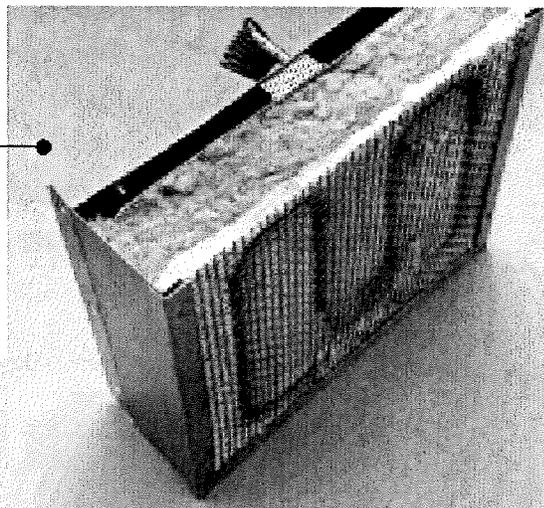
and operate, and require minimal maintenance under normal operating conditions. These heaters are also highly efficient, economical to operate and environmentally friendly. The economy of natural gas combined with the energy efficiency of CATA-DYNE emitters can save up to 80% in operating costs compared to electric explosion-proof heaters.

Most CATA-DYNE heaters for oil and gas applications are started with either 12 volt or 120 volt electrical elements (24, 208, 240, 480, and 600 volts are also available), but power is only required during the initial start up. No power is needed to operate heaters or heater controls once the heater has started and the catalytic reaction has been established.

## **CATA-DYNE™ INFRARED HEATERS**

CATA-DYNE infrared heaters have a variety of applications in the oil and gas industry, and are designed for economical and efficient operation plus simplicity of installation. This has been accomplished by ensuring that as many components as possible have the same specifications for thread sizes, hole diameters, accessories, etc. The following is a list of the standard equipment supplied with each CATA-DYNE heater:

- 1** CATA-DYNE patented explosion-proof catalyst bed
- 2** Appliance regulator - 3/8" NPT, 1/2 psi inlet pressure and 7" outlet pressure (natural gas models only)
- 3** Manual shut-off ball valve - 3/8" NPT
- 4** 100% safety shut-off valve (SSOV) (3/8" NPT) and thermocouple
- 5** Heater boxes constructed of 300 series stainless steel for maximum corrosion protection
- 6** Standard 3/8" NPT gas connections
- 7** Hub junction boxes (3/4" NPT) rated for use in Class I, Divisions 1 & 2, Group D, hazardous locations

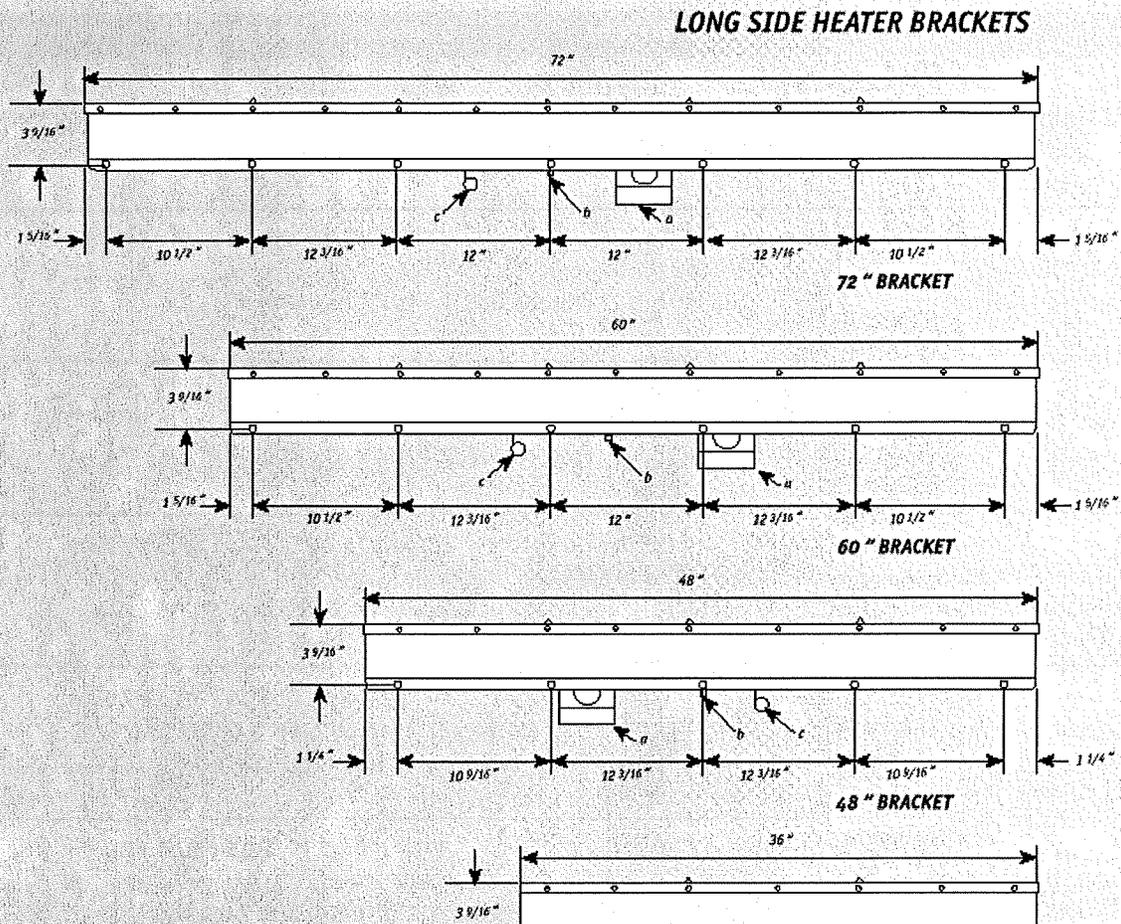
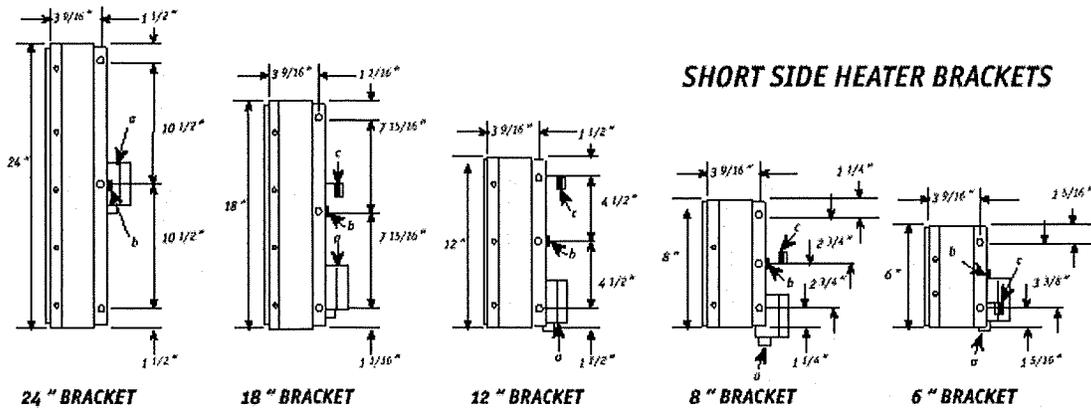


### **ADDITIONAL FEATURES:**

- All CATA-DYNE heaters are designed to run on either clean natural gas or liquid propane gas. They provide an unbeatable combination of economy, longevity and workmanship.
- CATA-DYNE heaters can be banked to obtain any BTU/hr (kW) rating desired.
- CATA-DYNE heaters start with either a 12 volt vehicle battery or with other standard electrical current.
- Once started, CATA-DYNE heaters do not require any electrical power to operate, making them ideal for remote locations.
- Each design change and new accessory is carefully examined and thoroughly tested to ensure excellence and continuity of the CATA-DYNE product line. Customers can be confident that their products will be supported for many years to come.

### **PERSONAL SAFETY**

- Adequate ventilation must be incorporated in any building design to ensure oxygen replenishment and removal of any carbon dioxide.
- Protection grills should be used on any installation where personnel may come in contact with the face of the heater.
- Depending on the application, any volatile organic compounds that come in contact with the catalytic surface are consumed by the catalyst.



### General Notes

**a** Electrical junction box 3/4" NPT female connection

**b** Gas connection 3/8" NPT male connection

**c** Thermocouple location

\* When Ordering: Specify bracket location whether short side or long side

**Gas Connection - 3/8" NPT**

**Fuel Source: Natural or Propane Gas;**

**Fuel Consumption based on:**

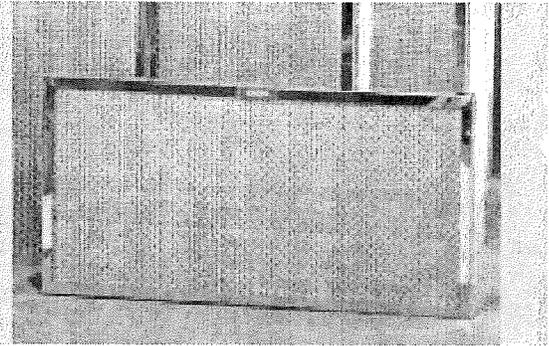
**1,000 BTU/ft<sup>3</sup> (37 MJ/m<sup>3</sup>)**

**at Standard Temperature Pressure - \*Natural Gas;**

**2,500 BTU/ft<sup>3</sup> (93 MJ/m<sup>3</sup>)**

**at Standard Temperature Pressure - \*\*Propane Gas;**

**21,560 BTU/lb (50.0 MJ/kg) - \*\*\*Liquid Propane Gas**



## CATA-DYNE HEATERS

**(800 - 18,000 BTU/hr)**

<b>Models</b>	<b>Ratings</b>	<b>Weight</b>	<b>Dimensions (length x width x depth)</b>
<i>Mini Heater</i>	<i>800 BTU/hr (0.234 kW)</i>	<i>1.0 lb (0.45 kg)</i>	<i>4.5" x 4.25" x 1.7" - 11.4 x 10.8 x 4.3 cm</i>
Starting Elements: Flame Start (NOT explosion-proof) Fuel Consumption: *Natural Gas: 0.60 ft <sup>3</sup> /hr (0.0017 m <sup>3</sup> /hr); **Propane Gas: 0.24 ft <sup>3</sup> /hr (0.007 m <sup>3</sup> /hr); ***Liquid Propane Gas: 0.028 lb/hr (13.0 g/hr)			
<i>BX 8x8</i>	<i>3,500 BTU/hr (1.024 kW)</i>	<i>3.6 lb (1.6 kg)</i>	<i>8" x 8" x 3.1" - 20.3 x 20.3 x 7.9 cm</i>
Starting Elements: 12V/7.1A; 120V/0.7A; 240V/0.42A Fuel Consumption: *Natural Gas: 3.5 ft <sup>3</sup> /hr (0.10 m <sup>3</sup> /hr); **Propane Gas: 1.4 ft <sup>3</sup> /hr (0.04 m <sup>3</sup> /hr); ***Liquid Propane Gas: 0.15 lb/hr (74 g/hr)			
<i>BX 6x24</i>	<i>6,000 BTU/hr (1.8 kW)</i>	<i>9.5 lb (4.3 kg)</i>	<i>24" x 6" x 3.1" - 61.0 x 15.2 x 7.9 cm</i>
Starting Elements: 12V/15.0A; 120V/2.1A; 208V/1.2A; 240V/1.0A; 480V/0.63A Fuel Consumption: *Natural Gas: 6.0 ft <sup>3</sup> /hr (0.17 m <sup>3</sup> /hr); **Propane Gas: 2.4 ft <sup>3</sup> /hr (0.068 m <sup>3</sup> /hr); **Liquid Propane Gas: 0.28 lb/hr (127 g/hr)			
<i>BX 12x12</i>	<i>6,000 BTU/hr (1.8 kW)</i>	<i>8.8 lb (4.0 kg)</i>	<i>12" x 12" x 3.1" - 30.5 x 30.5 x 7.9 cm</i>
Starting Elements: 12V/15.0A; 120V/2.1A; 208V/1.2A; 240V/1.0A Fuel Consumption: *Natural Gas: 6.0 ft <sup>3</sup> /hr (0.17 m <sup>3</sup> /hr); **Propane Gas: 2.4 ft <sup>3</sup> /hr (0.068 m <sup>3</sup> /hr); ***Liquid Propane Gas: 0.28 lb/hr (127 g/hr)			
<i>BX 12x24</i>	<i>12,000 BTU/hr (3.5 kW)</i>	<i>14.7 lb (6.7 kg)</i>	<i>24" x 12" x 3.1" - 61.0 x 30.5 x 7.9 cm</i>
Starting Elements: 12V/30.0A; 24V/15.0A; 120V/4.2A; 208V/2.4A; 240V/2.1A; 480V/1.0A; 600V/0.92A Fuel Consumption: *Natural Gas: 12.0 ft <sup>3</sup> /hr (0.34 m <sup>3</sup> /hr); **Propane Gas: 4.80 ft <sup>3</sup> /hr (0.14 m <sup>3</sup> /hr); ***Liquid Propane Gas: 0.56 lb/hr (254 g/hr)			
<i>BX 12x36</i>	<i>18,000 BTU/hr (5.3 kW)</i>	<i>38.0 lb (17.2 kg)</i>	<i>36" x 12" x 3.1" - 91.5 x 30.5 x 7.9 cm</i>
Starting Elements: 120V/5.0A; 208V/2.9A; 240V/2.5A; 480V/1.25A; 600V/1.0A Fuel Consumption: *Natural Gas: 18.0 ft <sup>3</sup> /hr (0.51 m <sup>3</sup> /hr); **Propane Gas: 7.2 ft <sup>3</sup> /hr (0.20 m <sup>3</sup> /hr); **Liquid Propane Gas: 0.83 lb/hr (376 g/hr)			
<i>BX 18x24</i>	<i>18,000 BTU/hr (5.3 kW)</i>	<i>25 lb (11.3 kg)</i>	<i>24" x 18" x 3.1" - x 61 x 30.5 x 7.9 cm</i>
Starting Elements: 12V/30.0A; 24V/15.0A; 120V/4.2A; 208V/2.4A; 240V/2.1A; 480V/1.0A Fuel Consumption: *Natural Gas: 18.0 ft <sup>3</sup> /hr (0.51 m <sup>3</sup> /hr); **Propane Gas: 7.2 ft <sup>3</sup> /hr (0.20 m <sup>3</sup> /hr); ***Liquid Propane Gas: 0.83 lb/hr (376 g/hr)			

Gas Connection - 3/8" NPT

Fuel Source: Natural or Propane Gas;

Fuel Consumption based on:

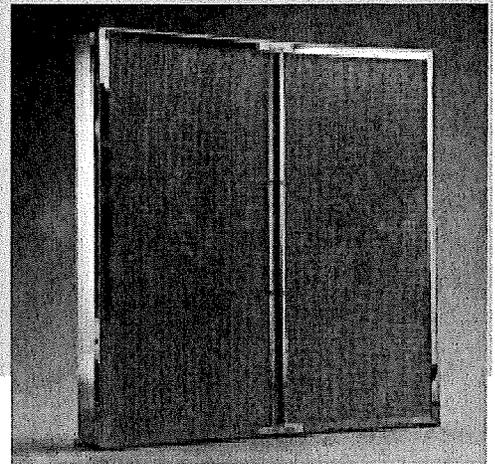
1,000 BTU/ft<sup>3</sup> (37 MJ/m<sup>3</sup>)

at Standard Temperature Pressure - \*Natural Gas;

2,500 BTU/ft<sup>3</sup> (93 MJ/m<sup>3</sup>)

at Standard Temperature Pressure - \*\*Propane Gas;

21,560 BTU/lb (50.0 MJ/kg) - \*\*\*Liquid Propane Gas



## CATA-DYNE HEATERS

(24,000 - 36,000 BTU/hr)

Models	Ratings	Weight	Dimensions (length x width x depth)
BX 12x48	24,000 BTU/hr (7.0 kW)	26.5 lb (12.0 kg)	48" x 12" x 3.1" - 121.9 x 30.5 x 7.9 cm
Starting Elements: 12V/30A; 120V/6.7A; 208V/3.9A; 240V/3.3A; 480V/1.7A; 600V/1.3A			
Fuel Consumption: *Natural Gas: 24.0 ft <sup>3</sup> /hr (0.68 m <sup>3</sup> /hr); **Propane Gas: 9.60 ft <sup>3</sup> /hr (0.27 m <sup>3</sup> /hr);			
***Liquid Propane Gas: 1.11 lb/hr (503 g/hr)			
BX 12x60	30,000 BTU/hr (8.8 kW)	32.5 lb (14.7 kg)	60" x 12" x 3.1" - 152.4 x 30.5 x 7.9 cm
Starting Elements: 12 V/45 A; 120 V/10.4 A; 208 V/6 A; 240V/5.21 A; 480 V/2.6 A; 600 V/2.1 A			
Fuel Consumption: *Natural Gas: 30.0 ft <sup>3</sup> /hr (0.85 m <sup>3</sup> /hr); **Propane Gas: 12.0 ft <sup>3</sup> /hr (0.34 m <sup>3</sup> /hr);			
***Liquid Propane Gas: 1.39 lb/hr (630 g/hr)			
BX 12x72	36,000 BTU/hr (10.5 kW)	47 lb (21.3 kg)	72" x 12" x 3.1" - x 182.9 x 30.5 x 7.9 cm
Starting Elements: 120V/12.1A; 208V/7A; 240V/6.0A; 480V/3A; 600V/2.4A			
Fuel Consumption: *Natural Gas: 36.0 ft <sup>3</sup> /hr (1.02 m <sup>3</sup> /hr); **Propane Gas: 14.4 ft <sup>3</sup> /hr (.41 m <sup>3</sup> /hr);			
***Liquid Propane Gas: 1.67 lb/hr (757 g/hr)			
BX 18x36	27,000 BTU/hr (7.9 kW)	38 lb (17.2 kg)	36" x 18" x 3.1" - 91.4 x 45.7 x 7.9 cm
Starting Elements: 120V/10A; 208V/5.8A; 240V/5.0A; 480V/2.5A; 600V/2.0A			
Fuel Consumption: *Natural Gas: 27.0 ft <sup>3</sup> /hr (0.77 m <sup>3</sup> /hr); **Propane Gas: 10.8 ft <sup>3</sup> /hr (0.31 m <sup>3</sup> /hr);			
**Liquid Propane Gas: 1.25 lb/hr (567 g/hr)			
BX 18x48	36,000 BTU/hr (10.5 kW)	50 lb (22.7 kg)	48" x 18" x 3.1" - x 121.9 x 45.72 x 7.9 cm
Starting Elements: 120V/13.3A; 208V/7.7A; 240V/6.7A; 480V/3.3A; 600V/2.7A			
Fuel Consumption: *Natural Gas: 36.0 ft <sup>3</sup> /hr (1.02 m <sup>3</sup> /hr); **Propane Gas: 14.4 ft <sup>3</sup> /hr (0.41 m <sup>3</sup> /hr);			
***Liquid Propane Gas: 1.67 lb/hr (758 g/hr)			
BX 24x24	24,000 BTU/hr (7.0 kW)	25.9 lb (11.7 kg)	24" x 24" x 3.1" - 61.0 x 61.0 x 7.9 cm
Starting Elements: 12V/30A; 24V/15A; 120V/4.2A; 208V/2.4A; 240V/2.1A; 480V/1.0A			
Fuel Consumption: *Natural Gas: 24.0 ft <sup>3</sup> /hr (0.68 m <sup>3</sup> /hr); **Propane Gas: 9.60 ft <sup>3</sup> /hr (0.27 m <sup>3</sup> /hr);			
***Liquid Propane Gas: 1.11 lb/hr (503 g/hr)			
BX 24x30	30,000 BTU/hr (8.8 kW)	32.0 lb (14.5 kg)	30" x 24" x 3.1" - 76.2 x 61.0 x 7.9 cm
Starting Elements: 12V/45A; 24V/22.5A; 120V/4.2A; 208V/2.4A; 240V/2.1A; 480V/1.0A			
Fuel Consumption: *Natural Gas: 30.0 ft <sup>3</sup> /hr (0.85 m <sup>3</sup> /hr); **Propane Gas: 12.0 ft <sup>3</sup> /hr (0.34 m <sup>3</sup> /hr);			
***Liquid Propane Gas: 1.39 lb/hr (630 g/hr)			
BX 24x36	36,000 BTU/hr (10.5 kW)	46.0 lb (21.0 kg)	36" x 24" x 3.1" - 91.5 x 61.0 x 7.9 cm
Starting Elements: 120V/10A; 208V/5.8A; 240V/5.0A; 480V/2.5A; 600V/2.0A			
Fuel Consumption: *Natural Gas: 36.0 ft <sup>3</sup> /hr (1.02 m <sup>3</sup> /hr); **Propane Gas: 14.4 ft <sup>3</sup> /hr (0.41 m <sup>3</sup> /hr);			
***Liquid Propane Gas: 1.67 lb/hr (758 g/hr)			

**Gas Connection - 3/8" NPT**

**Fuel Source: Natural or Propane Gas;**

**Fuel Consumption based on:**

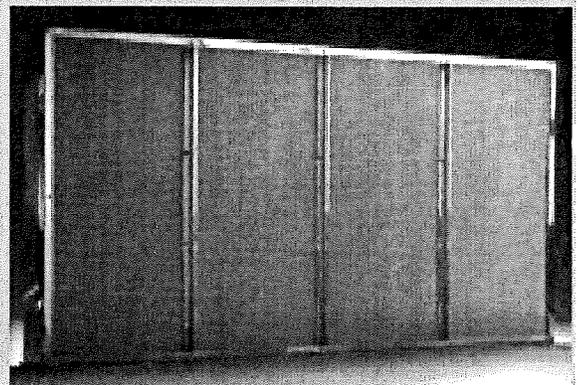
**1,000 BTU/ft<sup>3</sup> (37 MJ/m<sup>3</sup>)**

**at Standard Temperature Pressure - \*Natural Gas;**

**2,500 BTU/ft<sup>3</sup> (93 MJ/m<sup>3</sup>)**

**at Standard Temperature Pressure - \*\*Propane Gas;**

**21,560 BTU/lb (50.0 MJ/kg) - \*\*\*Liquid Propane Gas**



## **CATA-DYNE™ HEATERS**

**(45,000 - 72,000 BTU/hr)**

<b>Models</b>	<b>Ratings</b>	<b>Weight</b>	<b>Dimensions (length x width x depth)</b>
<b>BX 18x60</b>	<b>45,000 BTU/hr (13.2 kW)</b>	<b>44.0 lb (20.0 kg)</b>	<b>60" x 18" x 3.1" - 152.4 x 45.7 x 7.9 cm</b>
<b>Starting Elements: 120V/20.8A; 208V/12A; 240V/10.42A; 480V/5.2A; 600V/4.2A</b>			
<b>Fuel Consumption: *Natural Gas: 45.0 ft<sup>3</sup>/hr (1.28 m<sup>3</sup>/hr); **Propane Gas: 18.0 ft<sup>3</sup>/hr (0.48 m<sup>3</sup>/hr); ***Liquid Propane Gas: 2.09 lb/hr (948 g/hr)</b>			
<b>BX 18x72</b>	<b>54,000 BTU/hr (15.8 kW)</b>	<b>69.0 lb (31.3 kg)</b>	<b>72" x 18" x 3.1" - 182.9 x 45.7 x 7.9 cm</b>
<b>Starting Elements: 120V/24.2A; 208V/14A; 240V/12A; 480V/6.0A; 600V/4.8A</b>			
<b>Fuel Consumption: *Natural Gas: 54.0 ft<sup>3</sup>/hr (1.53 m<sup>3</sup>/hr); **Propane Gas: 21.6 ft<sup>3</sup>/hr (0.61 m<sup>3</sup>/hr); ***Liquid Propane Gas: 2.50 lb/hr (1,134 g/hr)</b>			
<b>BX 24x48</b>	<b>48,000 BTU/hr (14.0 kW)</b>	<b>65.0 lb (29.5 kg)</b>	<b>48" x 24" x 3.1" - 121.9 x 61.0 x 7.9 cm</b>
<b>Starting Elements: 120V/13.3A; 208V/7.7A; 240V/6.7A; 480V/3.3A; 600V/2.7A</b>			
<b>Fuel Consumption: *Natural Gas: 48.0 ft<sup>3</sup>/hr (1.36 m<sup>3</sup>/hr); **Propane Gas: 19.2 ft<sup>3</sup>/hr (0.54 m<sup>3</sup>/hr); ***Liquid Propane Gas: 2.22 lb/hr (1007 g/hr)</b>			
<b>BX 24x60</b>	<b>60,000 BTU/hr (17.5 kW)</b>	<b>76.0 lb (34.5 kg)</b>	<b>60" x 24" x 3.1" - 152.4 x 61.0 x 7.9 cm</b>
<b>Starting Elements: 120V/20.8A; 208V/12A; 240V/10.4A; 480V/5.2A; 600V/4.2A</b>			
<b>Fuel Consumption: *Natural Gas: 60.0 ft<sup>3</sup>/hr (1.36 m<sup>3</sup>/hr); **Propane Gas: 24.0 ft<sup>3</sup>/hr (0.68 m<sup>3</sup>/hr); ***Liquid Propane Gas: 2.78 lb/hr (1,261 g/hr)</b>			
<b>BX 24x72</b>	<b>72,000 BTU/hr (21.0 kW)</b>	<b>79.0 lb (35.8 kg)</b>	<b>72" x 24" x 3.1" - 182.9 x 61.0 x 7.9 cm</b>
<b>Starting Elements: 120V/24.2A; 208V/14A; 240V/12A; 480V/6.0A; 600V/4.8A</b>			
<b>Fuel Consumption: *Natural Gas: 72.0 ft<sup>3</sup>/hr (2.04 m<sup>3</sup>/hr); **Propane Gas: 28.8 ft<sup>3</sup>/hr (0.82 m<sup>3</sup>/hr); ***Liquid Propane Gas: 3.34 lb/hr (1,515 g/hr)</b>			

# INSTALLATION

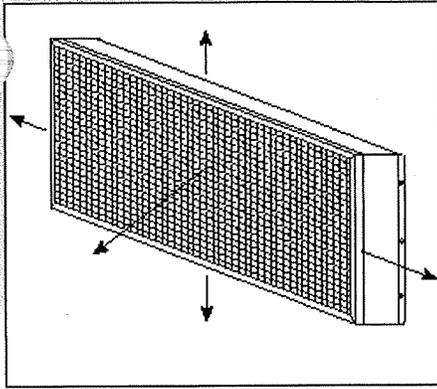


FIGURE 1

To ensure maximum efficiency of your CATA-DYNE heater, it should be installed with the heating surface positioned plus or minus 45° from the vertical plane at a height of no more than 8' (2.44 m). Overhead mounting should be restricted to heaters of 30,000 BTU/hr (8.8 kW) capacity and larger.

All heaters must be installed in accordance with the latest revisions of CAN/CGA-B149.1 and/or CAN/CGA-B149.2 and/or any local codes and regulations.

Before installing the heater, all information on the heater name plate must be carefully reviewed. The name plate lists all the fuel and electrical requirements for the heater.

## Heater Clearances

Appropriate clearances from the heating surface must be observed during the installation of CATA-DYNE heaters (See Figure 1)

### Heater Clearance

Radiant Surface Position	Radiant Surface			Sides	Top			Bottom		
	Heaters Up To 12,000 BTU/h	Over 12,000 Up To 48,000 BTU/h	Over 48,000 Up To 72,000 BTU/h	All Heaters Up To 72,000 BTU/h	Heaters Up To 12,000 BTU/h	Over 12,000 Up To 48,000 BTU/h	Over 48,000 Up To 72,000 BTU/h	Heaters Up To 12,000 BTU/h	Over 12,000 Up To 48,000 BTU/h	Over 48,000 Up To 72,000 BTU/h
Vertical (0°)	28"	42"	60"	12"	18"	18"	42"	7"	12"	18"
0-45° up	28"	42"	60"	12"	18"	32"	54"	0"	12"	18"
0-45° down	28"	42"	60"	12"	18"	18"	18"	22"	24"	42"

# OPERATION

All CATA-DYNE heaters are supplied with a Safety Shut-Off Valve (SSOV)/Thermocouple assembly to ensure the safe operation of the heater. Under NO circumstances should the reset button be held or locked into the depressed position by use of mechanical restraint.

### Start-up

**1** Ensure the heater has been installed according to all instructions and relevant codes.

**2** Turn on the main gas supply to the system.

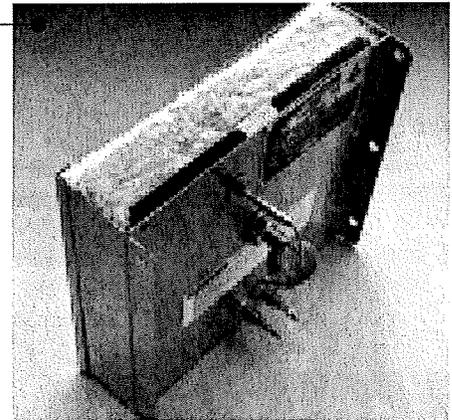
**3** If the heater is equipped with a thermostatic temperature controller, rotate the dial completely clockwise to the "fully open" position.

**4** Turn on the power to the electrical elements.

**5** After 15 minutes depress the reset button on the top of SSOV. The button should return to the original position and internally open the valve and allow gas to flow to the heater. If the valve does not stay open when the reset button is released it may be necessary to wait an additional few minutes and then depress the reset button again. This will allow the electrical elements additional time to warm up.

**6** When the catalytic reaction is well established, turn off the electrical power to the elements.

**7** If the heater is equipped with a thermostatic temperature controller, it can be set to the desired setting after the catalytic reaction has been established for at least one hour.



### Shut Down

Turn off the gas supply to the heater.

### Multi-heater start-up

CATA-DYNE heaters can also be purchased/installed in multi-heater assemblies. If these assemblies are 12V, each heater must be started individually. This ensures that the correct voltage and current will be applied to the heater from the power supply.

# Fuels

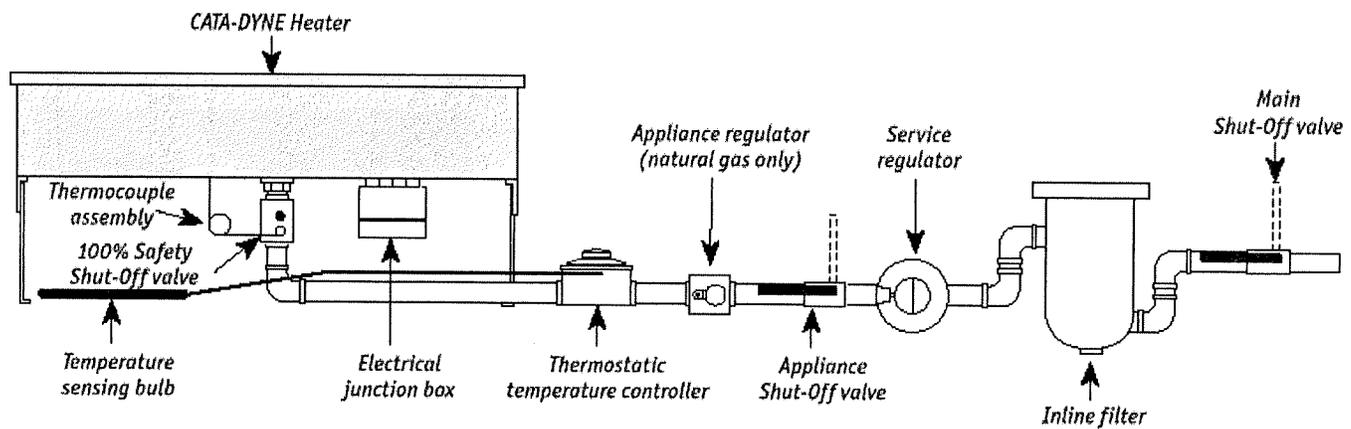
The CATA-DYNE™ flameless gas heater is designed to operate on clean and dry natural or propane gas as specified on the heater nameplate.

**Natural Gas** - These heaters are designed to use natural gas (1,000 BTU/ft<sup>3</sup>, 37 MJ/m<sup>3</sup>) at 7" w.c. (1.73 kPa) at standard temperature pressure. Heaters can be ordered to operate at 3.5" w.c. (0.86 kPa).

**LPG** - These heaters are designed to use propane gas (2,500 BTU/ft<sup>3</sup>, 88 MJ/m<sup>3</sup>) at 11" w.c. (2.72 kPa) at standard temperature pressure.

# PIPING

- A main shut-off valve must be installed upstream of all auxiliary heater controls.
- 100% safety shut-off valve (SSOV) can be mounted in any convenient position.
- Appliance regulator (natural gas only) must be installed in the upright position.
- Thermostatic temperature controller should be installed with the dial shaft in the horizontal position.
- Maximum inlet pressure to the 100% SSOV, thermostatic temperature controller and appliance regulator is 1/2 psi (3.4 kPa). If the inlet pressure is higher than this, a low pressure regulator must be installed upstream of these components.
- Maximum inlet pressure to the low pressure regulator is 250 psi (1.7 Mpa). If the inlet pressure is higher than this, a high pressure regulator must be installed upstream.
- All components should be installed as indicated below.

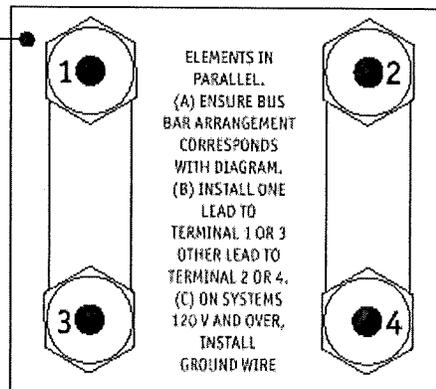


# ELECTRICAL

All wiring is to be installed in accordance with the latest Canadian or National Electrical Codes and/or local codes.

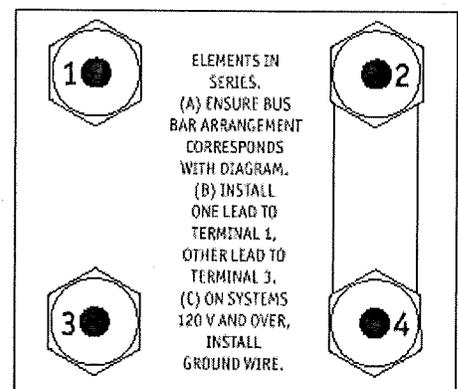
Ground connections for 120V up to 600V heaters are provided on the bottom of the junction box. The number of terminals in the junction box can be 2 or 4 depending on the number of

FIGURE 2



elements used in the fabrication of the heater. The connection procedure

FIGURE 3

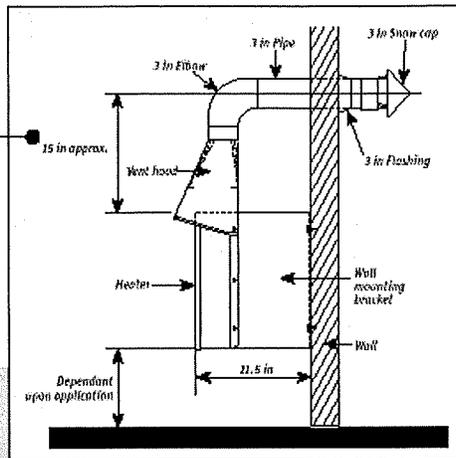


for the different combinations is as described in Figures 2 & 3.

# VENTILATION

The catalytic reaction in CATA-DYNE heaters occurs when natural gas or propane reacts with oxygen to produce water vapour, carbon dioxide and infrared energy. Ventilation must be provided to allow an adequate supply of oxygen for the reaction.

For every 1.0 ft<sup>2</sup> (0.093 m<sup>2</sup>) of heater surface, 60 ft<sup>3</sup>/hr (1.7 m<sup>3</sup>/hr) of air supply is required. For example, a BX 24x24 heater (24,000 BTU/hr - 7.0 kW) would require 240 ft<sup>3</sup>/hr (6.8 m<sup>3</sup>/hr) of air to ensure proper operation of the CATA-DYNE heater.



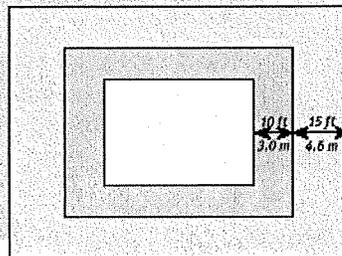
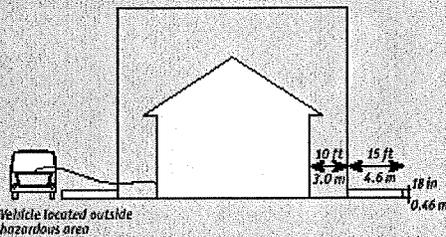
To reduce the carbon dioxide and water vapour concentrations in the building, a vent hood assembly can be installed to provide positive ventilation from the heater.

## 12V HAZARDOUS ELECTRICAL INSTALLATIONS

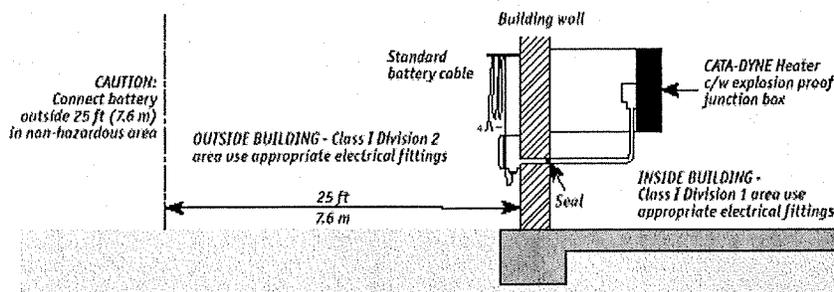
Most oil and gas production buildings have an area classification as follows:

- 1 Class I, Division 1** - within the building
- 2 Class I, Division 2** - outside the building for a distance of 10' (3.0 m) from the building at all elevations
- 3 Class I, Division 2** - outside the building for a distance of 25' (7.6 m) from the building at an elevation of 18" (0.46 m) from the ground

All electrical apparatus and wiring within the area must conform to the appropriate codes. For 12 volt battery started heaters, connection to the power supply must be outside of the Class I, Division 2 location



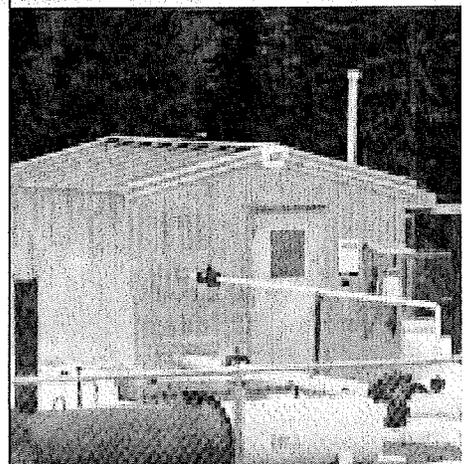
- Class I Division 1
- Class I Division 2
- Class I Division 2 18 in (0.46 m) from ground Subject to possible transient vapour



## EXPLOSION-PROOF HEATING APPLICATIONS

The efficiency, safety, and reliability of infrared technology have proven ideal for a variety of hazardous area heating requirements. The following is a partial list of explosion-proof heating applications for CATA-DYNE heaters:

- Separator facilities
- Dehydration buildings
- Meter runs
- Oil and gas well head shelters
- Water injection facilities
- Compressor facilities
- Storage and distribution facilities
- Oil and gas process equipment buildings
- Drilling rigs
- Exploration and testing facilities
- Pressure reducing stations
- Gasoline storage and dispensing facilities
- Petroleum refineries
- Petroleum exploration and testing facilities
- Header buildings
- Pipeline metering stations
- Instrumentation heating
- Gas metering pressure drop de-icing



# SPACE & SPOT HEATING SYSTEM DESIGN

## GENERAL USES

CATA-DYNE heaters are utilized for three basic types of heating:

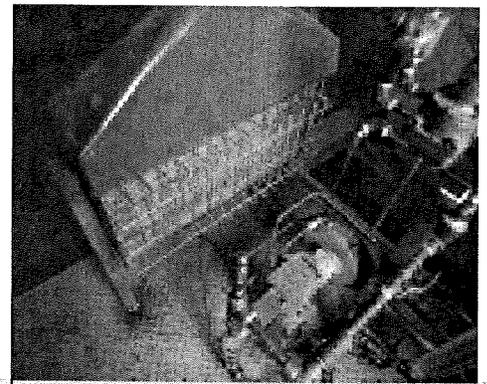
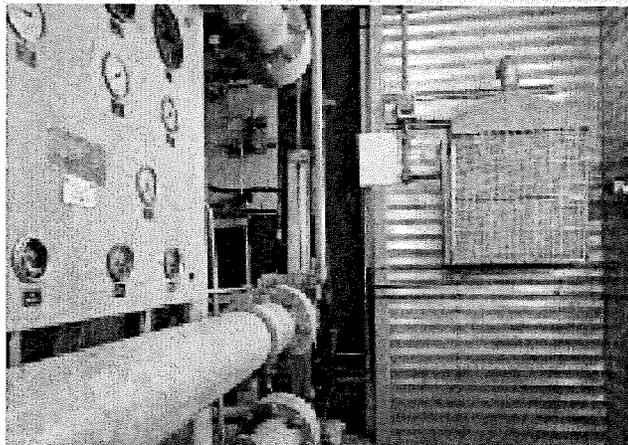
- Spot heating
- Space heating
- Combination space and spot heating

## SPACE HEATING

- A separate heat load calculation should be done for every building that will use a CATA-DYNE heater for space heating purposes. The heat load calculation determines the building heat losses through the structure and allows for air infiltration (Refer to the following Heat Load Calculations).
- CATA-DYNE heaters produce low intensity infrared heat that is absorbed by objects within the range of the heat source. The closer the object to the source of heat, the more heat the object will absorb. CATA-DYNE heaters should be placed close to the floor level within the building to heat objects close to the floor. Ideally, CATA-DYNE heaters should be mounted 1' - 3' (0.3 - 1 m) from the floor and equally spaced around the building perimeter for space heating applications. If low mounting is not practical, then overhead mounting may be utilized. Overhead mounted heaters should be sloped face down to a maximum 45° angle to direct the infrared

energy towards the floor. Overhead mounting should be restricted to heaters of 30,000 BTU/hr (8.8 kW) capacity and larger.

- If the building requires only one heater, place the CATA-DYNE heater as close as possible to the centre of the longest wall.
- For multiple heater installations, space the CATA-DYNE heaters as evenly as possible around the perimeter of the building.
- Make sure the piping is large enough to handle the gas load (Refer to the Piping Calculation in this catalogue for sizing information).
- Make sure the electrical starting system has sufficient current carrying capacity and conforms to all applicable electrical codes.
- It is advisable to install an indicator light in the electrical circuit to reduce the possibility of the power being left on once the heater is started.



## SPOT HEATING

There are several factors to consider when using CATA-DYNE heaters for spot heating:

- Infrared energy travels in straight lines from the face of the CATA-DYNE heater covering approximately 160° of arc and the amount of energy transfer is inversely proportional to the square of the distance. The heater should therefore be mounted as close as practical (minimum of 8" (20 cm)) to the object requiring heat for maximum temperature rise.
- Match the shape of the object requiring heat with the appropriate CATA-DYNE heater; e.g. BX 6x24 for long narrow objects or BX 12x12 for a square object.
- Objects requiring heat should, if possible, be painted dull, dark colours for maximum infrared absorption. Objects not requiring heat should be painted light or reflective colours.
- Maintain name plate clearances from combustible materials such as wood, cloth, paper, etc.
- Insulate and protect plastic, rubber and similar materials from direct intense infrared heat.

## BUILDING HEAT LOAD

The following calculation format can be used to determine the heat load requirements to provide space heating in most buildings.

The following general assumptions can be used in the calculation:

### SAMPLE HEAT LOAD CALCULATION

The following is a sample calculation of the heat load for a building.

The building is 12' x 20' (3.7 x 6.1 m) with an eaves height of 8' (2.4 m) and a peak height of 12' (3.7 m). It has one window - 2' x 4' (.61 x 1.22 m), 2 doors - 3' x 7' (.91 x 2.13 m) and is constructed of flat sheet metal with no insulation.

The floor is concrete with uninsulated edges. It will have three air changes per hour and a maximum temperature change of 100° F (37.7° C). Using these factors, you can calculate the heat load for this building by using the information on the Heat Load Calculation Sheet.

**(ANSWER: The final heating requirement for the building would be 193,100 BTU/hr (57 kW), which would require four BX 24x48 heaters).**

Ciscan's engineering department can assist companies with the design of your hazardous area heating systems. This includes heat load calculations and specification writing for individual buildings or projects.

**1** In most areas of Canada, a minimum temperature of -40° F (-40° C) and a building temperature of 60° F (16° C) are used, resulting in a  $\Delta T$  of 100° F (38° C).

**2** The minimum ventilation requirement for the CATA-DYNE heater is 60 ft<sup>3</sup>/hr (1.7 m<sup>3</sup>/hr) of air for every 1.0 ft<sup>2</sup> (0.093 m<sup>2</sup>) of heater surface.

## HEAT LOSS COEFFICIENTS ( $\mu$ )

### WALLS:

Flat metal	1.20
Corrugated metal	1.20 x expanded area
Metal with 1" insulation	0.22
Metal with 2" insulation	0.12
Concrete block - cinder 8"	0.39
- cinder 12"	0.36
- gravel 8"	0.51
- gravel 12"	0.47

### ROOFS:

Flat metal	1.30
Corrugated metal	1.30 x expanded area
Metal with 1" insulation	0.26
Metal with 2" insulation	0.14

### GLASS:

Vertical	1.13
Horizontal	1.40

### DOORS:

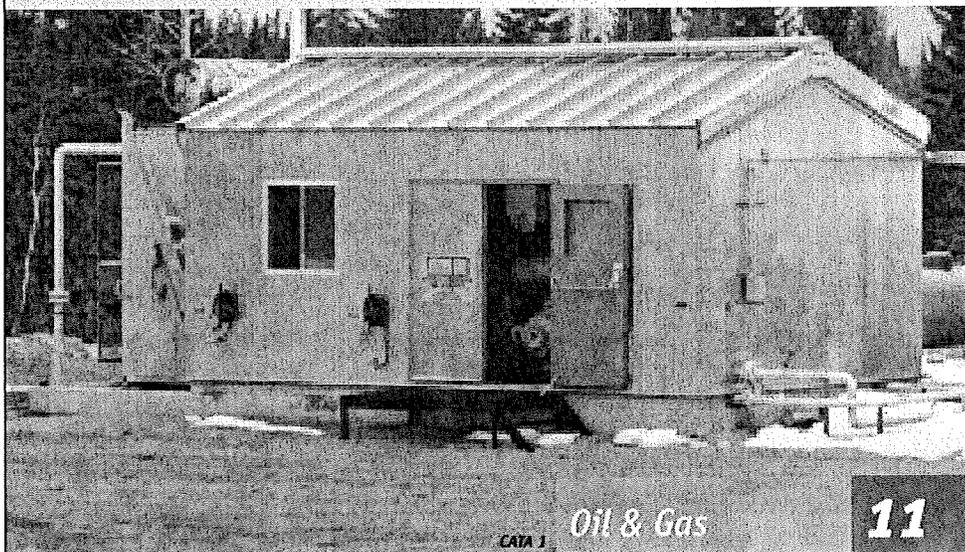
All	1.20
-----	------

### FLOOR:

Insulated edge	0.81
Uninsulated edge	0.55

### AIR:

0.018



# HEAT LOAD CALCULATION SHEET

## Building Specification

Size  
 Length \_\_\_\_\_ ft      Height at Peak \_\_\_\_\_ ft  
 Width \_\_\_\_\_ ft      Window Area \_\_\_\_\_ ft<sup>2</sup>  
 Height at Eaves \_\_\_\_\_ ft      Door Area \_\_\_\_\_ ft<sup>2</sup>

## Construction Material

Walls \_\_\_\_\_  
 Roof \_\_\_\_\_  
 Floor \_\_\_\_\_

## Temperature Requirements

$\Delta T$  = Required Inside Temperature - Lowest Outside Temperature

$\Delta T$  = \_\_\_\_\_ °F      to \_\_\_\_\_ °F

$\Delta T$  = \_\_\_\_\_ °F

## Air Requirements

Volume/hr = Volume of Building x Number of Air Changes/hr

Volume/hr = \_\_\_\_\_ ft<sup>3</sup> x \_\_\_\_\_ /hr  
 = \_\_\_\_\_ ft<sup>3</sup> x \_\_\_\_\_ /hr = \_\_\_\_\_ ft<sup>3</sup>/hr

	Heat Load = Area x $\mu$ x $\Delta T$	$\mu$	$\Delta T$	Heat Load BTU/hr
Wall Area (ft <sup>2</sup> )				
Roof Area (ft <sup>2</sup> )				
Window Area (ft <sup>2</sup> )				
Door Area (ft <sup>2</sup> )				
Floor Perimeter* (ft)				
Air (ft <sup>2</sup> )				
			Total	

Total x 1.5 =

\*If Floor Perimeter is greater than 400', the heat loss coefficient should be doubled. To allow for other unforeseen heat loss, the total heat load should be multiplied by a factor of 1.5

# HEAT LOAD CALCULATION SHEET

## Building Specification

Size  
 Length 20 ft      Height at Peak 12 ft  
 Width 12 ft      Window Area 2 x 4 = 8 ft<sup>2</sup>  
 Height at Eaves 8 ft      Door Area 2 (3x7) = 42 ft<sup>2</sup>

## Construction Material

Walls Flat metal  
 Roof Flat metal  
 Floor Concrete uninsulated

## Temperature Requirements

$\Delta T = \text{Required Inside Temperature} - \text{Lowest Outside Temperature}$   
 $\Delta T = \underline{60} \text{ } ^\circ\text{F}$  to  $\underline{-40} \text{ } ^\circ\text{F}$   
 $\Delta T = \underline{100} \text{ } ^\circ\text{F}$

## Air Requirements

Volume/hr = Volume of Building x Number of Air Changes/hr  
 $\text{Volume/hr} = \frac{(20 \times 12 \times 8) + 1/2 (20 \times 12 \times 4)}{\text{ft}^3} \times \underline{3} \text{ /hr}$   
 $= \frac{(1920 + 480)}{\text{ft}^3} \times \underline{3} \text{ /hr} = \underline{7200} \text{ ft}^3\text{/hr}$

	Heat Load = Area x $\mu$ x $\Delta T$	$\mu$	$\Delta T$	Heat Load BTU/hr
Wall Area (ft <sup>2</sup> )	$2 (20 \times 8) + 2 (12 \times 8) + 2 (1/2 \times 12 \times 4) = 560$	1.20	100	67,200
Roof Area (ft <sup>2</sup> )	$14.4 \times 20 = 288$	1.30	100	37,440
Window Area (ft <sup>2</sup> )	8	1.13	100	904
Door Area (ft <sup>2</sup> )	42	1.20	100	5,040
Floor Perimeter* (ft <sup>2</sup> )	$(2 \times 20) + (2 \times 12) = 64$	0.81	100	5,184
Air (ft <sup>2</sup> )	7200	0.018	100	12,960
			Total	128,728
			Total x 1.5 =	193,092 BTU/hr

\*If Floor Perimeter is greater than 400', the heat loss coefficient should be doubled.  
 To allow for other unforeseen heat loss, the total heat load should be multiplied by a factor of 1.5

## PIPING SIZE GUIDE

This guide can be used to determine the piping size requirement for the installation of CATA-DYNE heaters.

**1** Determine the total length of pipe required from the start of the piping to the final heater location.

**2** Using Table 1, determine the equivalent length of piping for all fittings required. This table accounts for the pressure drop across various fittings.

**3** Add the actual length of pipe (Step 1) and the equivalent length of pipe from the fittings (Step 2) to determine the total equivalent length of pipe.

**4** Determine the total fuel require-

ment needed to operate all of the heaters.

**5** Using Table 2 or 4 (natural gas) or Table 3 or 5 (propane), determine the maximum capacity of the proposed piping.

**6** If the maximum capacity is less than required to operate the heaters, the size of piping will have to be increased.

**TABLE 1 EQUIVALENT LENGTH OF THREADED FITTINGS**

Nominal Pipe Size (sch. 40)	Equivalent Length			
	45° Elbow ft/m	90° Elbow ft/m	Tee ft/m	Valve ft/m
3/8 in	0.58/0.18	1.23/0.37	2.46/0.75	1.23/0.37
1/2 in	0.73/0.22	1.55/0.47	3.10/0.94	1.55/0.47
3/4 in	0.96/0.29	2.06/0.63	4.12/1.26	2.06/0.63
1 in	1.22/0.37	2.62/0.80	5.24/1.60	2.62/0.80
1 1/4 in	1.61/0.49	3.45/1.05	6.90/2.10	3.45/1.05
1 1/2 in	1.88/0.57	4.02/1.23	8.04/2.45	4.02/1.23
2 in	2.41/0.73	5.17/1.58	10.3/3.14	5.17/1.58

## SAMPLE CALCULATION

Three BX 24x48 (48,000 BTU/hr - 14 kW) natural gas heaters are to be installed in a building 50' (15.2 m) from the current gas supply. A total of six 90° elbows, three tees, and one valve will be used with the pipe. Using the Piping Size Guide, will a 1/2" diameter pipe provide an adequate gas supply to the heaters?

Total BTU/hr (kW)

$$3 \times 48,000 = 144,000 \text{ BTU/hr (kW)}$$

Actual pipe length - 50'

Equivalent fitting length

$$(6 \times 1.55) + (3 \times 3.10) + (1 \times 1.55) = 20.15'$$

$$\text{Total equivalent length} - 50 + 20.15 = 70.15'$$

From Table 2 (natural gas), you will find that the maximum gas flow through 70' (21.3 m) of 1/2" diameter pipe is 79,000 BTU/hr (23.1 kW). This is below the required amount, so the pipe size is too small.

If the calculation is done with 3/4" diameter pipe, the equivalent pipe length of the fittings increases to 26.78' for a total equivalent length of 77' (23.5 m). The maximum flow through 80' (24.4 m) of 3/4" diameter pipe is 154,000 BTU/hr (45.1 kW) which would be sufficient to supply the heaters.

**TABLE 2 NATURAL GAS** maximum capacity in thousands of BTU/hr, for 7-14 " w.c. natural gas and a 1" w.c. pressure drop

Nominal Pipe Size (sch. 40)	Total Equivalent Pipe Length (ft)													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
1/2 "	227	156	125	107	95	86	79	74	69	65	58	52	48	45
3/4 "	474	326	262	224	199	180	166	154	145	137	121	110	101	94
1 "	894	614	493	422	374	339	312	290	272	257	228	207	190	177
1 1/4 "	1835	1261	1013	867	768	696	640	596	559	528	468	424	390	363
1 1/2 "	2749	1890	1517	1299	1151	1043	959	893	837	791	701	635	584	544
2 "	5295	3639	2922	2501	2217	2008	1848	1719	1613	1524	1350	1223	1126	1047

**TABLE 3 PROPANE** maximum capacity in thousands of BTU/hr, for 11" w.c. natural gas and a 1 in w.c. pressure drop

Nominal Pipe Size (sch. 40)	Total Equivalent Pipe Length (ft)													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
1/2 "	387	266	214	183	162	147	135	126	118	111	99	89	82	77
3/4 "	810	556	447	382	339	307	283	263	247	233	206	187	172	160
1 "	1525	1048	842	720	638	578	532	495	465	439	389	352	324	302
1 1/4 "	3131	2152	1728	1479	1311	1188	1093	1016	954	901	798	723	666	619
1 1/2 "	4691	3224	2589	2216	1964	1779	1637	1523	1429	1350	1196	1084	997	928
2 "	9034	6209	4986	4267	3782	3427	3153	2933	2752	2599	2304	2087	1920	1787

**TABLE 4 NATURAL GAS** maximum capacity in kW, for 1.75 - 3.50 kPa natural gas and a 250 Pa pressure drop

Nominal Pipe Size (sch. 40)	Total Equivalent Pipe Length (m)													
	3	6	9	12	15	18	21	24	27	30	35	40	45	50
1/2 "	67	46	37	32	28	25	23	22	20	19	18	17	16	15
3/4 "	141	97	78	66	59	53	49	46	43	40	37	35	32	31
1 "	265	182	146	125	111	100	92	86	81	76	70	65	61	58
1 1/4 "	543	374	300	257	228	206	190	176	166	156	144	134	126	119
1 1/2 "	814	560	449	385	341	309	284	264	248	234	216	201	188	178
2 "	1568	1078	865	741	657	595	547	509	478	451	415	386	362	342

**TABLE 5 PROPANE** maximum capacity in kW, for 2.7 kPa propane and a 250 Pa pressure drop

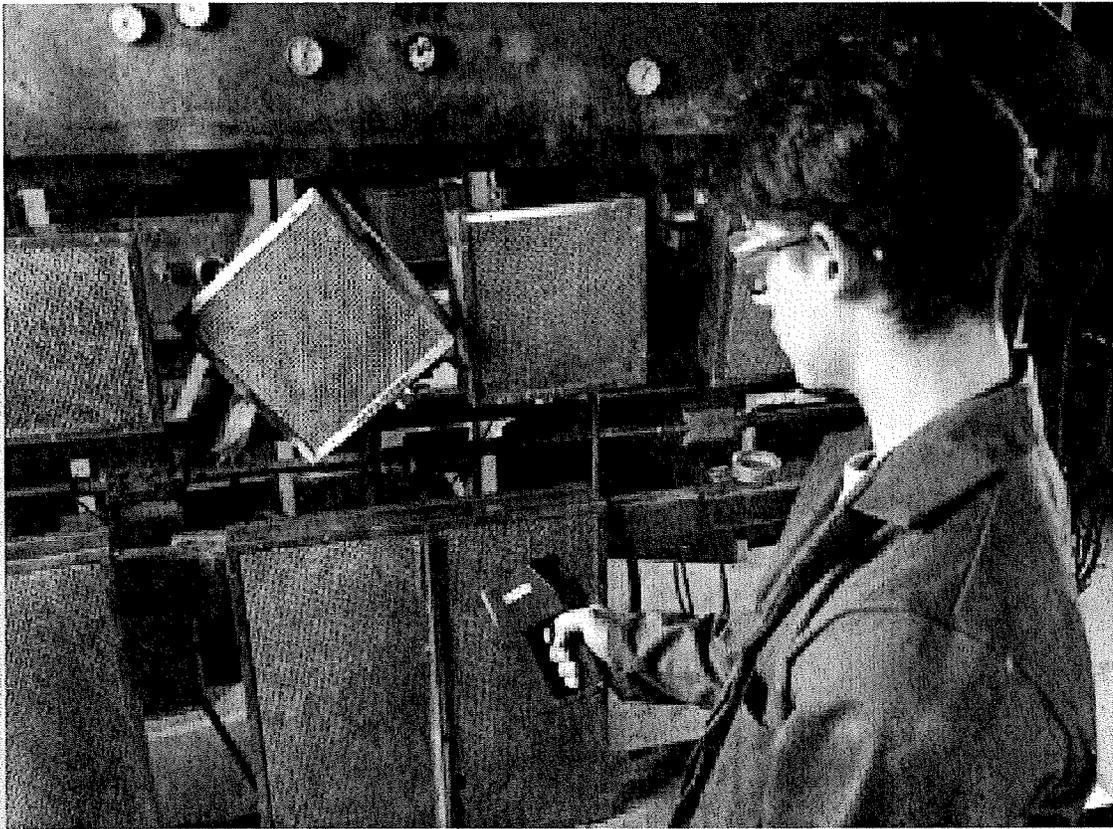
Nominal Pipe Size (sch. 40)	Total Equivalent Pipe Length (m)													
	3	6	9	12	15	18	21	24	27	30	35	40	45	50
1/2 "	115	79	63	54	48	43	40	37	35	33	30	28	26	25
3/4 "	240	165	132	113	100	91	84	78	73	69	63	59	55	52
1 "	452	310	249	213	189	171	158	147	138	130	120	111	104	99
1 1/4 "	927	637	512	438	388	352	324	301	282	267	245	228	214	202
1 1/2 "	1389	955	767	656	582	527	485	451	423	400	368	342	321	303
2 "	2676	1839	1477	1264	1120	1015	934	869	815	770	708	659	618	584

**TABLE 6 CATA-DYNE HEATER RATING SPECIFICATIONS**

Model No.	BTU/hr Nominal	Pressure Rating Input in w.c.		Starting Voltage								Amperage						Gas Flow		
		Natural Gas	Propane	12 V	24 V	120 V	208 V	240 V	480 V	600 V	12 V	24 V	120 V	208 V	240 V	480 V	600 V	Natural (ft <sup>3</sup> /hr)	LPG (ft <sup>3</sup> /hr)	LPG (lb/hr)
BX 8 x 8	3,500	7"	11"	X	-	X	-	X	-	-	7.1	-	0.7	-	.4	-	-	3.5	1.4	0.15
BX 12 x 12	6,000	7"	11"	X	-	X	X	X	-	-	15.0	-	2.1	1.2	1.0	-	-	6.0	2.4	0.28
BX 6 x 24	6,000	7"	11"	X	-	X	X	X	X	-	15.0	-	2.1	1.2	1.0	.63	-	6.0	2.4	0.28
BX 12 x 24	12,000	7"	11"	X	X	X	X	X	X	X	30.0	15.0	4.2	2.4	2.1	1.0	.9	12.0	4.8	0.56
BX 12 x 36	18,000	7"	11"	-	-	X	X	X	X	X	-	-	5.0	2.9	2.5	1.25	1.0	18.0	7.2	0.83
BX 12 x 48	24,000	7"	11"	X	-	X	X	X	X	X	30.0	-	6.7	3.9	3.3	1.7	1.3	24.0	9.6	1.11
BX 12 x 60	30,000	7"	11"	X	-	X	X	X	X	X	45.0	-	10.4	6.0	5.2	2.6	2.1	30.0	12.0	1.39
BX 12 x 72	36,000	7"	11"	-	-	X	X	X	X	X	-	-	12.1	7.0	6.0	3.0	2.4	36.0	14.4	1.67
BX 18 x 24	18,000	7"	11"	X	X	X	X	X	X	-	30.0	15.0	4.2	2.4	2.1	1.0	-	18.0	7.2	0.83
BX 18 x 36	27,000	7"	11"	-	-	X	X	X	X	X	-	-	10.0	5.8	5.0	2.5	2.0	27.0	10.8	1.25
BX 18 x 48	36,000	7"	11"	-	-	X	X	X	X	X	-	-	13.3	7.7	6.7	3.3	2.7	36.0	14.4	1.67
BX 18 x 60	45,000	7"	11"	-	-	X	X	X	X	X	-	-	20.8	12.0	10.4	5.2	4.2	45.0	18.0	2.09
BX 18 x 72	54,000	7"	11"	-	-	X	X	X	X	X	-	-	24.2	14.0	12.0	6.0	4.8	54.0	21.6	2.50
BX 24 x 24	24,000	7"	11"	X	X	X	X	X	X	-	30.0	15.0	4.2	2.4	2.1	1.0	-	24.0	9.6	1.11
BX 24 x 30	30,000	7"	11"	X	X	X	X	X	X	-	45.0	22.5	4.2	2.4	2.1	1.0	-	30.0	12.0	1.39
BX 24 x 36	36,000	7"	11"	-	-	X	X	X	X	X	-	-	10.0	5.8	5.0	2.5	2.0	36.0	14.4	1.67
BX 24 x 48	48,000	7"	11"	-	-	X	X	X	X	X	-	-	13.3	7.7	6.7	3.3	2.7	48.0	19.2	2.22
BX 24 x 60	60,000	7"	11"	-	-	X	X	X	X	X	-	-	20.8	14.0	12.0	6.0	4.8	60.0	24.0	2.78
BX 24 x 72	72,000	7"	11"	-	-	X	X	X	X	X	-	-	24.2	14.0	12.0	6.0	4.8	72.0	28.8	3.34

**TABLE 7 CATA-DYNE HEATER RATING SPECIFICATIONS**

Model No.	kW Nominal	Pressure Rating kPa.		Starting Voltage								Amperage						Gas Flow		
		Natural Gas	Propane	12 V	24 V	120 V	208 V	240 V	480 V	600 V	12 V	24 V	120 V	208 V	240 V	480 V	600 V	Natural (m <sup>3</sup> /hr)	LPG (m <sup>3</sup> /hr)	LPG (gr/hr)
BX 8 x 8	1.02	1.73	2.72	X	-	X	-	X	-	-	7.1	-	0.7	-	0.4	-	-	0.10	0.04	74
BX 12 x 12	1.8	1.73	2.72	X	-	X	X	X	-	-	15.0	-	2.1	1.2	1.0	-	-	0.17	0.068	127
BX 6 x 24	1.8	1.73	2.72	X	-	X	X	X	X	-	15.0	-	2.1	1.2	1.0	.63	-	0.17	0.068	127
BX 12 x 24	3.5	1.73	2.72	X	X	X	X	X	X	X	30.0	15.0	4.2	2.4	2.1	1.0	0.9	0.34	0.14	254
BX 12 x 36	5.3	1.73	2.72	-	-	X	X	X	X	X	-	-	5.0	2.9	2.5	1.25	1.0	0.51	0.20	376
BX 12 x 48	7.0	1.73	2.72	X	-	X	-	-	-	-	30.0	-	6.7	3.9	3.3	1.7	1.3	0.68	0.27	503
BX 12 x 60	8.8	1.73	2.72	X	-	X	X	X	X	X	45.0	-	10.4	6.0	5.2	2.6	2.1	0.85	0.34	630
BX 12 x 72	10.5	1.73	2.72	-	-	X	X	X	X	X	-	-	12.1	7.0	6.0	3.0	2.4	1.19	0.476	884
BX 18 x 24	5.3	1.73	2.72	X	X	X	X	X	X	-	30.0	15.0	4.2	2.4	2.1	1.0	-	0.51	0.20	376
BX 18 x 36	7.9	1.73	2.72	-	-	X	X	X	X	X	-	-	10.0	5.8	5.0	2.5	2.0	0.77	0.31	567
BX 18 x 48	10.5	1.73	2.72	-	-	X	X	X	X	X	-	-	13.3	7.7	6.7	3.3	2.7	1.02	0.41	758
BX 18 x 60	13.2	1.73	2.72	-	-	X	X	X	X	X	-	-	20.8	12.0	10.4	5.2	4.2	1.28	0.48	948
BX 18 x 72	15.8	1.73	2.72	-	-	X	X	X	X	X	-	-	24.2	14.0	12.0	6.0	4.8	1.53	0.61	1,134
BX 24 x 24	7.0	1.73	2.72	X	X	X	X	X	X	-	30.0	15.0	4.2	2.4	2.1	1.0	-	0.68	0.27	503
BX 24 x 30	8.8	1.73	2.72	X	X	X	X	X	X	-	45.0	22.5	4.2	2.4	2.1	1.0	-	0.85	0.34	630
BX 24 x 36	10.5	1.73	2.72	-	-	X	X	X	X	X	-	-	10.0	5.8	5.0	2.5	2.0	1.02	0.41	758
BX 24 x 48	14.0	1.73	2.72	-	-	X	-	X	X	X	-	-	13.3	7.7	6.7	3.3	2.7	1.36	0.54	1,007
BX 24 x 60	17.5	1.73	2.72	-	-	X	X	X	X	X	-	-	20.8	14.0	12.0	6.0	4.8	1.36	0.68	1,261
BX 24 x 72	21.0	1.73	2.72	-	-	X	X	X	X	X	-	-	24.2	14.0	12.0	6.0	4.8	2.04	0.82	1,515



## ***TROUBLE SHOOTING***

- 1** *Ensure that the heater has been installed according to instructions.*
- 2** *Ensure that the fuel matches that listed on the heater name plate.*
- 3** *Ensure that the voltage matches that listed on the heater name plate.*
- 4** *Follow correct start-up procedures.*
- 5** *Allow approximately 30 minutes for the elements to preheat the catalyst bed.*
- 6** *Check for any physical damage. All signs of physical damage to the catalyst pad such as holes, tears or a general deterioration, or visible contamination of the catalyst bed signal that it is time to have the heater repaired.*
- 7** *Check the gas supply pressure at the heater — 7" w.c. (1.73 kPa) or 3.5" w.c. (0.86 kPa) for natural gas and 11" w.c. (2.72 kPa) for propane.*

# TROUBLE SHOOTING

- 8** Check the gas orifice for obstructions or dirt and ensure the size matches that listed on the heater name plate. It may be necessary to install a filter upstream of the heater or regulator if the gas supply is dirty. If the fuel supply is constantly dirty and/or wet it would be advisable to use bottled propane fuel.
- 9** Check the mounting position of the heater. The face of the heater should be preferably in the vertical position and should not vary more than 45° from the vertical position for maximum efficiency.
- 10** Check for saturation of the catalyst face caused by condensation or rain running down the face of the heater. If the heater has been exposed to water, place the unit in a warm area for a period of a few hours or longer if required. Once the moisture is removed, the heater can be re-installed and restarted.
- 11** Check the jumper cable size to ensure that the resistance of the cable is not reducing the current to the heater. This would not allow sufficient power to the electrical element to preheat the catalyst to the activity temperature. We suggest that you run the service vehicle at fast idle while starting the heater if starting using a 12 volt car/truck battery.
- 12** If building vibrations are affecting the SSOV, turn the SSOV 1/4 turn to the right. This should fix the problem.
- 13** CATA-DYNE heaters are designed to use clean fuel and to be used in non-contaminated atmospheres. Sulphur compounds in the fuel or atmosphere will poison the catalyst bed over a period of time and render the heater inoperative. If the heater has been exposed to sulphur compounds, it should be sent to Ciscan's factory for service.
- 14** If contaminated fuel is a problem, an inline filter system is recommended.
- 15** If inline filters are being used, make sure the cartridges are changed as often as recommended.
- 16** Avoid spraying the face of the heater with high pressure air, steam or water because this can damage the catalyst bed. If physical damage is visible, return the heater to the factory for servicing.
- 17** The minimum setting on the temperature controller corresponds to the individual heater(s) it is controlling. If the temperature controller is too low, the heater will not have sufficient fuel rating to operate and will stop.



MANUFACTURER OF CATA-DYNE™ EXPLOSION PROOF CATALYTIC HEATERS

## **SAFETY NOTICE**

### **120/240 Volt CATA-DYNE™ Heaters**

CATA-DYNE™ heaters using 120/240 volt electrical starting elements should have ground fault circuit interrupters (G.F.I.) installed in the electrical circuits to minimize the risk of damage caused by an electrical element failure. The G.F.I. Must be installed outside of the hazardous location.

Electrical element failures are rare and in most cases are caused by failure to turn off the electrical power to the CATA-DYNE™ heater once it is started. Other potential causes for failure include corrosion and contamination. Installation of a G.F.I. should confine the damage caused by a short circuit within the electrical element to the interior of the element.

In all cases, electrical power must be turned off to CATA-DYNE™ heaters once the heater is started. Failure to do so will cause damage to the heater and will create a potentially hazardous condition.

HEAD OFFICE AND FACTORY: 5918 ROPER ROAD, EDMONTON, ALBERTA T6B 3E1 PHONE: (403) 466-3178 FAX: (403) 468-5904 TOLL FREE: 1-800-661-8529

CALGARY OFFICE: 5219 MARIAN ROAD N.E., CALGARY, ALBERTA T2A 2Y1 PHONE: (403) 248-8311 FAX: (403) 272-3046

EUROPEAN OFFICE: NORTHAMPTONSHIRE, ENGLAND

**ISO 9002 REGISTERED QUALITY SYSTEM**



# CATA-DYNE™ HEATER

## STANDARD HEATER APPLICATIONS

## INSTALLATION & OPERATION INSTRUCTIONS

**WARNING:** Improper installation, adjustment, alteration, service or maintenance can cause property damage, injury or death. Read the installation, operating and maintenance instructions thoroughly before installing or servicing this equipment.



ISO 9002 REGISTERED QUALITY SYSTEM

The Cata-Dyne™ heater can be used in all industrial indoor locations where a source of infrared radiant heat is required, providing adequate ventilation is available.

### CERTIFICATION

Model WX (Series X) Cata-Dyne™ Explosion-proof, flameless infrared catalytic gas heaters are certified by the Canadian Standards Association (CSA) for use in Class I, Divisions 1 and 2, Group D hazardous (classified) locations and Factory Mutual Global (FM), for use in Class I, Division 1, Group D hazardous (classified) locations, temperature code T2C at an ambient temperature of 40°C (104°F).

The Model BX (Series G) Cata-Dyne™ heater is certified by CSA and FM for use in general industrial non-hazardous locations. The MKII model (Series X) Explosion-proof, flameless infrared catalytic gas heater is certified by CSA for use in Class I, Divisions 1 and 2, Group D hazardous (classified) locations. Models listed are certified for industrial use only, for either natural gas or propane gas. CSA approved models are equipped for high altitudes: 0- 4,500 ft (0-1,370 m) above sea level. CCI Thermal maintains an ISO-9002 registered quality management system at its Edmonton location.

### INSTALLATION

To ensure maximum efficiency of your Cata-Dyne™ heater, it should be installed with the heating surface positioned plus or minus 45° from the vertical plane at a height of no more than 8 ft (2.44m). All heaters must be installed in accordance with the latest revisions of the *Canadian*

### Cata-Dyne™ Heater - Models Available

WX Model (Series X)					
Approved for use in Class I, Division 1 and 2, Group D hazardous (classified) locations by both FM and CSA					
Model Number	Specifications (BTU/H Input Ratings) For Both Natural and Propane Gas		Model Number	Specifications (BTU/H Input Ratings) For Both Natural and Propane Gas	
	Max. BTU/H	Max. kW		Max. BTU/H	Max. kW
WX 6x6	1,000 BTU/H	0.293 kW	WX 18x24	12,000 BTU/H	3.514 kW
WX 6x12	2,000 BTU/H	0.586 kW	WX 18x30	15,000 BTU/H	4.393 kW
WX 6x24	4,000 BTU/H	1.171 kW	WX 18x36	18,000 BTU/H	5.272 kW
WX 6x60	10,000 BTU/H	2.929 kW	WX 18x48	24,000 BTU/H	7.029 kW
WX 8x8	1,778 BTU/H	0.521 kW	WX 18x60	30,000 BTU/H	8.786 kW
WX 10x12	3,333 BTU/H	0.976 kW	WX 18x72	36,000 BTU/H	10.543 kW
WX 12x12	4,000 BTU/H	1.171 kW	WX 24x24	16,000 BTU/H	4.686 kW
WX 12x24	8,000 BTU/H	2.343 kW	WX 24x30	20,000 BTU/H	5.857 kW
WX 12x36	12,000 BTU/H	3.514 kW	WX 24x36	24,000 BTU/H	7.029 kW
WX 12x48	16,000 BTU/H	4.686 kW	WX 24x48	32,000 BTU/H	9.372 kW
WX 12x60	20,000 BTU/H	5.857 kW	WX 24x60	40,000 BTU/H	11.715 kW
WX 12x72	24,000 BTU/H	7.029 kW	WX 24x72	48,000 BTU/H	14.058 kW

BX Model (Series G)					
Approved for use in general industrial non-hazardous locations by both FM and CSA					
Model Number	Specifications (BTU/H Input Ratings) For Both Natural and Propane Gas		Model Number	Specifications (BTU/H Input Ratings) For Both Natural and Propane Gas	
	Max. BTU/H	Max. kW		Max. BTU/H	Max. kW
BX 6x6	1,500 BTU/H	0.4 kW	BX 18x24	18,000 BTU/H	5.3 kW
BX 6x12	3,000 BTU/H	0.9 kW	BX 18x30	22,500 BTU/H	6.6 kW
BX 6x24	6,000 BTU/H	1.8 kW	BX 18x36	27,000 BTU/H	7.9 kW
BX 8x8	3,500 BTU/H	1.0 kW	BX 18x48	36,000 BTU/H	10.5 kW
BX 10x12	5,000 BTU/H	1.5 kW	BX 18x60	45,000 BTU/H	13.2 kW
BX 12x12	6,000 BTU/H	1.8 kW	BX 18x72	54,000 BTU/H	15.8 kW
BX 12x24	12,000 BTU/H	3.5 kW	BX 24x24	24,000 BTU/H	7.0 kW
BX 12x36	18,000 BTU/H	5.3 kW	BX 24x30	30,000 BTU/H	8.8 kW
BX 12x48	24,000 BTU/H	7.0 kW	BX 24x36	36,000 BTU/H	10.5 kW
BX 12x60	30,000 BTU/H	8.8 kW	BX 24x48	48,000 BTU/H	14.1 kW
BX 12x72	36,000 BTU/H	10.5 kW	BX 24x60	60,000 BTU/H	17.5 kW
			BX 24x72	72,000 BTU/H	21.0 kW

MKII Model (Series X)		
Approved for use in Class I, Division 1 and 2, Group D hazardous (classified) locations by CSA		
Model Number	Specifications (BTU/H Input Ratings) For Both Natural and Propane Gas	
	Max. BTU/H	Max. kW
MKII 12x12	4,000 BTU/H	1.171 kW
MKII 12x24	8,000 BTU/H	2.343 kW
MKII 24x24	16,000 BTU/H	4.686 kW

Model WX Series Heaters are certified for use in Class I, Division 1 and 2, Group D hazardous locations by both FM and CSA/CSA.

The WX Series Cata-Dyne™ features an improved efficiency catalyst pad that requires 1/3 less fuel to generate the same heat value as our BX Series Cata-Dyne™ heater.



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Electrical Code, CAN/CGA-B149.1, the *Natural Gas Installation Code* and/or CAN/CGA-B149.2, the *Propane Installation Code* and/or any local codes and regulations. Before installing the heater, all information on the heater nameplate must be carefully reviewed. The nameplate lists all the fuel and electrical requirements for the heater.

Natural Gas – these heaters are designed to use natural gas (1000 BTU/ft<sup>3</sup>, 37 MJ/m<sup>3</sup>) at 7 in w.c. (1.73 kPa), 4.5 in w.c. (1.12 kPa), or 3.5 in w.c. (0.86 kPa).

Propane – these heaters are designed to use propane gas (2500 BTU/ft<sup>3</sup>, 88 MJ/m<sup>3</sup>) at 11 in w.c. (2.72 kPa).

## SPECIFICATIONS

### Clearances

Appropriate clearances from the heating surface must be observed during the installation of the Cata-Dyne™ heaters (See Figure 1).

### Fuels

The Cata-Dyne™ flameless gas heater is designed to operate on clean, dry natural or propane gas as specified on the heater nameplate.

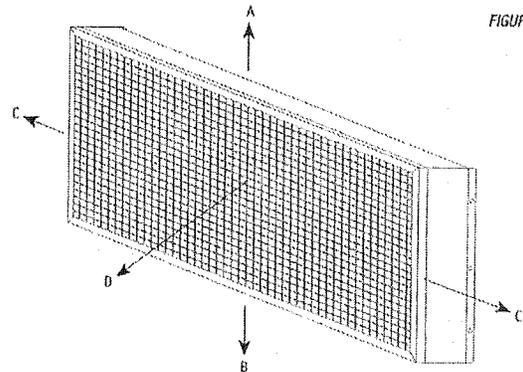


FIGURE 1

HEATER CLEARANCE										
Radiant Surface Position	Radiant Surface			Sides	Top			Bottom		
	Heaters Up To 12,000 BTU/h	Over 12,000 Up To 48,000 BTU/h	Over 48,000 Up To 72,000 BTU/h	All Heaters Up To 72,000 BTU/h	Heaters Up To 12,000 BTU/h	Over 12,000 Up To 48,000 BTU/h	Over 48,000 Up To 72,000 BTU/h	Heaters Up To 12,000 BTU/h	Over 12,000 Up To 48,000 BTU/h	Over 48,000 Up To 72,000 BTU/h
Vertical (0°)	28 in	42 in	60 in	12 in	18 in	18 in	42 in	7 in	12 in	18 in
0-45° up	28 in	42 in	60 in	12 in	18 in	32 in	54 in	0 in	12 in	18 in
0-45° down	28 in	42 in	60 in	12 in	18 in	18 in	18 in	22 in	24 in	42 in

### Piping

1. A main shut-off valve must be installed upstream of all auxiliary heater controls.
2. The 100% safety shut-off valve and appliance regulator (natural gas heaters only) must be installed in the upright position.
3. The thermostatic temperature controller should be installed with the dial shaft in the horizontal position.
4. The maximum inlet pressure to the 100% safety shut-off valve, thermostatic temperature controller and appliance regulator is 1/2 psi (3.4 kPa). If the inlet pressure is higher than this, a low-pressure service regulator must be installed upstream of these components.
5. The maximum inlet pressure to the low-pressure service regulator is 250 psi (1.7 MPa). If the inlet pressure is higher than this, a high-pressure regulator must be installed upstream.
6. All components should be installed as indicated in Figure 2 (WX and BX models only) or Figure 3 (MKII model only).

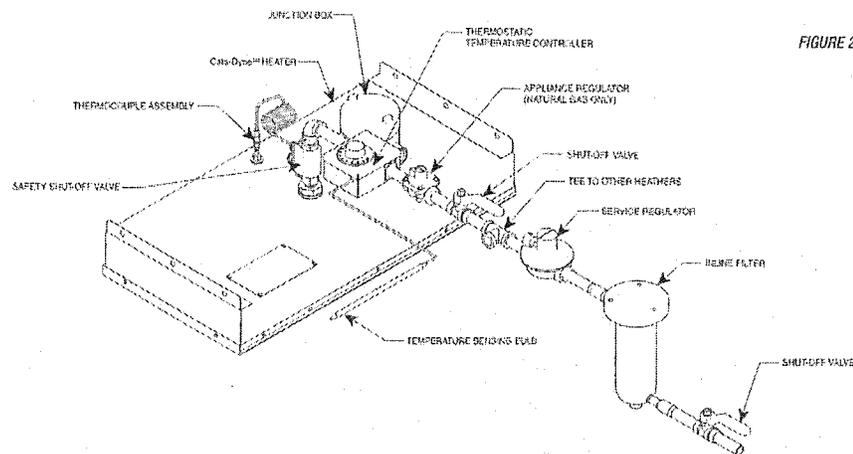


FIGURE 2

## Electrical

1. All wiring is to be installed in accordance with the latest revisions of the Canadian Electrical Code (CEC) and/or any applicable local codes.
2. It is desirable to install an indicating light on all starting systems. This will reduce the possibility of the power being left on once the heater is started, which can severely reduce the lifespan of the heater.
3. Ground connections for 120V and above heaters are required as indicated in Figures 4 and 5.
4. The number of terminals in the junction box can be two or four depending on the number of elements used in the fabrication of the heater. All MK-II models incorporate a single element and therefore have only two terminals. The connection procedure for the different combinations is as described in Figures 4 and 5:

## Ventilation

The catalytic reaction in Cata-Dyne™ heaters occurs when natural gas or propane reacts with oxygen to produce water vapor, carbon dioxide and infrared energy. Ventilation must be provided to allow an adequate supply of oxygen for the reaction.

For every 1.0 ft<sup>2</sup> (0.093 m<sup>2</sup>) of heater surface, 60 ft<sup>3</sup>/hr (1.7 m<sup>3</sup>/hr) of air supply is required. For example, a BX 24x24 heater (24,000 BTU/hr 7.0 kW) would require 240 ft<sup>3</sup>/hr (6.8 m<sup>3</sup>) of air to ensure proper operation of the Cata-Dyne™ heater.

To reduce the carbon dioxide and water vapor concentrations in the building, a vent hood assembly can be installed to provide positive ventilation from the heater (See Figure 6).

FIGURE 3

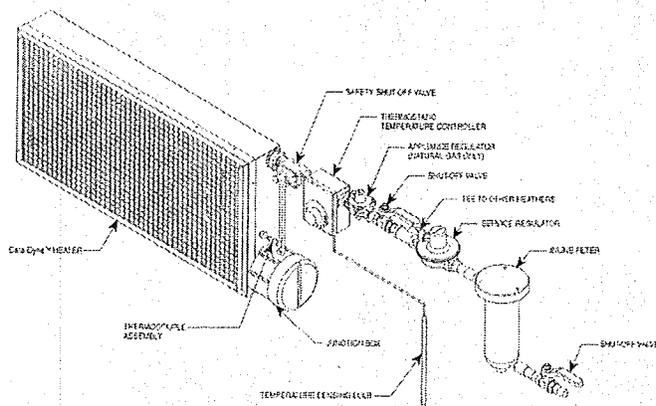


FIGURE 4

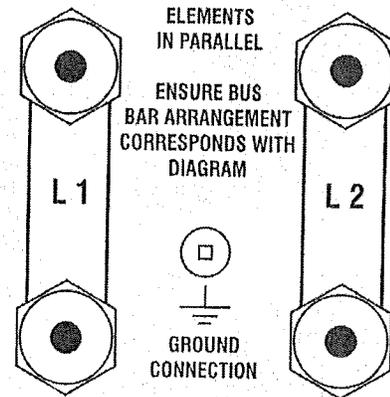


FIGURE 5

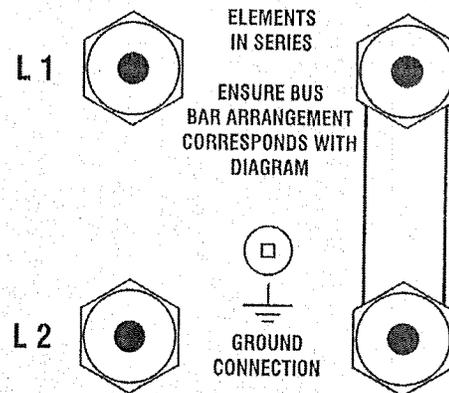
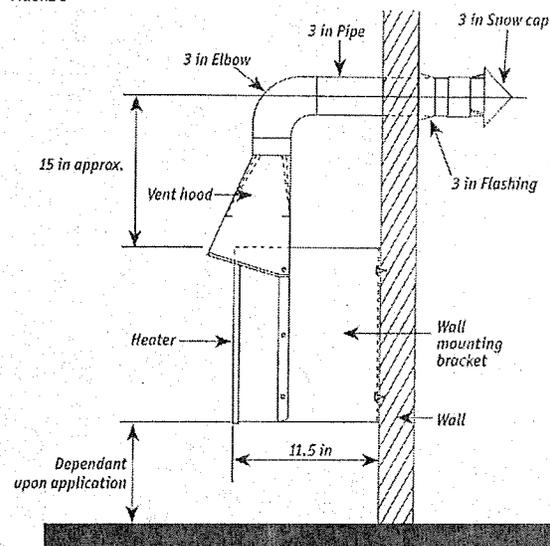


FIGURE 6



## OPERATION

All Cata-Dyne™ heaters are supplied with a Safety Shut-Off Valve (SSOV)/Thermocouple assembly to ensure the safe operation of the heater. Under no circumstances should the reset button be held or locked into the depressed position by use of a mechanical restraint. A tamper resistant model SSOV is available if desired.

### Start-up

1. Ensure the heater has been installed according to all instructions and relevant codes.
2. Turn on the main gas supply to the system.
3. If the heater is equipped with a thermostatic temperature controller, rotate the dial completely clockwise to the fully open position.
4. Turn on the power to the electrical elements.
5. After 15 minutes, depress the reset button on the top of the 100% safety shut-off valve. The button should return to the original position and internally open the valve and allow gas to flow to the heater. If the valve does not stay open when the reset button is released, it may be necessary to wait an additional few minutes and then depress the reset button again. This will allow the electrical elements additional time to warm up.
6. When the catalytic reaction is well established, turn off the electrical power to the elements.
7. If the heater is equipped with a thermostatic temperature controller, it can be set to the desired setting after the catalytic reaction has been established for at least one hour.

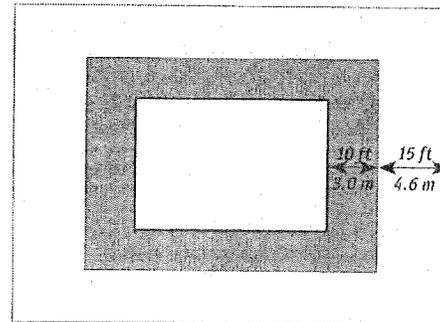
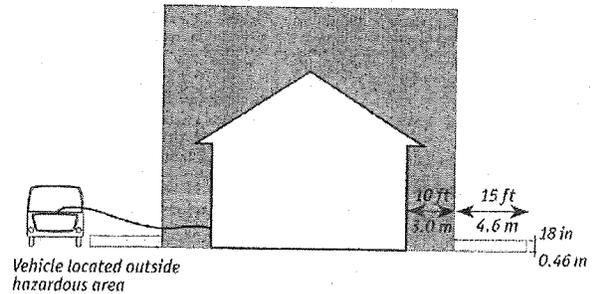
### Shut down

Turn off the gas supply to the heater.

### Multi-heater start-up

Cata-Dyne™ heaters can also be purchased/installed in multi-heater assemblies. If these assemblies are 12V, each heater must be started individually. This ensures the correct voltage and current will be reaching the heater from the power supply.

## 12 V HAZARDOUS ELECTRICAL INSTALLATIONS

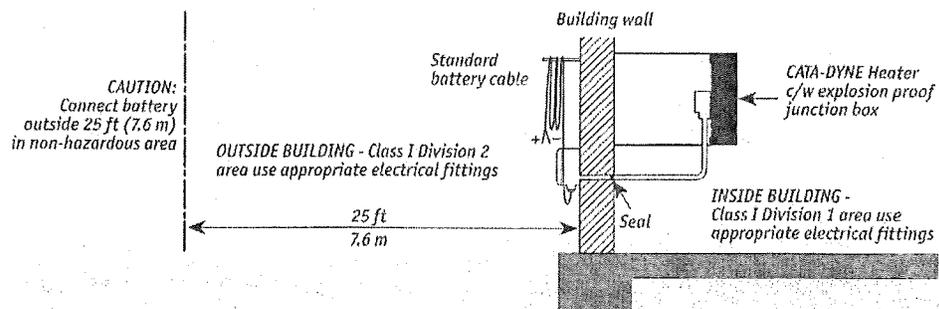


- Class I Division 1
- Class I Division 2
- Class I Division 2
- 18 in (0.46 m) from ground Subject to possible transient vapour

Most oil and gas production buildings have an area classification as follows:

1. Class I, Division 1, within the building.
2. Class I, Division 2, outside the building for a distance of 10 ft (3.0 m) from the building at all elevations.
3. Class I, Division 2, outside the building for a distance of 25 ft (4.5 m) from the building at an elevation of 18 in (0.45 m) from the ground.

All electrical apparatus and wiring within this area must conform to the appropriate codes. Connection to the power supply must be outside of the Class I, Division 2 location.



## SPOT HEATING

There are several factors to consider when Cata-Dyne™ heaters are utilized for spot heating.

Infrared energy travels in straight lines from the face of the Cata-Dyne™ heater covering approximately 160° of arc and is inversely proportional to the square of the distance. The heater should therefore be mounted as close as practical (min. of 8 in (20 cm)) to the object requiring heat for maximum temperature rise.

Match the shape of the object requiring heat with the appropriate Cata-Dyne™ heater, e.g. WX/BX 6x24 for long narrow objects or WX/BX 12x12 for a square object.

Objects requiring heat should be painted dull, dark colors for maximum infrared absorption and objects not requiring heat should be painted light or reflective colors.

Maintain nameplate clearances from combustible materials such as wood, cloth, paper, etc.

Insulate and protect plastic, rubber and similar materials from direct intense infrared heat.

## SPACE HEATING

A separate heat load calculation should be done for each building in which a Cata-Dyne™ heater will be installed for space heating purposes.

The heat load calculation determines the building heat losses through the structure and allows for air infiltration (refer to the sample Heat Load Calculation in the Cata-Dyne™ catalogue).

Cata-Dyne™ heaters produce low intensity infrared heat that is absorbed by objects within the range of the heat source. The closer the object is to the source of heat, the more heat the object will absorb. Cata-Dyne™ heaters should be placed close to the floor level within the building to heat objects close to the floor.

Ideally, Cata-Dyne™ heaters should be mounted 1-3 ft (0.3-1 m) from the floor and equally spaced around the building perimeter for space heating applications.

If low mounting is not practical, then overhead mounting may be utilized. Overhead mounted heaters should be sloped face down to a maximum 45° angle to direct the infrared energy towards the floor. Overhead mounting should be restricted to heaters of 30,000 BTU/hr (8.8 kW) capacity and larger.

If the building requires only one heater, place the Cata-Dyne™ heater as close as possible to the center of the longest wall.

For multiple heater installations, space the Cata-Dyne™ heaters as evenly as possible around the perimeter of the building.

Make sure the piping is large enough to handle the gas load (refer to the sample Piping Calculation in the Cata-Dyne™ catalogue for sizing information).

Make sure the electrical starting system has sufficient current carrying capacity and conforms to all applicable electrical codes.

It is advisable to install an indicator light in the electrical circuit to reduce the possibility of the power being left on once the heater is started.

## PERSONAL SAFETY

The Cata-Dyne™ flameless infrared catalytic gas heater does not produce harmful carbon monoxide gas when used with natural gas or propane. Adequate ventilation must be incorporated in any building design to ensure oxygen replenishment and removal of any carbon dioxide. Protective grills should be used on any installation where personnel may come in contact with the face of the heater.

## ORDERING INFORMATION

You can order any of CCI Thermal's products by telephone, fax, mail or e-mail. To assist us in processing your order as quickly and efficiently as possible, please provide us with the following information:

- ◆ Cata-Dyne™ product name
- ◆ Cata-Dyne™ model number
- ◆ Fuel gas - natural gas or propane
- ◆ Starting voltage - 12, 24, 120, 208, 240, 480, or 600 volt
- ◆ Accessories required:
  - Protection Grill
  - Wall Mount Brackets
  - Thermostat
  - Regulator
  - Start Up Leads (12 volt system only)
  - Vent Hood
  - Other
- ◆ Company name and contact
- ◆ Billing address, phone number, fax or e-mail
- ◆ Shipping address and phone number
- ◆ Shipping instructions
- ◆ Special tagging instructions
- ◆ Date required
- ◆ Method of payment:
  - on account - P.O. number required
  - credit card - Visa or Mastercard number
  - cash or cheque

## GUARANTEE

CCI Thermal warrants all Cata-Dyne™ flameless infrared heaters sold to be free from defects in material or workmanship under normal use and service. The company agrees to repair or replace any Cata-Dyne™ heater which, upon its examination, reveals it to have been defective due to faulty workmanship or material, if returned to our factory, transportation PREPAID, within one (1) year from date of purchase. The company does not assume responsibility for misuse or misapplication of its heaters.

Warranty is void if Cata-Dyne™ heaters are used with sour, dirty or wet gas, or where sulphur content is greater than allowable for utility gas specifications. Warranty is void if, upon our inspection, the heater has been tampered with. Neither CCI Thermal nor the selling dealer shall be held responsible for loss of time, inconvenience, commercial loss or consequential damages relating to the use of Cata-Dyne™ heaters.

## RETURN GOODS POLICY

Prior written approval must be obtained from CCI Thermal for the return of any Cata-Dyne™ product(s). A restocking charge of 15% will apply. All returns must be shipped to our factory in Edmonton, freight prepaid. Final acceptance will be contingent on inspection at our factory.

## REPAIRS

Cata-Dyne™ heaters may require periodic maintenance or repair. Our factory is staffed with technicians who are qualified to perform any required repairs. The procedure to follow to have a heater repaired is as follows.

Send the heater to our factory in Edmonton. Include the following information with the heater:

- ◆ Company name and address
- ◆ Contact name
- ◆ Telephone number/fax number/e-mail
- ◆ P.O. number
- ◆ Advise if an estimate is required prior to starting the repair
- ◆ Details on the repair or conversion required
- ◆ Return shipping instructions

**NOTE:** Under the terms of our certification, all repairs must be performed at our factory in Edmonton.

## TROUBLE SHOOTING

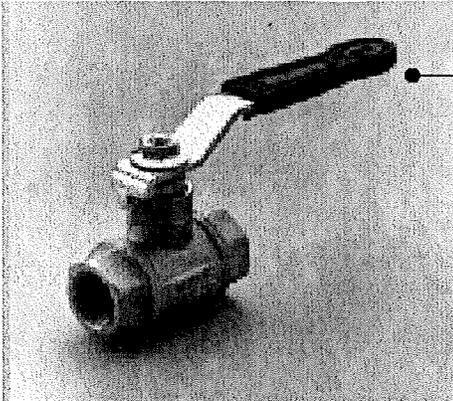
1. Ensure that the fuel matches that listed on the nameplate.
2. Ensure that the voltage matches that listed on the nameplate.
3. Check for any physical damage. All signs of physical damage to the catalyst pad such as holes, tears or a general deterioration of the catalyst bed signal that it is time to have the heater repaired.
4. Check the gas supply pressure at the heater – 7 in w.c. (1.73 kPa), 4.5 in w.c. (1.12 kPa), or 3.5 in w.c. (0.86 kPa) for natural gas and 11 in w.c. (2.72 kPa) for propane.
5. Check the gas orifice for obstructions or dirt and ensure the size matches that listed on the nameplate. It may be necessary to install a filter upstream of the heater or regulator if the gas supply is dirty. If the fuel supply is constantly dirty and/or wet it would be advisable to use bottled propane fuel.
6. Check the mounting position of the heater. The face of the heater should be preferably in the vertical position and should not vary more than 45° from the vertical position for maximum efficiency.
7. Check for saturation of the catalyst face caused by condensation or rain running down the face of the heater. If the heater has been exposed to water, it is advisable to place the unit in a warm area for a period of a few hours or longer if required. Once the moisture is removed, the heater can be re-installed and re-started.
8. Check the jumper cable size to ensure that the resistance of the cable is not reducing the current to the heater. This would not allow sufficient power to the electrical element to preheat the catalyst to the activity temperature. It is recommended to run the service vehicle at fast idle while starting the heater.
9. Cata-Dyne™ heaters are designed to use clean fuel and to be used in non-contaminated atmospheres. Sulphur compounds in the fuel or atmosphere will poison the catalyst bed over a period of time and render the heater inoperative. If the heater has been exposed to sulphur compounds, it should be sent to the factory for service.
10. Avoid spraying the face of the heater with high-pressure air, steam or water because this can damage the catalyst bed. If physical damage is visible, return the heater to the factory for servicing.
11. Ensure that the temperature controller is correct for the model size, fuel, and pressure specifications for the heater it is fitted to. If the temperature controller is too low, the heater will not have sufficient fuel rating to operate and will stop.

*Separate Installation and Operation Instructions are available for oven and industrial heating applications.*

# CATA-DYNE™

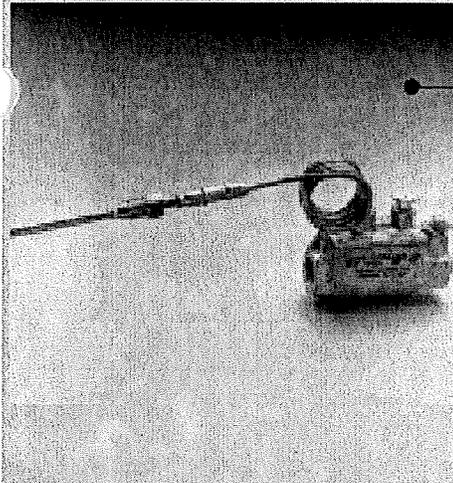
## ACCESSORIES

*A variety of quality accessories are available for use with CATA-DYNE infrared catalytic gas heaters. These accessories enhance and expand the operation and use of the heaters.*



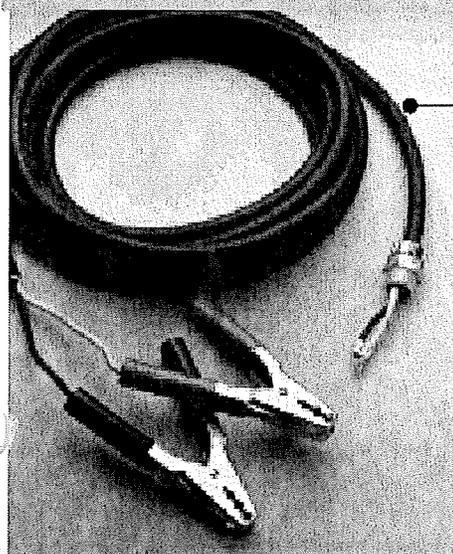
### MANUAL SHUT-OFF VALVE

A 3/8" NPT manual shut-off ball valve is supplied with all manually controlled CATA-DYNE heaters. Standard equipment includes female NPT inlet and outlets and forged brass, which increases the strength of the body. The hard chrome-plated ball has teflon seats and an anti-corrosion dacromet treated handle.



### 100% SAFETY SHUT-OFF VALVE/THERMOCOUPLE

This assembly is a standard feature for all manually controlled CATA-DYNE heaters. The fuel supply to the CATA-DYNE must be manually introduced and the catalytic reaction established before the fuel supply will remain on unattended. The SSOV works in conjunction with the thermocouple as a safety feature. The valve will automatically shut off the gas supply to the heater if, for any reason, the thermocouple senses that the heater face temperature has dropped below the activation temperature. Connections are 3/8" NPT female. The maximum inlet pressure the valve will withstand is 1/2 psi (3.5 kPa).



### ELECTRICAL START-UP LEADS (for 12 volt systems)

Leads are available for starting 12 volt heaters from a battery or other power supply. These leads are manufactured with heavy duty spring loaded serrated jaw clamps at one end and closed loop terminal ends at the other. A strain relief connector is also attached to enable the user to seal the connection between the cable and the heater junction box. Standard lengths are 25' (7.6 m), 30' (9.14 m) and 40' (12.19 m). See installation instructions for typical oil and gas field applications.

# THERMOSTATIC TEMPERATURE CONTROL VALVE

The thermostatic temperature control valve is used to control building temperature for space heating applications. It will control temperatures ranging from 32° - 110° F (0 - 44° C), has a connection size of 3/8" NPT female, and a capillary length of 5' (1.5 m). Thermostats are also available for temperatures ranging from 200° - 550° F (93° - 287° C) for oven applications.

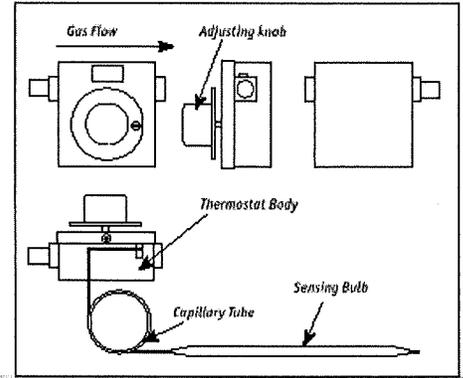
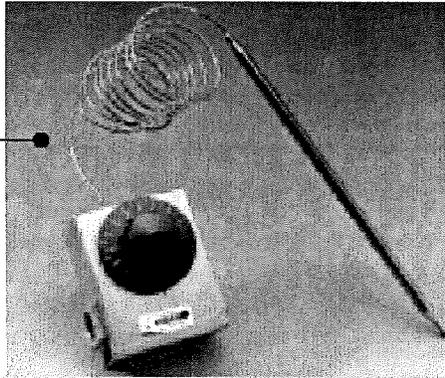
This unit automatically regulates the fuel flow to the CATA-DYNE heater(s) from 100% when heat is required to approximately 30% when the thermostat is satisfied. No electrical power is required to operate this unit.

All thermostats are factory set to specific BTU (kW) and fuel ratings. If the thermostat is to be used with a heater of a different rating or fuel, it must be sent to Ciscan's factory to be reset. Maximum pressure to the valve is 1/2 psi (3.5 kPa).

With CATA-DYNE heaters larger than 18,000 BTU/hr (5.3 kW), Ciscan recommends that one temperature controller be used per heater. This allows each heating unit to be independent and makes the heating system more efficient.

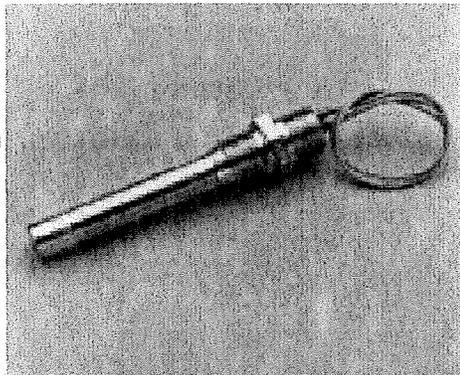
The accompanying chart is a guide to the different minimum and maximum settings for each heater size and fuel gas.

**Note:** The thermostatic temperature control valve is considered an optional accessory and is not mandatory. No aspect of safety will be compromised by not using a thermostat.



**Minimum and Maximum Settings**

Heater Size	Fuel	Min/Max. (BTU/HR)	Min/Max. (kW)
BX 8x8	Natural Gas	1,200/3,500	0.35/1.02
	Propane Gas	1,000/3,500	0.29/1.02
BX 6x24	Natural Gas	2,000/6,000	0.59/1.76
	Propane Gas	1,500/6,000	0.44/1.76
BX 12x12	Natural Gas	2,000/6,000	0.59/1.76
	Propane Gas	1,500/6,000	0.44/1.76
BX 12x24	Natural Gas	4,000/12,000	1.17/3.51
	Propane Gas	3,000/12,000	0.88/3.51
BX 12x36	Natural Gas	6,000/18,000	2.34/5.27
	Propane Gas	4,500/18,000	1.76/5.27
BX 12x48	Natural Gas	8,000/24,000	2.34/7.03
	Propane Gas	6,000/24,000	1.76/7.03
BX 12x 60	Natural Gas	10,000/30,000	2.93/8.79
	Propane Gas	8,000/30,000	2.34/8.79
BX 12x72	Natural Gas	12,000/36,000	2.93/8.79
	Propane Gas	9,000/36,000	2.34/8.79
BX 18x24	Natural Gas	6,000/18,000	1.76/5.27
	Propane Gas	4,500/18,000	1.32/5.27
BX 18x36	Natural Gas	9,000/27,000	2.64/7.91
	Propane Gas	6,750/27,000	1.98/7.91
BX 18x48	Natural Gas	12,000/36,000	3.51/10.5
	Propane Gas	9,000/36,000	2.64/10.5
BX 18x60	Natural Gas	16,000/45,000	4.10/12.3
	Propane Gas	12,000/45,000	3.08/12.3
BX 18x72	Natural Gas	18,000/54,000	5.27/15.8
	Propane Gas	13,500/54,000	3.95/15.8
BX 24x24	Natural Gas	8,000/24,000	2.34/7.03
	Propane Gas	6,000/24,000	1.76/7.03
BX 24x30	Natural Gas	10,000/30,000	2.93/8.79
	Propane Gas	7,500/30,000	2.20/8.79
BX 24x36	Natural Gas	12,000/36,000	3.51/10.5
	Propane Gas	9,000/36,000	2.64/10.5
BX 24x48	Natural Gas	16,000/48,000	4.69/14.1
	Propane Gas	12,000/48,000	3.51/14.1
BX 24x60	Natural Gas	20,000/60,000	5.86/17.6
	Propane Gas	15,000/60,000	4.39/17.6
BX 24x72	Natural Gas	24,000/72,000	7.03/21.1
	Propane Gas	18,000/72,000	5.27/21.1



## THERMOSWITCHES

A thermoswitch senses temperature and opens or closes a pair of electrical contacts when the pre-set temperature is reached. When used with a CATA-DYNE heater, this device senses the internal temperature of the heater and adjusts accordingly.

When the heater reaches operating temperature during the start-up phase, the thermoswitch contacts close the electrical circuit to the solenoid valve control circuitry, allowing the fuel gas to flow to the heater. If the heater temperature drops below operating temperature, the thermoswitch contacts open the solenoid valve control circuitry, the valve closes and the gas flow to the heater is stopped.

Thermoswitches are used on CATA-DYNE electronic control systems. They are available for general purpose and hazardous applications.

## PRESSURE REGULATORS

Ciscan Industries carries a selection of gas appliance pressure regulators capable of controlling pressure at very low flows. These regulators are designed primarily for applications where precise control of flow is an essential operating requirement.

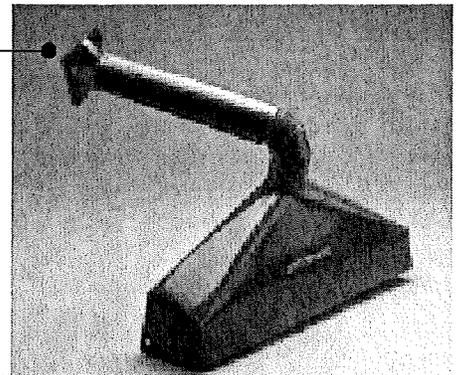
**Appliance:** This regulator has a maximum inlet pressure of 1/2 psi (3.5 kPa) inlet and is factory set at 7" w.c. (1.7 kPa) outlet pressure. Connection size is 3/8" NPT inlet and outlet.

## VENT HOOD ASSEMBLY

This galvanized steel assembly vents the products of reaction (carbon dioxide and water vapour) outside the building. Its main function is to eliminate excessive moisture buildup that could condense and form ice around windows and doorways.

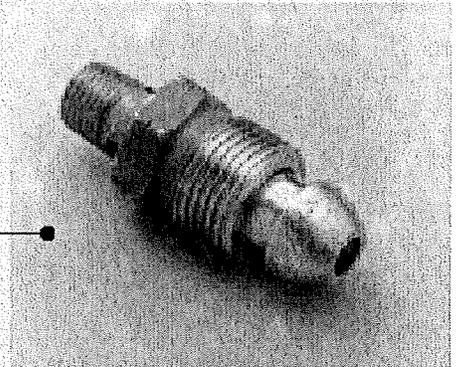
Each vent hood assembly consists of:

- 1 exhaust hood
- 1 length of vent pipe
- 1 elbow
- 1 flashing, and
- 1 snow cap



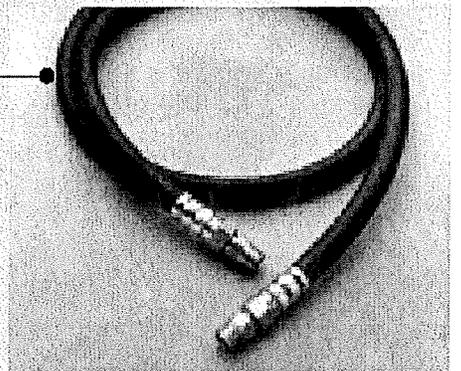
## POL ADAPTERS

This product is a straight adapter that reduces a propane cylinder adapter to 1/4" NPT.



## FUEL GAS HOSE

This product is a CGA approved propane hose, rated for 350 psi (2.4 Mpa) maximum working pressure. Ciscan carries standard stock in lengths of 5' (1.5 m), 10' (3 m), 15' (4.5 m) and 20' (6 m), and other lengths are also available. The connection size at each end is 3/8" NPT male.

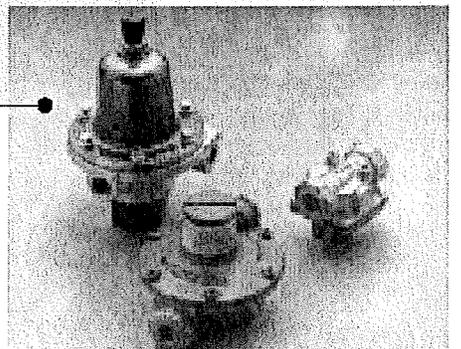


(A pressure regulator is supplied with all certified natural gas models.)

**Low Pressure:** Maximum inlet pressure of 250 psi (1.7 MPa) and is factory set at 11" w.c. (2.7 kPa) outlet pressure. Connection size is 1/4" NPT inlet by 3/8" NPT outlet.

**Maximum rating - 140,000 BTU/hr (41 kW) propane**

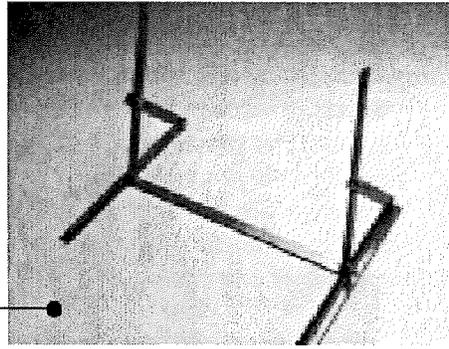
**Maximum rating - 70,000 BTU/hr (20.5 kW) natural gas.** A screwed vent connection is provided.



**High Pressure:** Maximum rating of 6,000 psi (41 MPa) inlet pressure and is factory set at 50 psi (345 kPa) outlet pressure. Connection size is 1/4" NPT inlet and outlet.

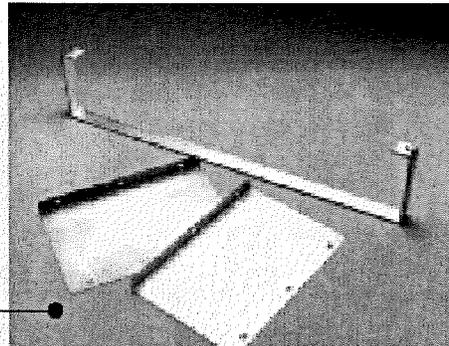
## FLOOR STANDS

Floor stands are available for all CATA-DYNE heater models. These stands allow the heater to be placed closer to the object being heated than with the wall mounting system. The face of the heater can also be adjusted to the optimum heating angle. To ensure proper installation, consult the appropriate local codes and/or regulations.



## WALL MOUNTING BRACKETS

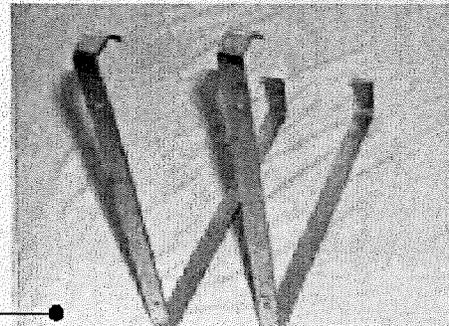
Standard wall mounting brackets are manufactured from stainless steel with 3/8" diameter holes for wall mounting bolts. The brackets mount heaters 7 1/2" (19 cm) away from the wall to allow access to the back of the heater. Brackets for large units over 12,000 BTU/hr (3.5 kW) are manufactured from heavy gauge mild steel flat bar.



## 45° WALL MOUNTING BRACKETS

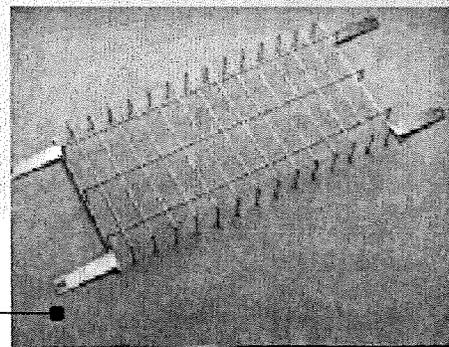
This specialized bracket simplifies installation of all 18" (457 mm) and 24" (610 mm) CATA-DYNE heaters. Made from mild rolled steel with a zinc plate finish, it is ideal for the following heater sizes:

<i>BX 18x24</i>	<i>BX 18x36</i>
<i>BX 18x48</i>	<i>BX 18x60</i>
<i>BX 18x72</i>	<i>BX 24x24</i>
<i>BX 24x30</i>	<i>BX 24x36</i>
<i>BX 24x48</i>	<i>BX 24x60</i>
<i>BX 24x72</i>	



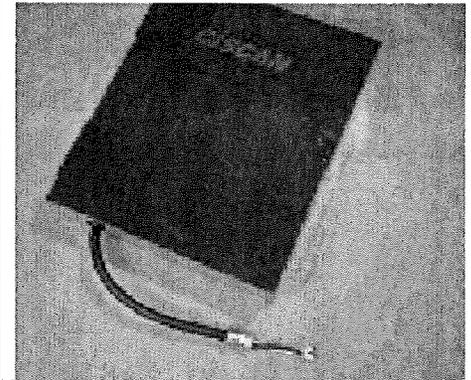
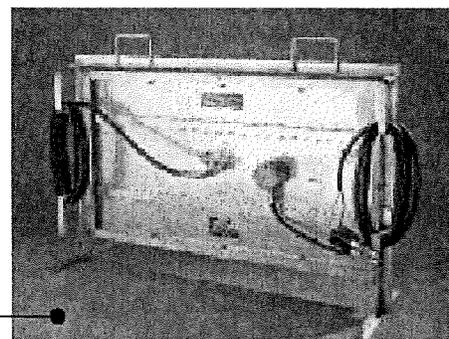
## PROTECTION GRILLS

Ciscan offers a range of protective grills designed to protect personnel from coming in direct contact with the face of the CATA-DYNE heater. A protection grill should be used when the heater is mounted along walkways or other areas where personnel may come in contact with the face of the heater.



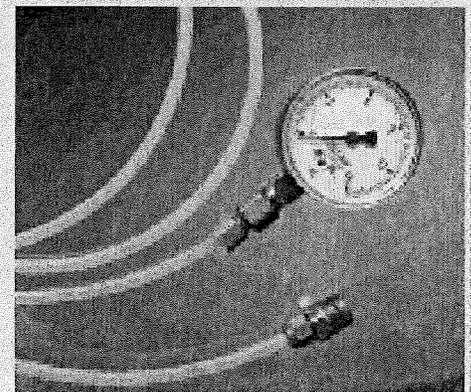
## PORTABLE HEATER STAND

Portable heater stands are available in sizes BX 12x24, BX 24x24, BX 24x36, and BX 24x48. Easily moveable, they feature durable steel angle frames and hooks for hoses and start-up cables. The heater swivels about the centre bolt to direct heat. Follow local codes and regulations.



## BATTERY CABLE CABINET

The Battery Cable Cabinet offers a convenient solution for storing battery start-up leads. Manufactured from heavy duty 20 gauge mild steel, it can be used with all lengths of battery cables from 25' - 40' (7.6 - 12.2 m). Not only will this durable cabinet help prevent leads from being stolen, the sturdy casing will protect them from adverse weather conditions, thereby increasing the life of your battery cables. The cabinet is finished with a durable high-gloss powder coat, and it is lockable and easy to install.



## GAS PRESSURE TEST KIT

This portable kit accurately tests and measures the gas pressure going into a CATA-DYNE heater. Ideal for all heater sizes, it eliminates pressure "guess work" when checking heater performance and also replaces the need to fit test ports on pipelines used for heater operation. The Gas Pressure Test Kit includes a 15" w.c. (3.7 kPa) pressure gauge, a 6' (1.8 m) PVC tube and the connection to the SSOV. It is compatible with both natural gas and propane heaters.

# FLO-DRI GAS SCRUBBERS

Fuel gas from natural gas wells may contain some form of contamination such as water, salt, H<sub>2</sub>S, aerosols, and/or particulates that can interfere with the operation of a CATA-DYNE heater, resulting in costly repairs and down time. Flo-Dri gas scrubbers have been designed to remove contaminants, thereby greatly reducing your operating costs. Use of a scrubber will help reduce wear and corrosion of the SSOV.

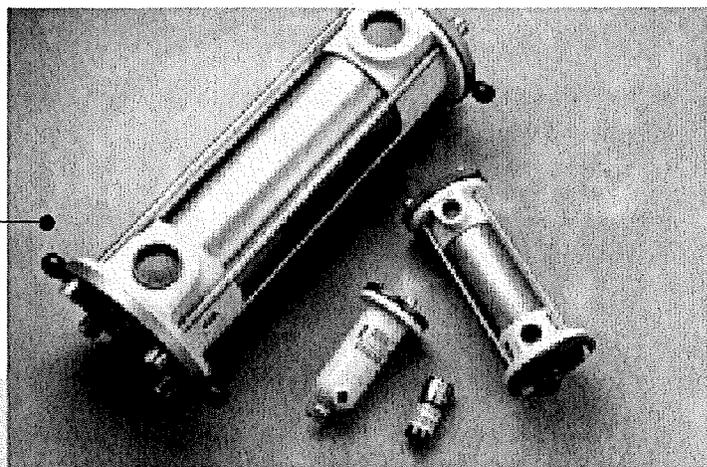
## Flo-Dri works in three stages:

**1 Impaction** - As the contaminated fuel gas enters the lower chamber of the Flo-Dri Scrubber, it expands and impacts on the surface of the diffuser assembly which causes the larger droplets to fall to the bottom.

**2 Absorption** - Fuel gas continues upward through the scrubber media where the contaminants are absorbed.

**3 Mechanical Entrapment (low micron rating to .5μ)** - In the final filtration stage, the gas leaves through a special filter which traps any remaining particles. The result is gas that is virtually free of any contaminants.

Flo-Dri has been designed with a patented "quick change" feature that offers the easiest replacement in the industry. Simply relieve pressure, twist and lift. The units can be serviced without removing them from the gas line.



All housings are mounted vertically and the flow is always upward. Plumbing can be accomplished on any model with a minimum of effort. Channeling is eliminated by Flo-Dri's exclusive spring loaded feature which compresses the cartridge within the housing.

## FLO-DRI FILTER SIZING CHART

Gas Flow in Cu. Ft. per hour	Heater Size	Recommended Filter
3.6	8x8	G10
6	12x12	G10
12	12x24	G10
18	18x24	G10
24	24x24	G25
30	24x30	G25
36	24x36	G25
48	24x48	G60
60	24x60	G60
72	24x72	G60
84	Combination of the above	G100
96	"	G100
108	"	G100
120	"	G100
132	"	G100
144	"	G100
156	"	G100
168	"	G150
336	"	2 - G150

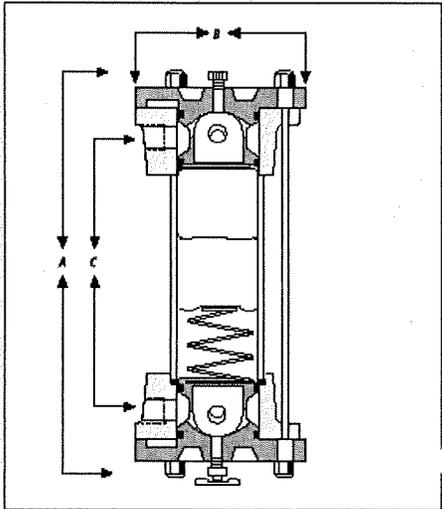
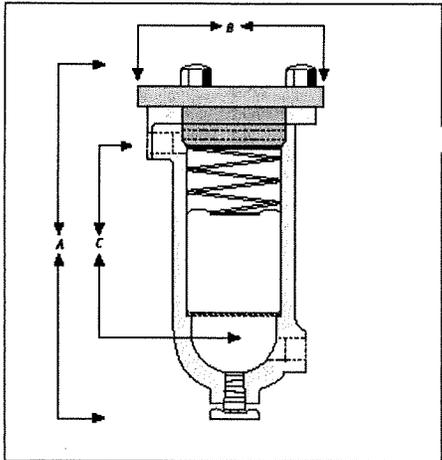
\*Note: The above recommendations are for moisture, contaminants and oil. For H<sub>2</sub>S, increase the filter size to next larger filter starting at the 12x24 heater size.

# Types of Cartridge Media

AA - Moisture                      MS - Contamination Removal  
 AC - Oil and Odour              XX - H<sub>2</sub>S Removal

## MEDIA SELECTION AND CHANGE OUT CHART

Media	Contaminant Removed	Change Out Recommendations
AA - Cartridge	Moisture only	2 months
MS - Cartridge	Moisture, other contaminants (No H <sub>2</sub> S)	3 months
XX - Cartridge	H <sub>2</sub> S, moisture, other contaminants	1 month (this cartridge requires frequent change outs)
R - Cartridge	Oil, water, heavy liquids (may be used in series with any of the above)	1 month or when used in series change with other cartridges as above



*\*Note: Good filtration will maintain the efficiency of the heater. For extremely contaminated gas streams, more frequent change outs may be required.*

## FLO-DRI CARTRIDGES

Model No.	Working PSIG	No. of Cartridges	Overall Length A	Overall Diameter B	Port to Port C	Pipe Size NPT	Replacement Cartridge No.	Bed Volume Cu. Inch
G-10A	150	1	7 1/3"	4"	5"	1/4"	1	12.56
G-25A	250	2	12 7/8"	5"	8 1/8"	3/4"	25	30.78
G-25A-5	250	5	21"	5"	16 1/4"	3/4"	25	74.02
G-60A	250	3	18"	6 1/4"	12"	1"	60-2	84.47
G100A	250	4	23 1/2"	7"	17 1/2"	1 1/2"	100-3	199.06
G-150A	250	2	25 1/4"	9 1/2"	9 1/2"	2"	150-4	376.52

*Ciscan will include a tag with every Flo-Dri Gas Scrubber that will help you keep track of information such as when you installed the cartridge and how long it lasted. Return the tag to Ciscan and we will monitor this information for you.*

*When ordering, please specify:*

*Model No.*

*Cartridge Replacement No.*

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### ***air-x-hemphill***

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(918) 712-8268 Fax (918) 712-8269  
airxhemphill.com

## INTRODUCTION

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

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

Naturally, prudent judgement should always be exercised when repairing, replacing or particularly modifying any original parts to make certain that they are equivalent to the original design. Most standard parts and components are maintained in factory stock at *air-x-hemphill* and are available on a 24 hour emergency basis if necessary.

## RECEIPT OF EQUIPMENT & SITING

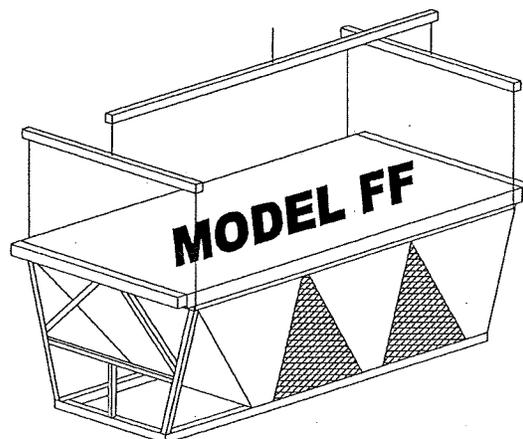
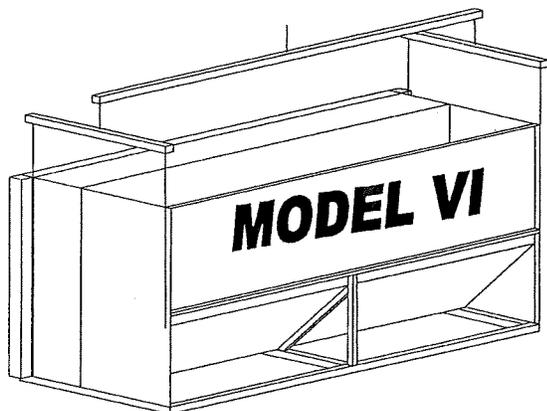
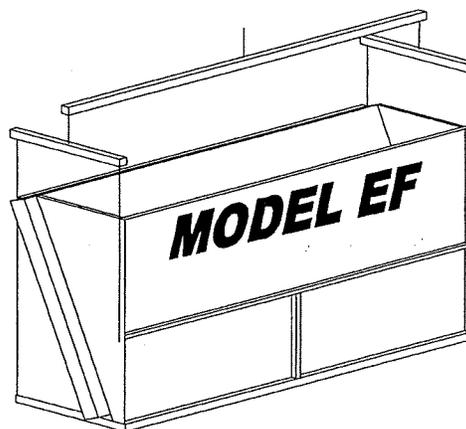
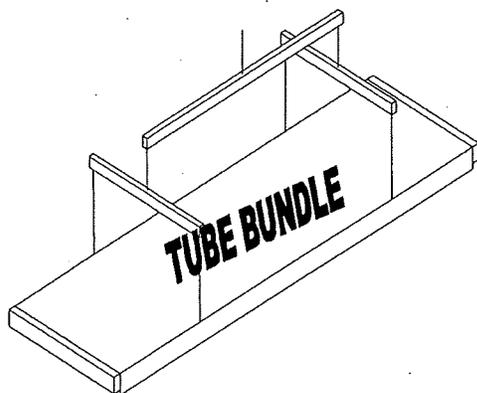
Upon arrival at site, the cooler should be inspected thoroughly by receiving personnel. Damage in transit could be the result of dropping or being struck by heavy objects or equipment. Observe the sub-skid, flanges, plenum side panels and coil sections for any apparent physical damage. Dents, bent flanges,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

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

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

## UNLOADING & HANDLING COOLERS

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



## PRIOR TO RUN-IN & START UP

### HYDROSTATIC TEST

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

### BEARINGS

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

### FANS

Check fan blade bolts and hub bushing set screws for tightness. Rotate fan by hand to insure that shaft, speed reducer, and driver turn freely. The fan blades should be checked for adequate tip clearance and blade pitch angle. To measure this, first move all blades past a fixed point on the inside of the fan ring and observe which blade has the least amount of clearance at that point. Then move the blade selected 360 degrees to the point of minimum clearance. Refer to the section on fans. If the fan is found not to be centered in the fan ring, slight adjustment of the tip clearance can be made by loosening the fan shaft bearing bolts and moving the complete fan and fan shaft assembly until it is centered in the fan ring. To check the fan blade angle, use a level bubble protractor (this can be obtained from *air-x-hemphill*). Loosen the nuts on the bolts and place the protractor on the angle setting mark or the clevis. Refer to fan manufactures information for proper location and *air-x-hemphill* parts list for design angle. Using a mallet, tap on the shank end of the blade to adjust the angle. Tighten fan blade bolts to the proper torque (refer to manufactures maintenance instructions) making sure to tighten evenly. Recheck blade angle. Occasionally coolers may be equipped with an auto-variable type fan. These fans have blade angles controlled by varying the air supply pressure. Air pressure should be applied to the fan before starting to check for proper operation. **Before starting, any electric motor should be "bumped" to check for proper direction of fan rotation and air flow.** This will also insure that the motor is in proper working order.

## **LOUVERS/SHUTTERS**

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

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

## **V-BELT DRIVES**

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

## **GEAR BOX**

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

## **VIBRATION SWITCH (OPTIONAL)**

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

## **PROCESS START-UP**

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

## **HEADER ACCESS PLUGS**

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

## WINTER OPERATION – FANS

It is highly recommended that during winter or cold weather operation, when the daily ambient high temperature is below approx 60°F, that the fan pitch be reset to one-half of the summer design pitch. This applies to constant speed applications, i.e. engine drive coolers. Note: The design fan pitch is shown on the Parts List, G/A Drawing and Specification Sheet. Specific instructions for adjusting the fan pitch are contained in the fan section of the IOM.

### Reducing air flow (fan pitch) during cold weather offers multiple benefits:

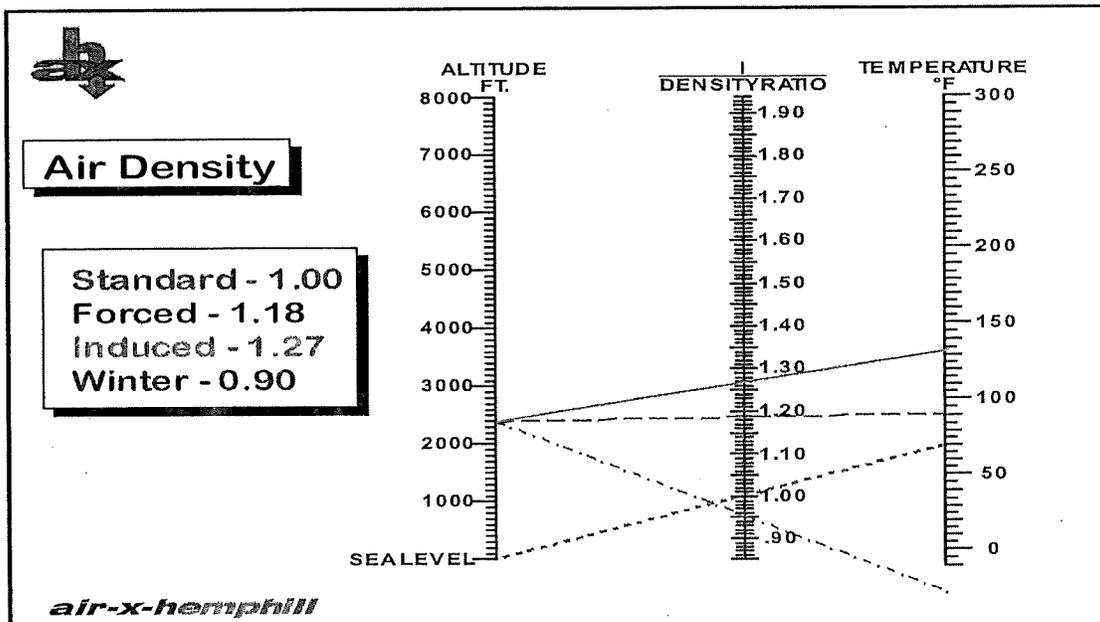
1. It significantly reduces the parasite fan hp and enables more hp to be used for compression.
2. It will result in much improved temperature control for process services and will reduce the chance for over cooling and potential hydrate formation (freeze up).
3. It will significantly reduce stress and blade load on the fan and prevent possible cavitation, overload and stall conditions from occurring when louvers are closed.

### The following fan laws apply:

Air Flow - Varies as a *Direct* ratio of fan speed.

Static Pressure - Varies as the *Square* of the change in air flow.

Fan Horsepower - Varies as the *Cube* of change in fan speed and varies *Directly* with air density.



## LONG TERM MAINTENANCE

### FIN CLEANING

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

### TUBE CLEANING

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

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

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

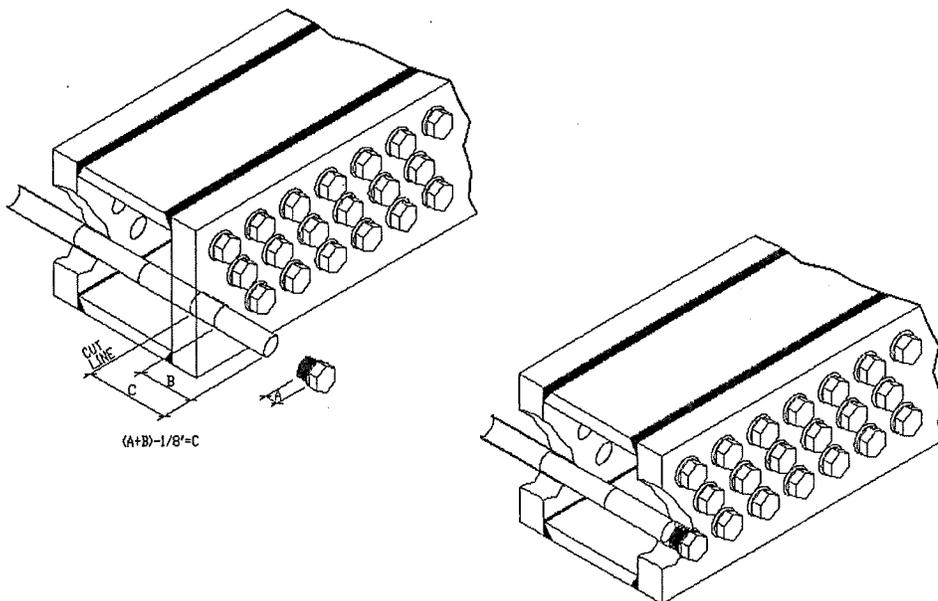
### LEAKING TUBES

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

## INSTRUCTIONS FOR USING TAPER PINS FOR SEALING TUBES

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

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



## INSPECTION

### TUBES

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

### FANS

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

### BEARINGS

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

### STRUCTURE

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

### HEADERS

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

## RECOMMENDED SPARE PARTS

We suggest that one each of the parts that are designated by an asterisk (\*) on the individual job parts list contained in the Table of Contents be carried in a stock of spare parts or be readily available. The down time caused by waiting for delivery of a spare part may cost far more in lost production or service than the cost of the item itself.

Spare parts orders should be specified in accordance with the parts list description and always include the *air-x-hemphill* model and Job number of the cooler.

## **WARRANTY**

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

## **LIMITATION OF LIABILITY**

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

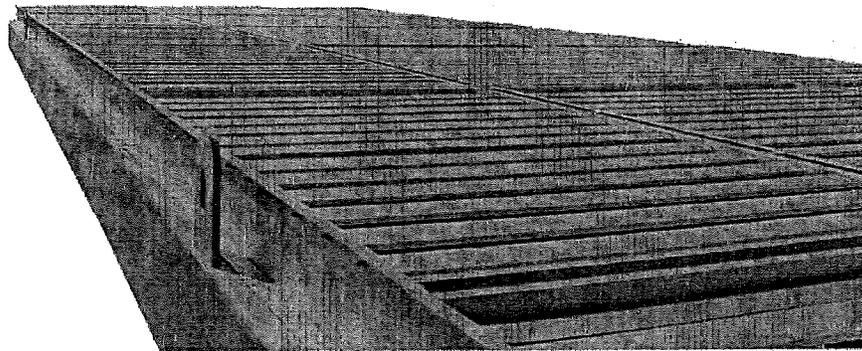
***air-x-hemphill***

2230 East 49<sup>th</sup> Street, Tulsa, Oklahoma 74105  
(918) 712-8268 Fax (918) 712-8269  
airxhemphill.com

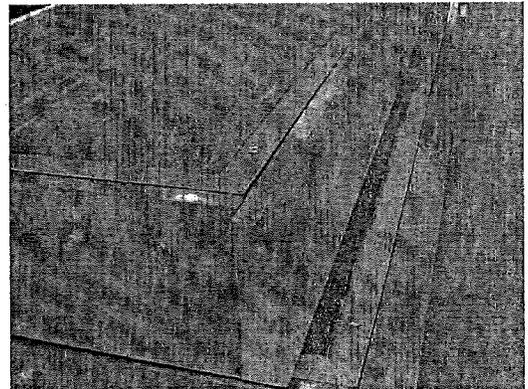


# Duraflow Industrial Louvers

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



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



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

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

## Technical Information / Standard Configurations

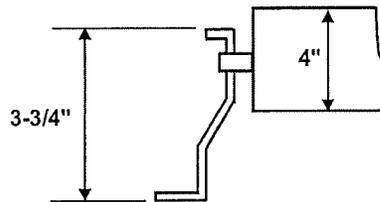
Aluminum Frame (extrusion):	6063-T5
Aluminum Frame (folded sheet):	3003-H14
Galvanized Steel Frame:	A653-G90 Carbon Steel (Mechanical Galvanized Finish)
Blades:	6063-T6 Aluminum
Blade Pins:	
Aluminum:	6061-T6 Aluminum
Stainless Steel:	303 Stainless Steel
Torque Tube:	6063-T6 Aluminum
Actuator Rod:	6063-T6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

### Assembly Hardware:

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

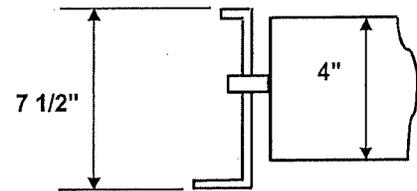
### Series 300

- 3 3/4" Frame
- 4" Blade



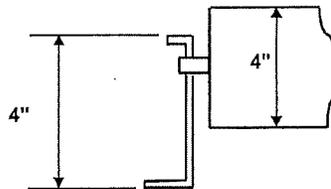
### Series 740

- 7 1/2" Frame
- 4" Blade



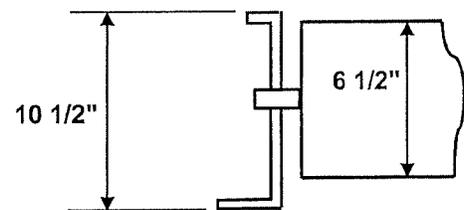
### Series 400

- 4" Frame
- 4" Blade



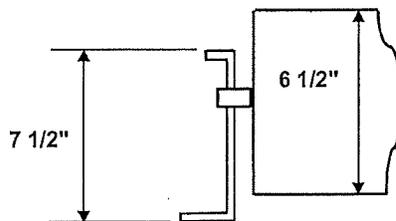
### Series 1000

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



### Series 700

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



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

# AIRTECH PRODUCTS, INC.

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

918-241-0264 (Phone)

918-241-0270 (Fax)

## Duraflow Industrial Louvers

### Installation and Maintenance Instructions

#### PRE-INSTALLATION ACTIVITIES:

1. With the louver crate resting firmly on either saw horses or a smooth and level area at grade, remove packing crate top and sides.
2. Make a visual inspection of the louver frame, blades and all linkages/drive mechanisms to ensure there was no shipping damage.
3. Various small parts needed to connect the drive linkages are shipped in a separate and smaller cardboard box. Keep this box at hand but out of the way and in a safe place.
4. Inspect the mounting surface of the cooler giving particular attention to ensure it provides uniform support of the louver perimeter and that it is structurally adequate to support all static and dynamic loadings.
  - a. If the louver is to be mounted in a horizontal configuration, it is **CRITICALLY IMPORTANT** to ensure the mounting surface is uniform and level to +/- .25" over 20'. Airtech louvers are manufactured to precise tolerances and bolting to an off-level surface will cause binding in the moving parts. This will result in inconsistent operation, shorten product life and can cause permanent damage that voids the manufacturers warranty.
  - b. If the louver is to be mounted in a vertical configuration, the installer must confirm there will be uniform support / attachment to the mounting surface at spacing not greater than 18" centers on the louver perimeter flange. Failure to do so may result in bending of the louver frame and inconsistent operation, a shortened product life and can cause damage that voids the manufacturers warranty.
5. Take a moment to visualize the installation and plan the placement of individual louver sub-assemblies. Although all louver installations involve essentially the same procedure, any given application will have some unique characteristics. Some projects will require louver sections to link together at the side via torque tube connectors while others may link together at the ends via end links on the actuator rod. Small projects may require neither type of connection while large projects will require both.
6. Open the cardboard box of small parts and confirm all the necessary pieces are at hand. Depending on the application, this could be torque tube couplings, actuator rod end links, grade level operator components, clevises, etc. Please note, unless the louvers are to be attached via angle clips, the actual attachment hardware won't be included in the louver shipment.
7. Most of the time, louver installation is easiest done using self-drilling speed screws, ¼" x 1¼" long, fine thread. Ensure a screw is in place on all corners and not greater than 18" centers around the louver perimeter. Simply drill through the louver flange into the host structure making sure the screw is completely pulled down tight. If retaining clips is your preferred method of attachment, please review to "Reference A" for instructions on use and installation.

## MOUNTING & ATTACHMENT

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

**MAINTENANCE INSTRUCTIONS (Annual)**

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

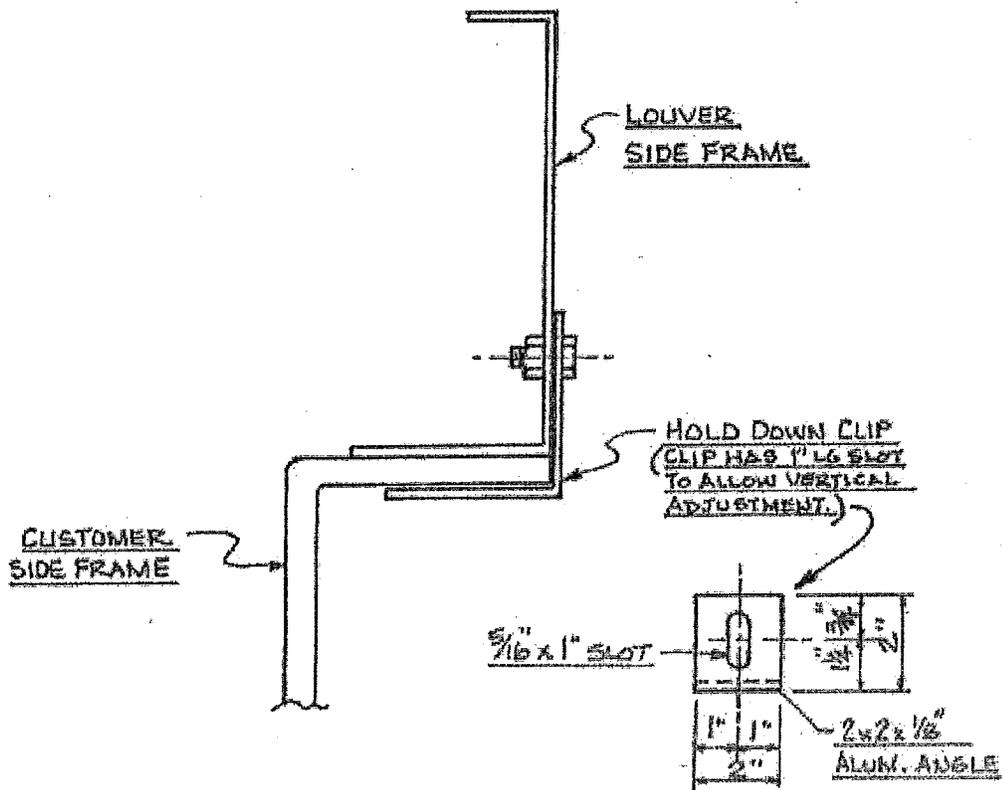
**RECOMMENDED SPARE PARTS LIST**

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

# AIRTECH Products Inc.

## Reference A

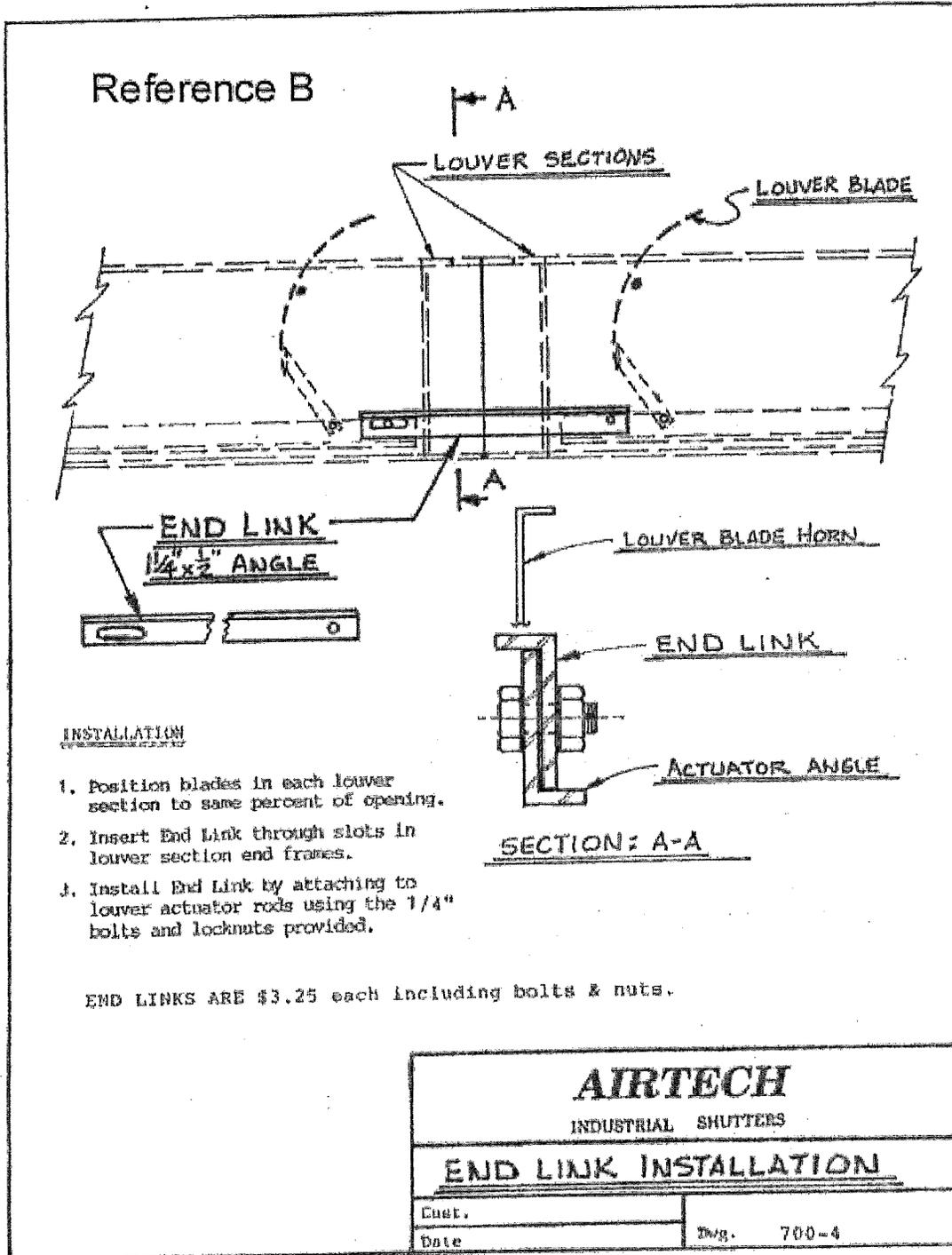
### MOUNTING CLIP DETAIL



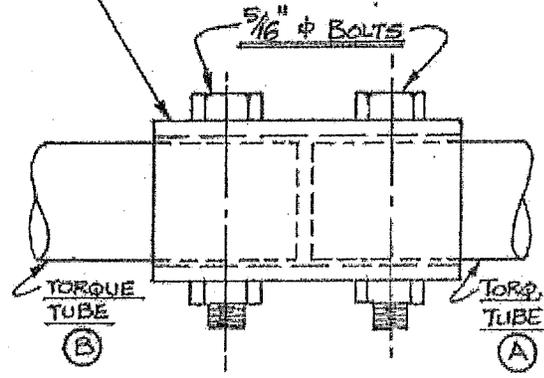
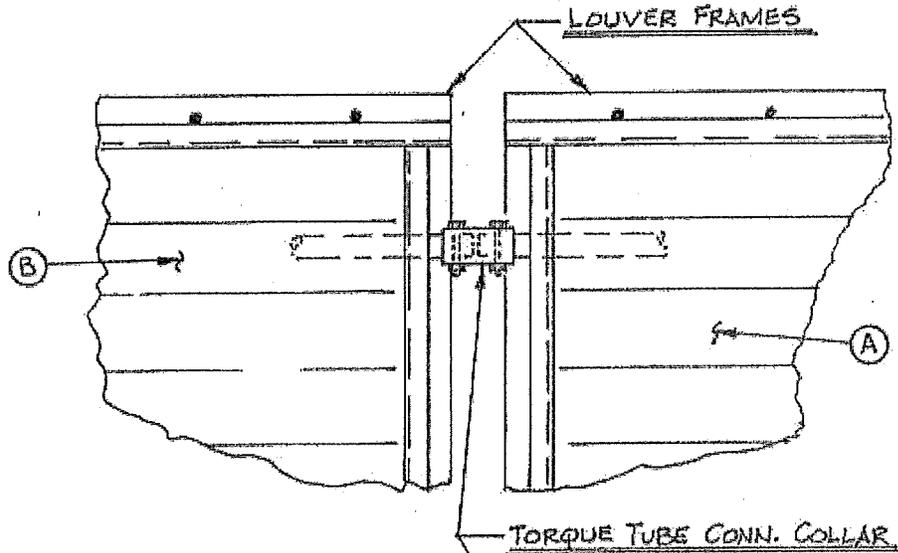
P.O. BOX 790

SAND SPRINGS, OK 74063

(918) 241-0264



### Reference C



#### INSTALLATION

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

**AIRTECH**

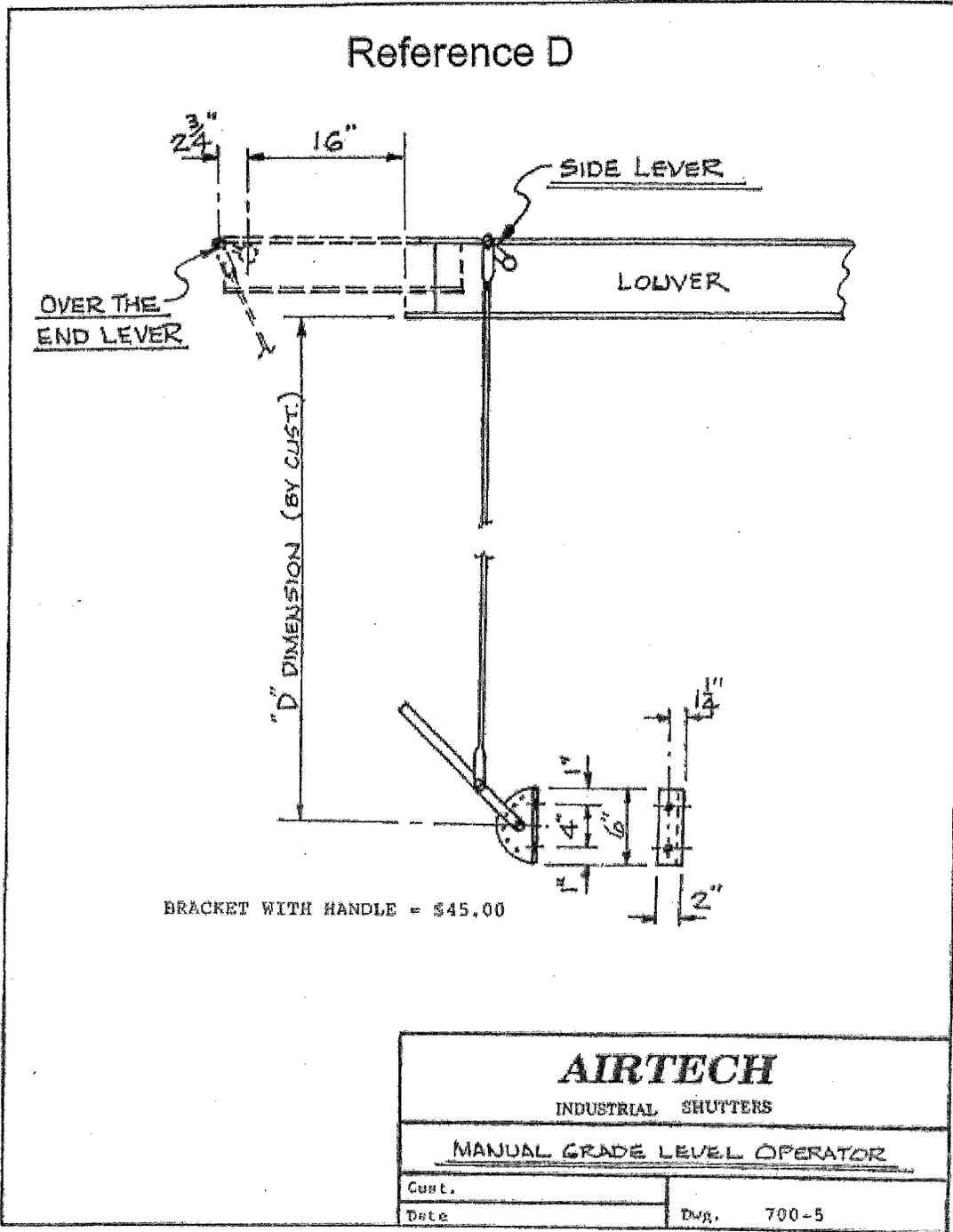
INDUSTRIAL SHUTTERS

Connecting Collar Installation

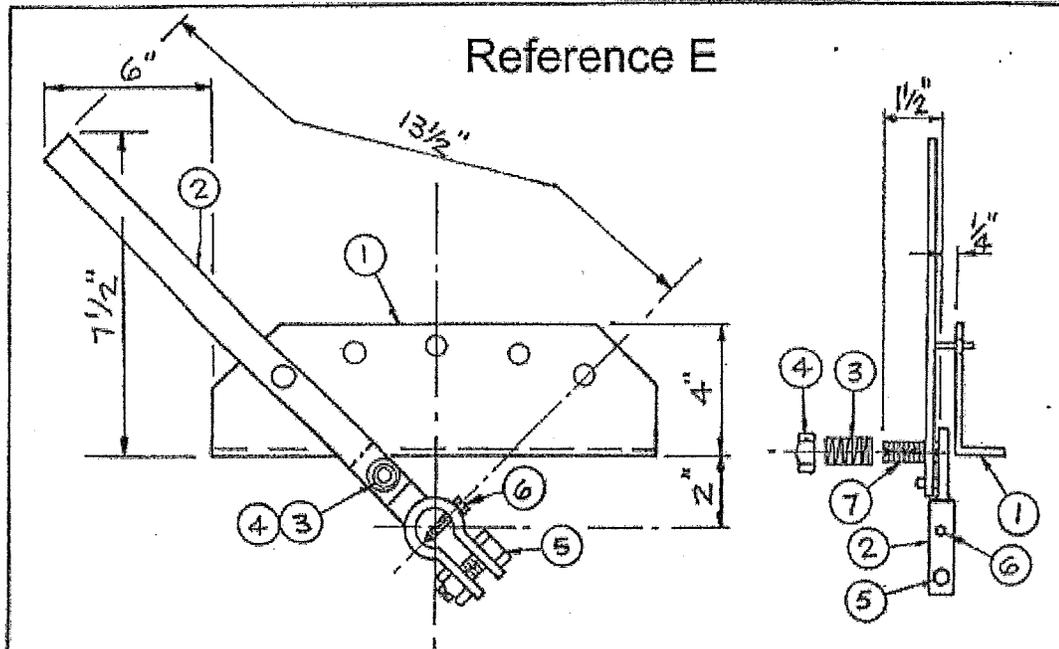
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Date

Dwg. 700-4



<b>AIRTECH</b>	
INDUSTRIAL SHUTTERS	
<u>MANUAL GRADE LEVEL OPERATOR</u>	
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Date	DWG. 700-5



Reference E

MANUAL OPERATOR DETAIL

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

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

## Reference F

# AIRTECH PRODUCTS, INC.

P.O. Box 790                      918-241-0264 (Phone)  
8101 West 16<sup>th</sup> Street        918-241-0270 (Fax)  
Sand Springs, OK 74063

## Louver Materials of Construction

Aluminum Frame (extrusion):	6063 T6
Aluminum Frame (folded sheet):	3003 H14
Galvanized Steel Frame:	A653-G90 10 Ga. Carbon Steel (Mechanical Galvanized Finish)
Blades:	6063-T6 Aluminum
Blade Pins:	
Aluminum:	6061-T6 Aluminum
Stainless Steel:	303 Stainless Steel
Torque Tube:	6063-T6 Aluminum
Actuator Rod:	6063-T6 Aluminum
Actuator Lever Arm:	6061-T6 Aluminum
Clevis:	1018 Carbon Steel
Clevis to Arm Connecting Link:	6061-T6 Aluminum
Assembly Hardware:	
Cap Screws:	ANSI/ASME 18.2.1 ¼-20, Grade 5, Zinc Plate
Nuts:	Nylon Insert lock nut, Performance Spec IFI/100, MIL/N/25027, Light Hex, Standard Height, Zinc Plate
Bearings:	Glass Filled Nylon, (Per API Specification 681)

*Airtech Products, Inc.*

*P.O. Box 790*

*8101 West 16th Street*

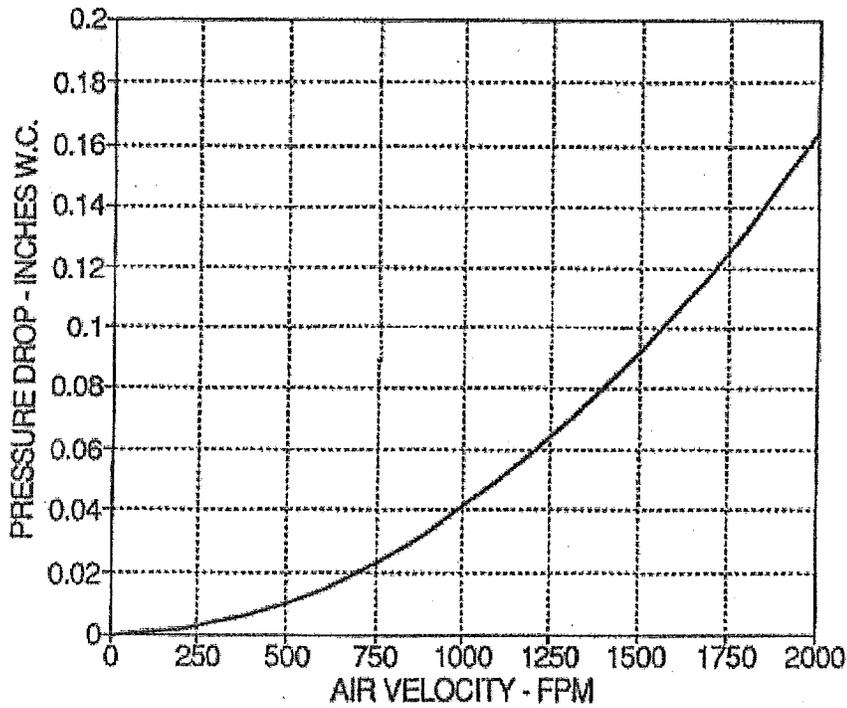
*Sand Springs, OK 74063*

Reference G

*918-241-0264 Phone*

*918-241-0270 Fax*

LOUVER PRESSURE DROP CURVE

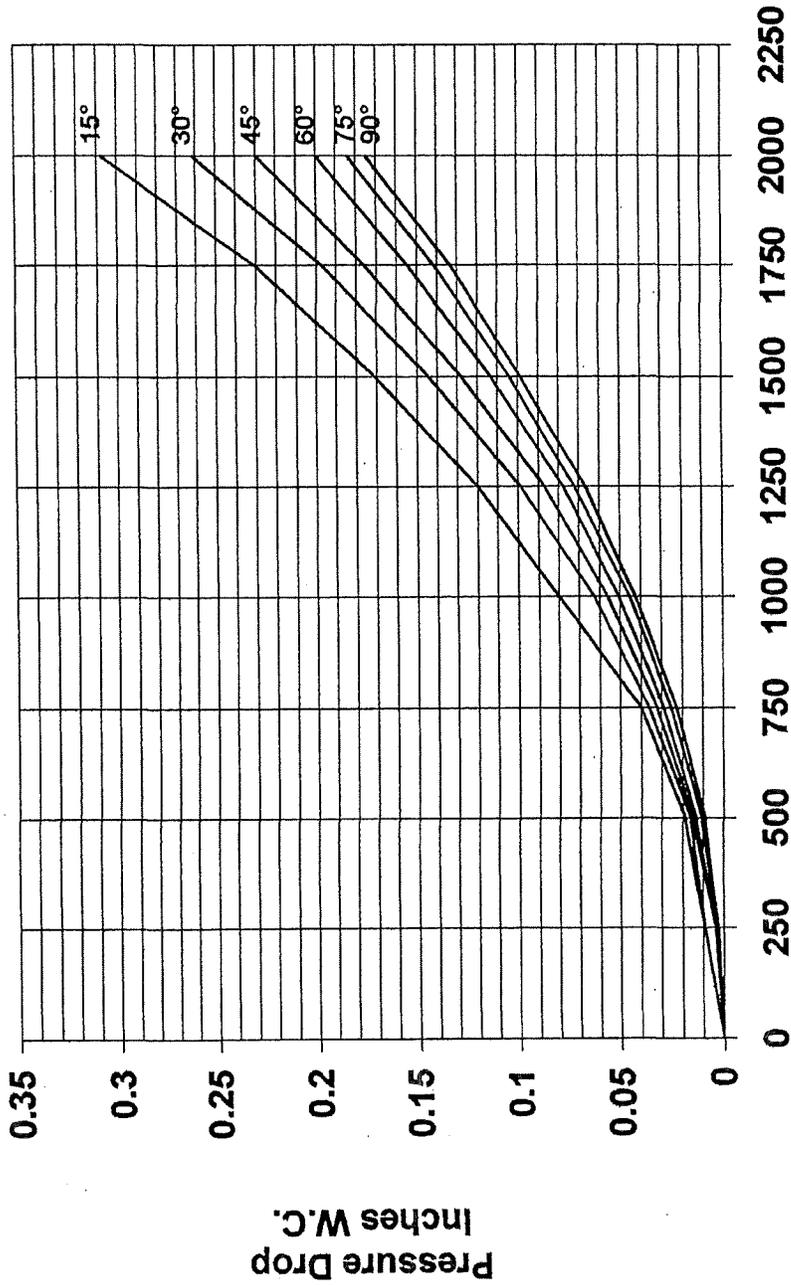


DENSITY RATIO = 1.0

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



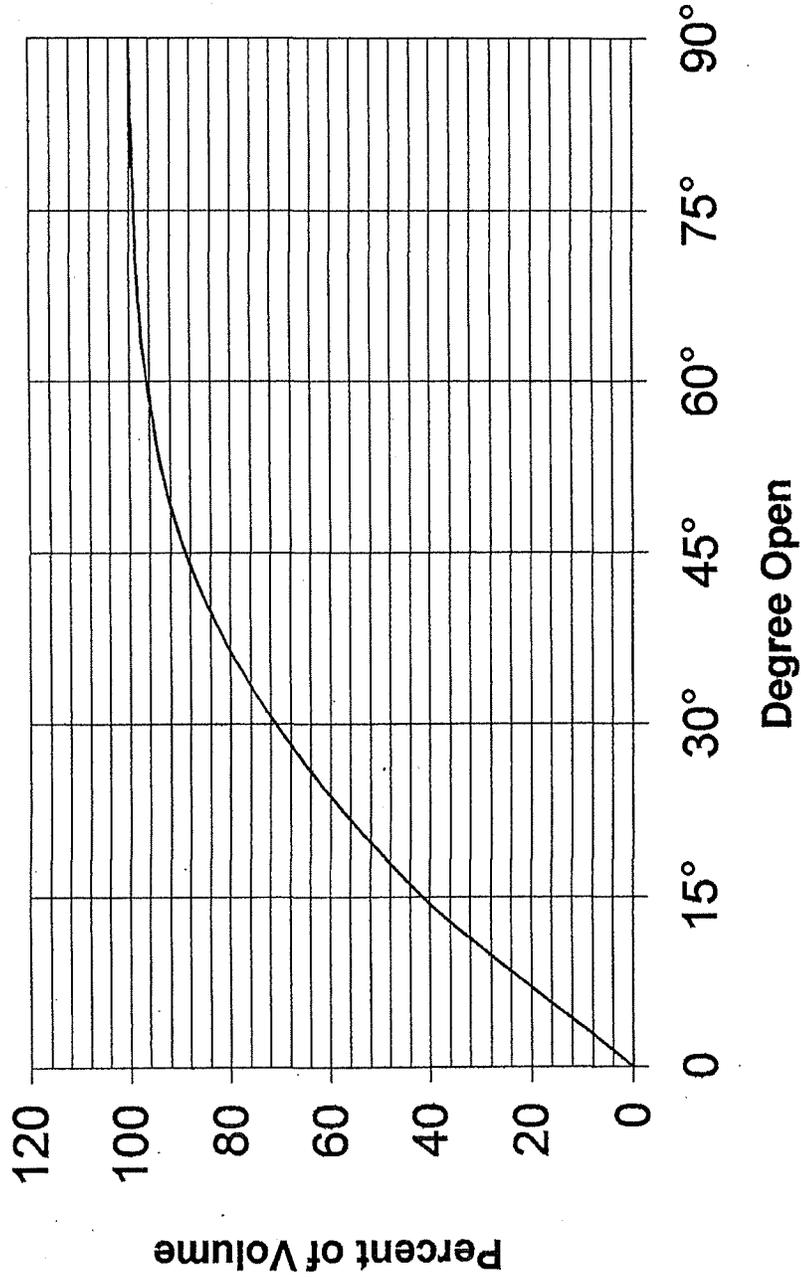
# Pressure Drop vs Degree of Opening



Air Velocity - FPM  
(DR = 1.0)



### Percent of Volume Per Degree Open





# CLASS 10000 FANS OWNER'S MANUAL

INSTALLATION

MAINTENANCE

OPERATION

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## INSTALLATION

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### ABOUT THIS MANUAL .....

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

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

### INSPECTION

All Moore units are carefully balanced, inspected and packed at the factory. If any damage is evident

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

### IDENTIFY YOUR FAN'S FEATURES

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

# 2.0 INSTALLATION

## 2.1 GETTING STARTED

### 2.1.1 FAN IDENTIFICATION

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

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

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

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

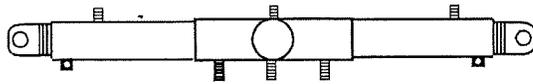
Moore keeps records indexed by serial and job numbers of all fans produced for at least forty years in order to provide proper maintenance advice and information on spare parts and replacements.

### 2.1.2 PLANNING THE INSTALLATION

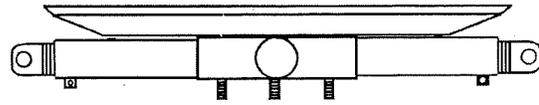
The sequence given for the installation may be changed if the conditions warrant. For example, the air seal may be installed on the hub before the hub is installed on the drive shaft. (In fact, for inverted fans, it is necessary to install the air seal first.) The installation should be planned before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

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

## 2.2A INSTALL HUB AND AIR SEAL



Hub Only Without Air Seal



Air Seal Installed on Hub

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

**To install the hub:**

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

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

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

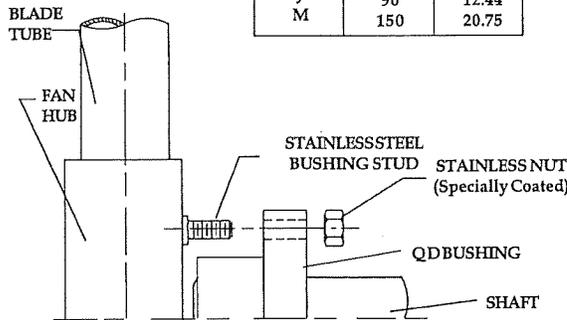
Do not clean or alter the lubricant coating on the hex nuts.

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

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

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

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



HUB INSTALLATION ON QD BUSHING

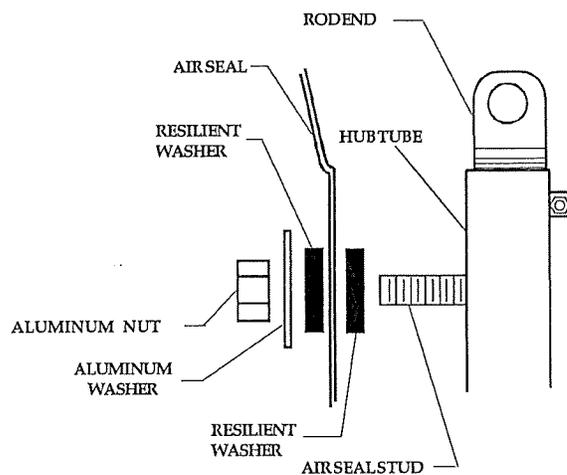
**To install the airseal:**

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

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

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

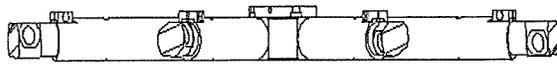
Note that the diameter of the resilient washers, before they are compressed, is slightly less than the diameter of the aluminum washer. Tighten each nut until the resilient washer's diameter is the same as the aluminum washer. Do not overtighten. Overtightness exists when the resilient washer has expanded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



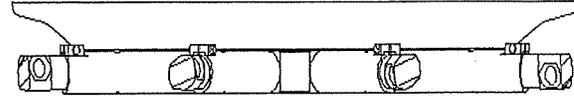
AIR SEAL INSTALLATION ON HUB

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

# 2.2B INSTALL HUB AND AIR SEAL



Hub Only Without Air Seal



Air Seal Installed on Hub

### Hub installation instructions

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

### Lubrication:

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

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

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

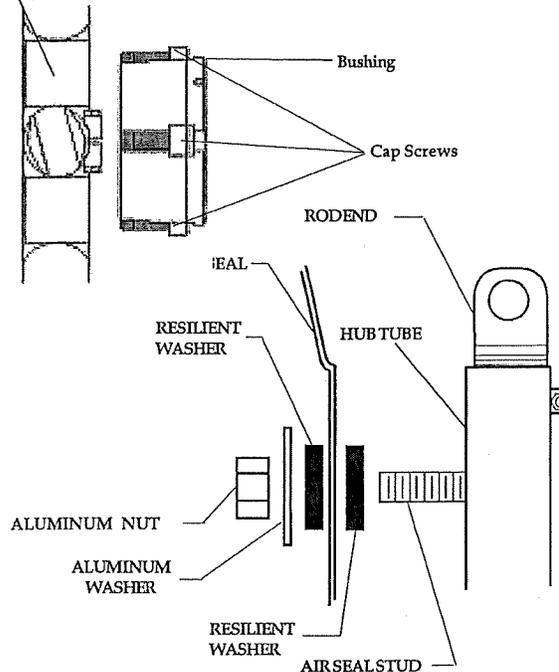
### Installation:

Install the bushing in the hub by aligning the threaded holes on the I.D. of the hub with the slots on the OD of the bushing with the cap screws captured between the bushing and the hub. Insert the bushing in the hub. Using a hex key wrench, sequentially tighten the socket head cap screws until the bushing is almost fully engaged in the hub. Leave slight play between the bushing and hub to facilitate installation on the shaft.

Place the hub/bushing on the shaft. (Preferably cap screw heads will be towards free end of shaft.) Insert the key, and tighten the setscrew to secure the hub and key to the shaft. Now begin sequentially tightening the socket head cap screws (approximately 2-3 turns per cap screw initially) to firmly engage the bushing in the hub and seat the bushing on the shaft. Once the bushing/hub is firmly seated on the shaft, continue tightening the cap screws sequentially until the specified torque, shown in the following table, is reached. DO NOT over-tighten cap screws as this could cause damage to the hub.

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

FAN HUB



AIR SEAL INSTALLATION ON HUB

### Caution:

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

### To install the airseal:

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

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

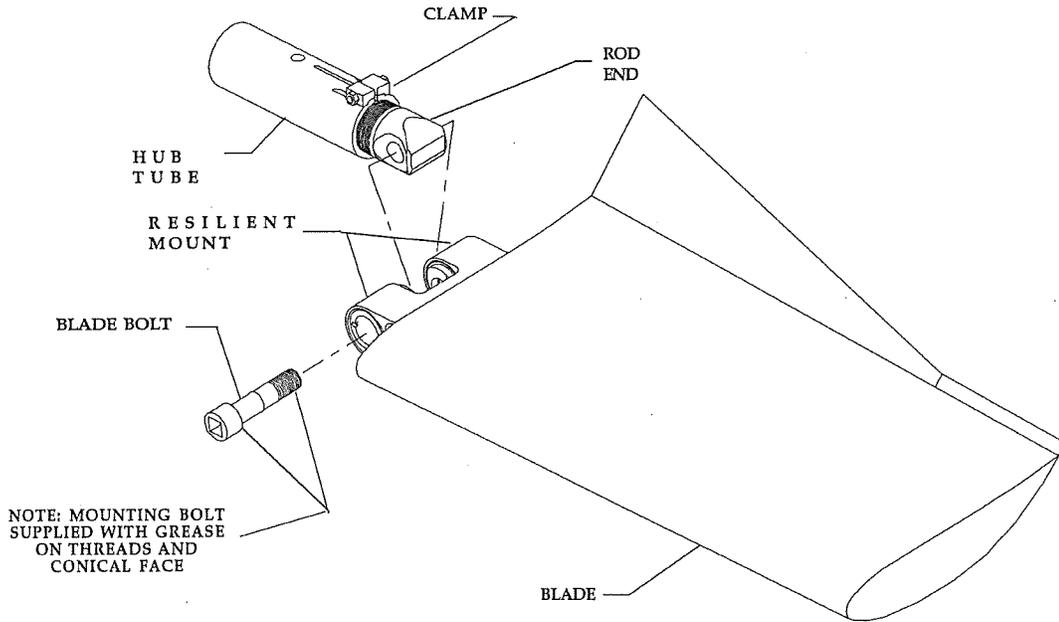
Place one resilient washer on each stud as shown in the drawings at left. Place the air seal onto the studs and install the remaining hardware, following the sequence shown in the drawings. Do not lubricate this end of the studs.

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

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

## 2.3 INSTALL AND ADJUST BLADES

### 2.3.1 INSTALL BLADES



#### BEFORE INSTALLING BLADES....

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

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

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

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

Install one blade: Clean any dirt or grease from the rod end and the surfaces of the resilient mounts. Align the rod end hole with the holes in the resilient mounts and insert the blade mounting bolt first through the resilient mount with the recess to accept the bolt head, then through the rod end hole and screw

the bolt into the second resilient mount lightly. A 3/4" drive torque wrench with a short extension may be used. The blade mounting bolt is supplied from the factory with grease on the threads and conical face. Do NOT clean the grease from the bolt.

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

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

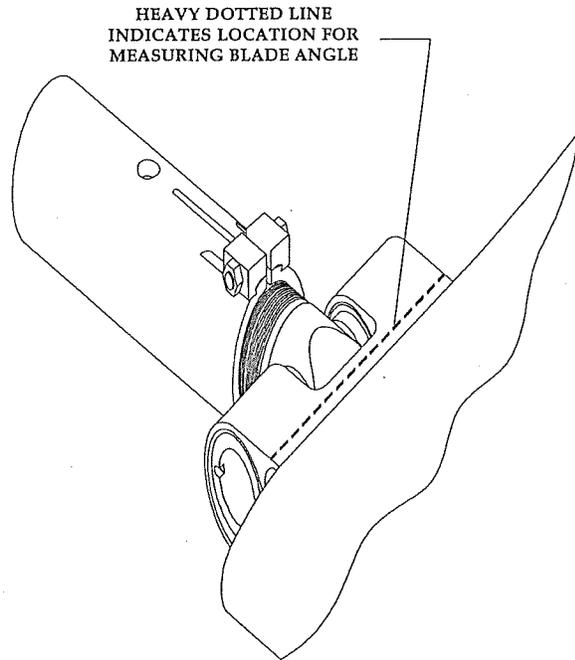
Install the rest of the blades so that they are identical with the first blade. Torque all bolts to 200 ft-lbs (28 m-kg). If blades are installed properly, they will return to their undisturbed position if the tips are pressed in the axial direction with moderate force (10 to 20 lb).

### 2.3.2 ADJUST BLADE ANGLE

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

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

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



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

### 2.3.3 ADJUST DIAMETER IF REQUIRED

At times it may be necessary to adjust the fan diameter to suit a particular ring. To do so, loosen the clamp nut so that the rod end can be rotated in the hub tube. One complete revolution will increase or decrease the radius of the fan by .059" (1.5 mm). Take care that the clevis is returned to exactly the factory-set angle unless it is intended that the blade loading be

changed as discussed in the previous section. A match mark may be made at a point on the threads and the tube before turning to assure that exactly one revolution is made. Tighten the clamp nut to 18 ft-lbs (3.36m-kg).

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

## 2.4 START-UP PROCEDURES

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

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

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

After the fan has been operating for several minutes,

stop the fan and observe the blades as the fan comes to rest. All of the blades should return to their original position at the same rate.

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

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

## 3.0 MAINTENANCE

### 3.1 PERIODIC INSPECTION

#### 3.1.1 PURPOSE

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

#### 3.1.2 FREQUENCY OF INSPECTION

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

#### 3.1.3 BLADE ANGLE AND RUNNING POSITION

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

#### 3.1.4 CRACKS, DENTS AND CORROSION

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

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

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

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

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

#### 3.1.5 HUB INSPECTION

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

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



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

## 3.2 ANNUAL INSPECTION

### 3.2.1 CLEAN BLADES IF INDICATED

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

### 3.2.2 CHECK SYSTEM PRESSURE

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

### 3.2.3 CLOSE INSPECTION

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

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

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

## 3.3 VIBRATION AND UNBALANCE

### 3.3.1 GENERAL

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

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

### 3.3.2 FAN UNBALANCE

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

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

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

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

It should be noted that the loads imposed on the drive shaft and its supporting bearings by fan unbalance

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

### 3.3.3 BELT DRIVE UNITS

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

### 3.3.4 ROUGH GEARS

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

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

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

## MAINTENANCE

### 3.3.5 THROAT FLUTTER

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

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

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

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

### 3.3.6 FIELD BALANCING

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

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

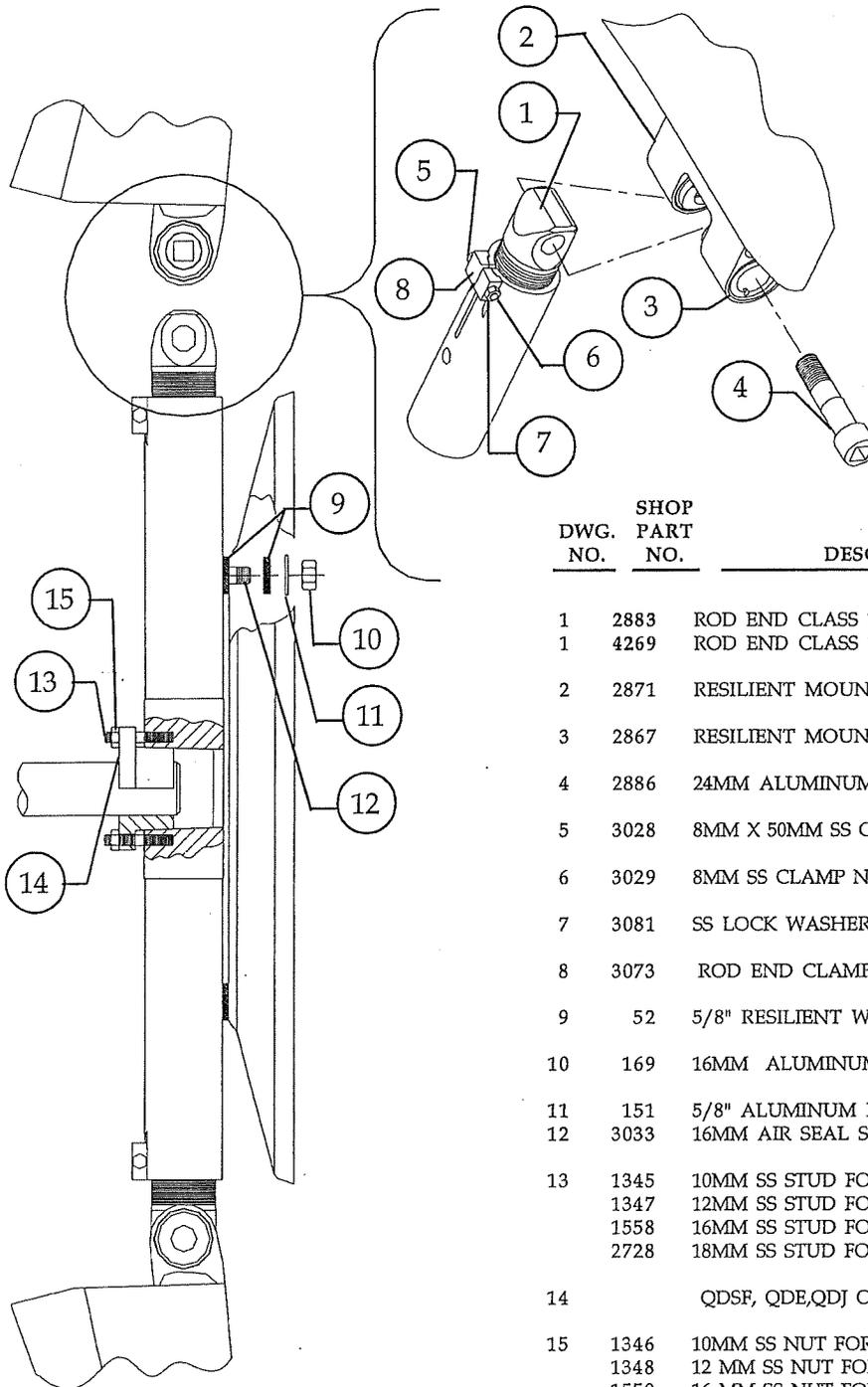
## 3.4 WARRANTY

MOORE FANS LLC (the Seller) warrants only to Buyer, as its purchaser for resale, that the fans manufactured and sold by Seller to Buyer under this Agreement will be free from all defects in material and workmanship under ordinary use for a period of two (2) years from the date of shipment or one (1) year from the date the fan is installed on a customer's premises, whichever occurs first. This warranty period shall apply only if Seller receives written notice of any defect within the warranty period. Upon receipt of such notice, Seller, at its option, may require Buyer to return the fan at Buyer's cost to Seller for inspection by Seller. If the fan is found to be defective on inspection by Seller, as a sole and exclusive remedy, Seller will, at its option, either repair or replace the fan. This warranty shall not apply to

damage on account of misuse, neglect or accident or shipping damage, or if repairs or part replacements have been made or attempted without Seller's prior written authorization. SELLER SHALL NOT BE LIABLE IN ANY EVENT FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR BREACH OF THIS OR ANY WARRANTY. THIS WARRANTY IS IN LIEU OF ALL OTHER GUARANTEES OR EXPRESSED WARRANTIES AND ALL IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR A PARTICULAR PURPOSE. DUE TO THE VARIETY OF CONDITIONS UNDER WHICH THE FANS MAY BE USED, RISKS OF RESULTS OBTAINED FROM USE OF THE FANS, WHETHER USED ALONE OR IN COMBINATION WITH OTHER PRODUCTS, IS ENTIRELY BUYER'S. THE ABOVE LIMITATIONS ON DAMAGE AND EXCLUSION OR LIMITATION OF IMPLIED WARRANTIES ARE NOT APPLICABLE TO THE EXTENT PROHIBITED BY STATE LAW.

# 3.5A PARTS LIST

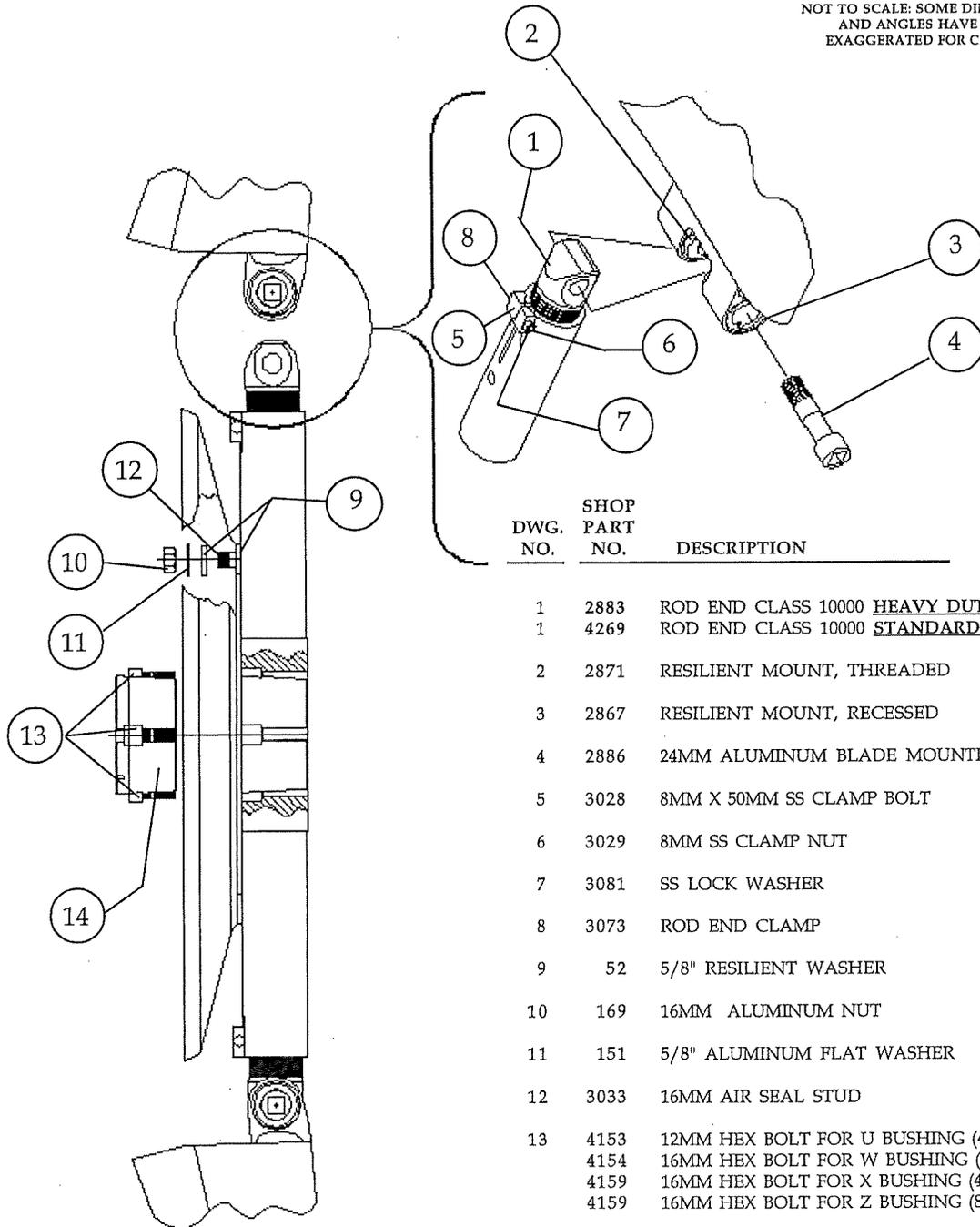
NOT TO SCALE: SOME DIMENSIONS  
AND ANGLES HAVE BEEN  
EXAGGERATED FOR CLARITY



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

# 3.5B PARTS LIST

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



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

## 4.0 OPERATION

### 4.1 AERODYNAMIC ABUSE

#### 4.1.1 ABOUT THIS SECTION . . .

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

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

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

#### 4.1.2 NORMAL OPERATING CONDITIONS

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

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

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

#### 4.1.3 ABNORMAL CONDITIONS

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

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

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

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

## 4.2 BLADE OVERLOAD

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

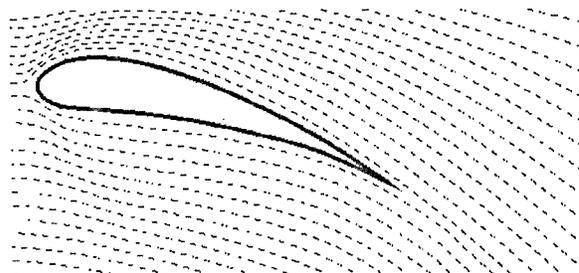
The Moore system of rating is based upon the pressure that each blade will produce at a given RPM with good efficiency. This pressure is called 100% blade load. When blade load exceeds 110%, the fan will not only operate at lower efficiency, it may be subject to structural damage as well.

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

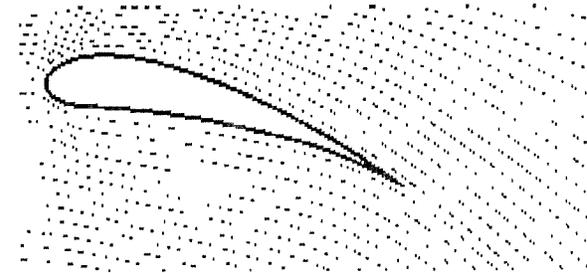
Why is a blade overload condition of such concern? We are all aware of the fact that an airplane traveling at a given speed can carry only a certain load. If the speed of the airplane is decreased or the load increased, stalling flow over the wing will occur. In the case of an airplane, approximately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

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

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



**AIRFLOW IN NORMAL FLOW**  
Downward flow provides lift to the wing



**AIRFLOW IN STALLING FLOW**  
Note lack of air deflection downward.

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

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

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

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

## 4.3 CAUSES OF IMPROPER BLADE LOADING

### 4.3.1 VARIATION FROM PREDICTED CONDITIONS

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

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

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

### 4.3.2 EXCESSIVE TIP CLEARANCE

Unless the fan ring is very close to the tip of the blade, air from the high pressure surface of the

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

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

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

### 4.3.3 POOR ENTRANCE CONDITIONS

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

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

### 4.3.4 EXCESSIVE DEFLECTION

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

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

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

the fan, even though it does not reach the full rated pressure.

#### 4.3.5 CONCLUSION

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

## 4.4 CHECKING BLADE LOAD

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

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

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

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

Start the fan and record on the chart provided the blade angle and the static pressure indicated. Advance the blade angle by one or two degrees and repeat the performance, recording again these read-

ings. Keep increasing the angle and following this procedure until the motor is fully loaded, in which case the fan is able to consume full rated fan horsepower without overload OR until the curve which will have started on a definite slope begins to approach the horizontal. It will be noted that the static pressure will be consistently increasing with increased blade angle until the blade loading reaches maximum, at which point it will level off.

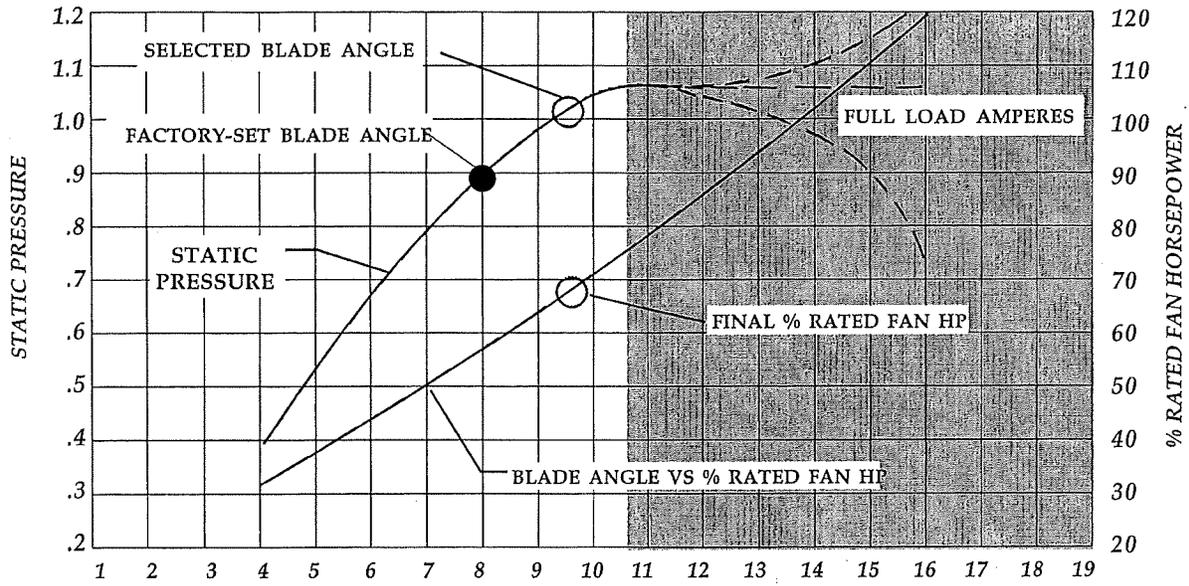
Subsequent increases in blade angle may have quite different effects, depending on the individual installation. The static pressure curve may merely stay level or may drop off sharply. In rare cases, it may level off and again start rising as the fan begins operating as a centrifugal blower.

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

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

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

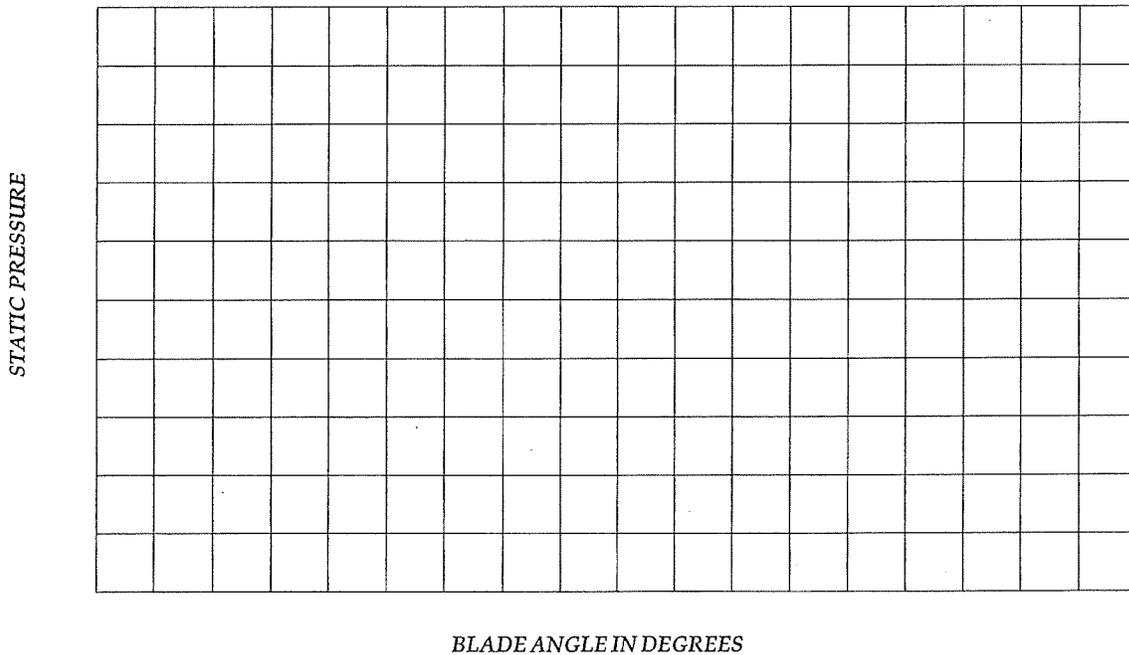
OPERATION



4.4.1 SAMPLE GRAPH of BLADE ANGLE IN DEGREES

Note in the chart above that static pressure (and air flow) has reached its maximum at an 11 degree blade setting and blade overload is beginning. With further increase in blade angle, anything may happen, as indicated by the dotted extensions into the shaded overload area. Note that the final selected blade

angle is 5% below the point where the static pressure curve has reached its maximum at an 11 degree blade setting and blade overload is beginning. The horsepower curve has been added to illustrate the point that in an overload condition, horsepower will increase without increased performance.



BLANK CHART FOR CUSTOMER USE

## 4.5 DAMAGING OPERATING CONDITIONS

### 4.5.1 GENERAL

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

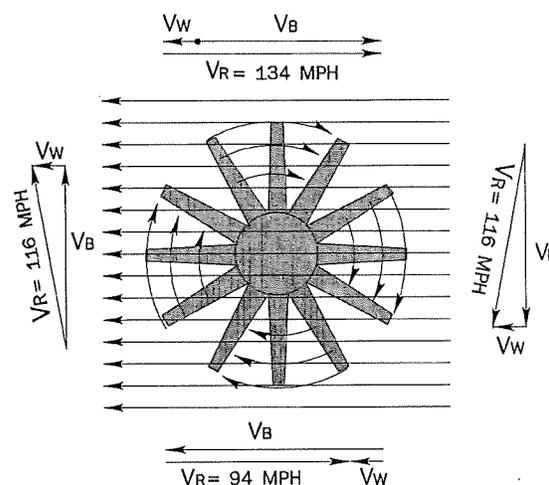
Ideally, air should approach a fan in an axial direction and at a uniform velocity over the area of the fan. Air approaching a fan at an angle tends to increase the relative velocity of the blades to the air on one side of the fan and decrease the relative velocity on the other side. This means that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

### 4.5.2 WIND

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

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

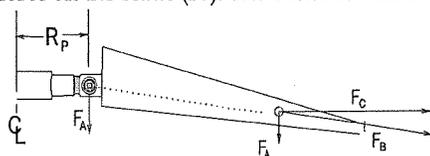
The illustration above assumes a fan operating with a tip speed ( $V_B$ ) of 10,000 feet per minute (114 miles per



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

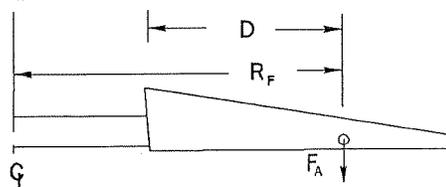
### THE EFFECT OF AIR LOAD ON HUB AND DRIVE

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



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

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



tions.

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

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

## OPERATION

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

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

### 4.5.3 OBSTRUCTIONS

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

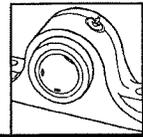
The total free area from which the fan can draw air should be twice the net area of the fan (fan area minus hub area). In other words, the air approaching the inlet of the fan should have no more than half the velocity of the air passing

through the fan. This area should be distributed reasonably uniformly. It would be unwise to attempt to operate a fan with one-half or one-third of the fan area completely blanked off. Such a condition would cause stalling of the fan blade through one-half the revolution but create a condition of overload in the half which was not blocked off. Excessive vibration would result. Any condition which forces the air to approach the fan in a non-axial direction should be avoided.

### 4.5.4 UNEVEN TIP CLEARANCE

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

# FEATURES/BENEFITS



## Type E/DOUBLE-INTERLOCK/Type K/TAF

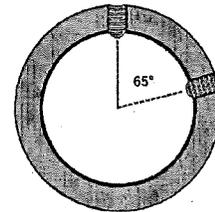
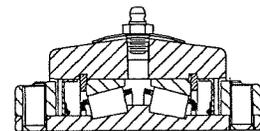
These four product lines have many common features and benefits that are shown on this page. Unique features for each product are shown on the following pages.

The common components used by all four lines include:

- Bearings
- Seals
- Locking collars
- Bore range

### General Features:

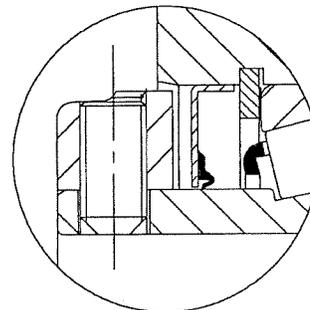
- Factory assembled, adjusted and pre-lubricated
- Case hardened rollers and races
- Easy installation and maintenance
- 65 degree set screw angle  
Springlok collar/flingers—  
More holding power than 90 or 120 degree
- Single rubber lip contacting seals



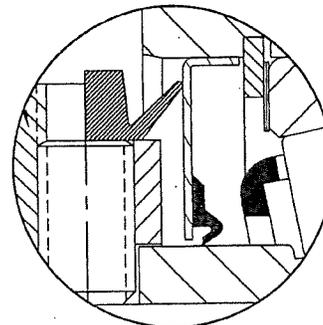
## EXCLUSIVE SEALING DESIGNS AND FEATURES

Rolling Elements Never Exposed to Contaminants

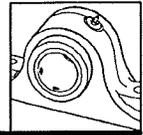
- Exclusive "R" Seal features a combination metal shield and positive land riding contacting lip seal. Keeps contaminants out, lubricants in.
- E-TECT Seal option gives extra protection with a combination face rubbing seal in addition to the "R" Seal System. (See page B5-58)
- TIMKEN™ tapered roller bearing inserts allow for combination radial and thrust loads.
- Lip design conforms to cones. Permits grease to purge.
- Close fit oversized collars act as flingers for added protection in dusty or damp environments.



Standard "R" Seal System



E-TECT Seal System



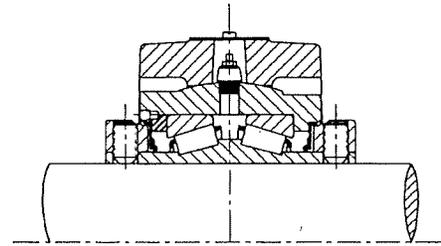
# FEATURES/BENEFITS

## TAF

### TAF Is A Cost Saving Alternative To SAF SPHERICAL BEARINGS

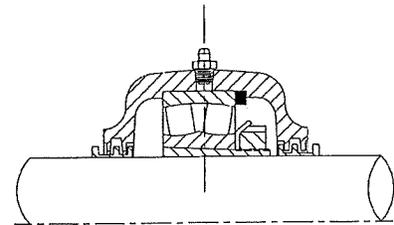
Mounts Fast, Stays Cleaner And Extends Service Life

- Shaft ready - mounts six times faster than SAF
- Interchangeable with SAF style pillow blocks
- Self-aligning, factory assembled, adjusted and lubricated
- Available in 1-7/16" up to 7" shaft diameters
- Equipped with expansion or non-expansion housing
- E-TECT seal option available up to 7"
- Optional Smart Housings accomodate speed, vibration and temperature sensor kits



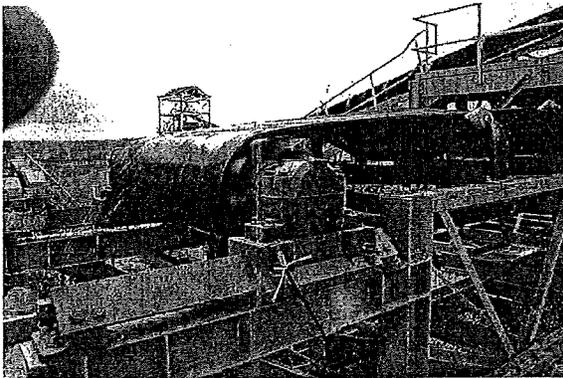
TAF

Self-alignment provided by spherically machined housing.

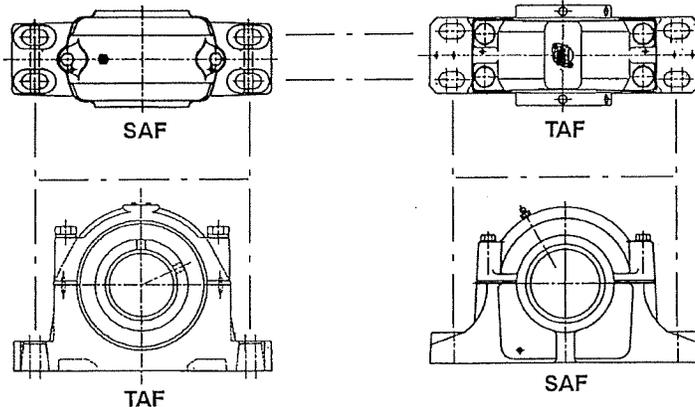


SAF

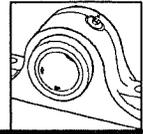
Self-alignment provided by insert, limited by seal interference.



TAF Is Interchangeable With SAF Mounting Dimensions



# FEATURES/BENEFITS



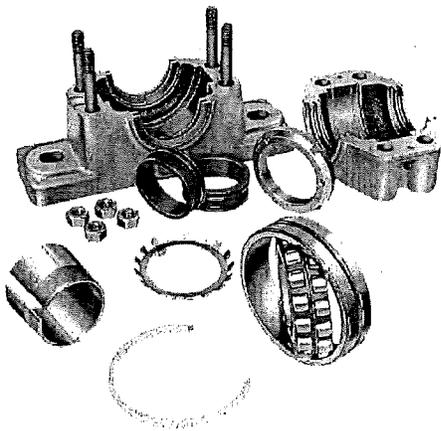
## Type K/DOUBLE-INTERLOCK/TAF

### DODGE BEARINGS SAVE YOU TIME AND MONEY

Compare These DODGE TAF, Type K & DOUBLE-INTERLOCK Bearing Advantages Against Standard SAF Pillow Blocks

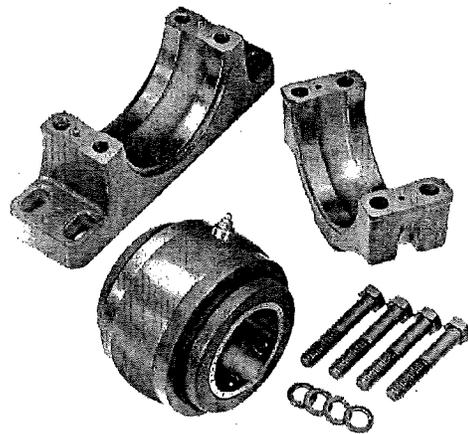
#### Standard SAF

- Four prices
- Up to six packages
- Open bearing
- Feeler gauge required
- Grease required



#### DODGE TAF, Type K and DOUBLE-INTERLOCK

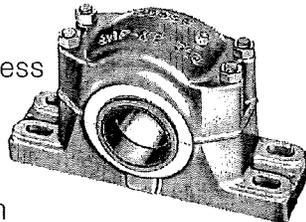
- One price
- Sealed bearing
- Factory adjusted
- Factory lubricated
- **Shaft ready**



### Compare Standard SAF and DODGE Sealing Designs

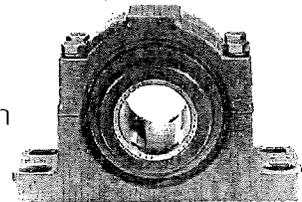
#### STANDARD SAF

- Seals ride independently of bearing
- Less than 1° static misalignment
- Sealing effectiveness decreases as misalignment increases
- Seals distort when misalignment occurs

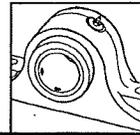


#### DODGE TAF, TYPE K, DOUBLE-INTERLOCK

- Inner unit carries seal
- Up to 5° static misalignment
- Seal and bearing ride together in inner unit
- Seals maintain contact on cones even with misalignment



# SPECIFICATION



## Type E, Type K, DOUBLE-INTERLOCK and TAF

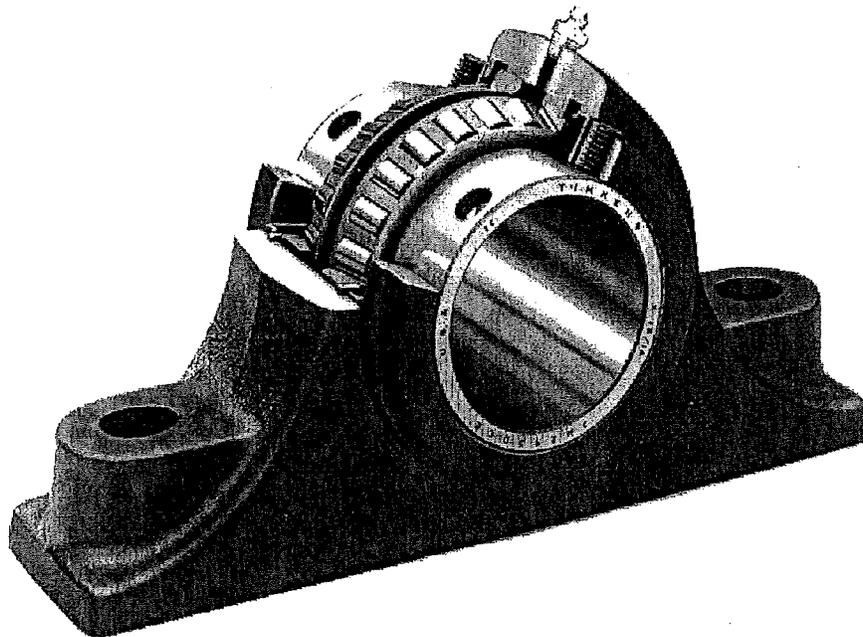
Type E, Type K, DOUBLE-INTERLOCK and TAF mounted bearings are all general purpose high capacity tapered roller bearings capable of handling any combination of radial and thrust load within the capacity of the bearing.

All of these bearings are mounted to the shaft by means of set screw collars having 65 degree set screw spacing for optimum clamping force. The Type E, DOUBLE-INTERLOCK, and TAF mounted bearings have a locking collar at each end of their extended inner races. Type K has a single locking collar. The tapered roller bearings for these mounted bearings all have case carburized inner races (cones), outer races (cups), and rollers.

Bearings are preassembled, prelubricated and factory adjusted. They are normally equipped with land riding contact type seals with a metal deflector guard.

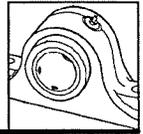
The standard housing material for most of these mounted bearings is ASTM A48 Class 30 Iron having a minimum tensile strength of 30,000 psi. The outer housing for the Type K and DOUBLE-INTERLOCK flange bearings thru 4" bore size utilize housings made of ductile iron (ASTM A536 Grade 65-45-12) with 65,000 psi tensile strength. Type E pillow blocks are also available with cast steel housing having a tensile strength of 70,000 psi for 2 bolt base thru 3-1/2" bore size and 4 bolt base from 3-15/16" thru 5" bore size on an assembled or order basis.

The Type K, DOUBLE-INTERLOCK pillow blocks and flange bearings plus the TAF pillow blocks all have split outer housings used with completely assembled, lubricated and adjusted inner units simplifying replacement of the bearing in the pillow block or flange bearing. All Type E mounted bearings, Type K take up units and all D units, S-1 units, and B-1 units have solid one piece housings.

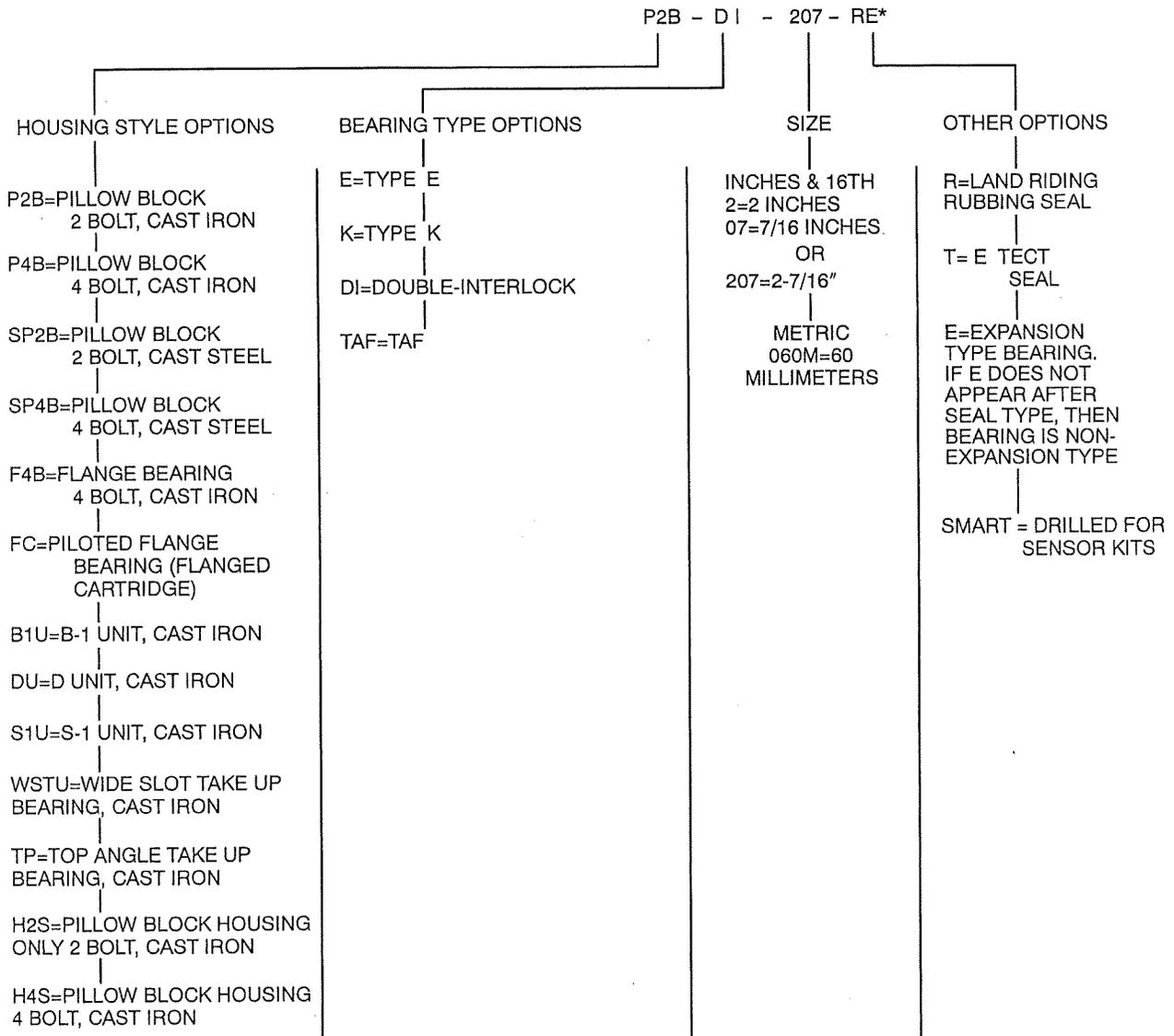


SELECTION/DIMENSIONS TYPE E PAGE B5-11/B5-22	SELECTION/DIMENSIONS TYPE K PAGE B5-11/B5-34	SELECTION/DIMENSIONS DOUBLE-INTERLOCK PAGE B5-11/B5-44	SELECTION/DIMENSIONS TAF PAGE B5-11/B5-52
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# NOMENCLATURE

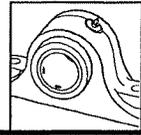


## Type E, Type K, DOUBLE-INTERLOCK and TAF NOMENCLATURE



SELECTION/DIMENSIONS TYPE E PAGE B5-11/B5-22	SELECTION/DIMENSIONS TYPE K PAGE B5-11/B5-34	SELECTION/DIMENSIONS DOUBLE-INTERLOCK PAGE B5-11/B5-44	SELECTION/DIMENSIONS TAF PAGE B5-11/B5-52
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# SELECTION



## Type E, Type K, DOUBLE-INTERLOCK And TAF Tapered Roller Bearings

DODGE Type E, K, DI and TAF Double Row Tapered Roller Bearings have the capacity to carry heavy radial loads and combined radial and thrust loads. The maximum recommended load which can be applied is limited by various components in the system such as bearing, housing, shaft, shaft attachment, speed and life requirements as listed in this catalog. DODGE tapered roller bearings have been applied successfully even when these limits have been exceeded under controlled operating conditions. Contact DODGE Application Engineering (864) 297-4800 for applications which exceed the recommendations of this catalog.

**L<sub>10</sub> Hours Life** --- The life which may be expected from at least 90% of a given group of bearings operating under identical conditions.

$$L_{10} = \left( \frac{C_{90}}{P} \right)^{10/3} \times \left( \frac{1,500,000}{\text{RPM}} \right)$$

Where: C<sub>90</sub> = Dynamic Capacity (Table 1, pg.B5-14), lbs.  
P = Equivalent Radial Load, lbs.

### GENERAL

**Heavy Service** --- For heavy shock loads, frequent shock loads, or severe vibrations, add up to 50% (according to severity of conditions) to the Equivalent Radial Load. Consult DODGE Application Engineering for additional selection assistance.

Thrust load values shown in the table below are recommended as a guide for general applications that will give adequate L<sub>10</sub> life for pillow blocks. The maximum thrust load should not exceed values shown on Table 3. Where substantial radial load is also present, it is advisable to calculate actual L<sub>10</sub> life to assure that it meets the requirements. The effectiveness of the shaft attachment to carry thrust load depends on proper tightening of the setscrews, shaft tolerance and shaft deflections. Therefore, it is advisable to use auxiliary thrust carrying devices such as shaft shoulder, snap ring

or a thrust collar to locate the bearing under thrust loads heavier than shown below, or where extreme reliability is desired.

RPM RANGE		20-200	201-2000	over 2000
RECOMMENDED	E, DI, TAF	C <sub>90</sub> /4	C <sub>90</sub> /8	C <sub>90</sub> /12
THRUST LOAD	K	C <sub>90</sub> /5	C <sub>90</sub> /8	C <sub>90</sub> /12

The shaft tolerances recommended below are adequate for normal radial and radial/thrust load applications. The radial load is limited by the attachment to the shaft (see Table 1). Where the applied radial load (F<sub>R</sub>) exceeds this limit (maximum allowable slip fit radial load), a snug-to-light press fit of the shaft is required. Since the allowable load, especially at a low speed, is very large, the shaft should be checked to assure adequate shaft strength.

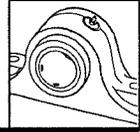
The magnitude and direction of both the thrust and radial load must be taken into account when selecting a housing. **When pillow blocks are utilized, heavy loads should be directed through the base. Where uplift loads are involved, see Tables 6, 7, and, pg.B5-19 for maximum values.** Where a load pulls the housing away from the mounting base, both the hold-down bolts and housing must be of adequate strength. Auxiliary load carrying devices such as shear bars are advisable for side or end loading of pillow blocks and radial load for flange units.

SHAFT SIZE	TOLERANCE, INCHES
UP TO 1-1/2"	+0.0000-.0005"
1-5/8 TO 4	+0.000 -.001"
4-7/8 TO 6	+0.000-.0015"
6-7/16-8"	+0.000-.002"

**NOTE:** The L<sub>10</sub> life calculated using the above formula is subject to life adjustment factors in accordance with ABMA standards described on page B14-45.

HOW TO ORDER PAGE B5-8	EASY SELECTION PAGE B5-15	ENGINEERING/TECHNICAL PAGE B5-17	SELECTION/DIMENSIONS TYPE E, METRIC PAGE B5-61/B5-68
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# SELECTION



## Type E, Type K, DOUBLE-INTERLOCK And TAF Tapered Roller Bearings

### SELECTING BEARINGS SUPPORTING RADIAL LOADS ONLY

1. Define  $L_{10}$  Life Hours desired.
2. Establish bearing radial load,  $F_R$   
( $F_R = P$  for Pure Radial Load Conditions).  
The DODGE program BEST™\* can be used to find application loads.
3. Establish RPM.

Using the easy selection Table 2, pg. B5-15 find, under the RPM column, the equivalent radial load that equals or is higher than the application radial load for the desired life. The shaft size on the far left will be the minimum shaft size that you can use for your application. If the desired life is different than the values shown on the chart, use alternate Method A shown below.

- Example: 1.  $L_{10}$  Life = 30,000 Hours  
2. Radial load = 3800 lbs.  
3. RPM = 1,000

At the intersection of the 1,000 RPM column and the 30,000 hours  $L_{10}$  life row, the equivalent radial load of 3910 lbs. exceeds the 3800 lbs. radial load for shaft sizes 2-11/16"-3". A bearing with bore ranging from 2-11/16" to 3" may be used for this application.

### ALTERNATE METHOD A --- SELECTING A BEARING FOR AN $L_{10}$ LIFE VALUE NOT SHOWN IN THE EASY SELECTION CHART.

The  $L_{10}$  life equation can be rearranged so that the bearing dynamic capacity  $C_{90}$  is identified in terms of  $L_{10}$ , RPM and P.

$$C_{90} = \left( \frac{L_{10} \times \text{RPM}}{1,500,000} \right)^{0.3} \times P$$

( $P = F_R$  for Pure Radial Load Conditions)

Since the  $L_{10}$ , RPM, and P are known, solve for  $C_{90}$ . Select from the dynamic capacity column on Table 1, pg. B5-14 the  $C_{90}$  value equal to or greater than the  $C_{90}$  value just calculated. The bore size on the far left represents the bore size selection. Check that the application RPM does not exceed the MAX. RPM on Table 1. Also check that the radial load does not exceed the Maximum Allowable Slip Fit Radial Load shown on Table 1. If it does, a line to line to light press fit of shaft is required. When selecting an  $L_{10}$  life of less than 30,000 hours, particular attention must be paid to shaft deflection and proper lubricant selection.

### SELECTING BEARINGS SUPPORTING COMBINATION RADIAL AND THRUST LOADS

When a bearing supports both a radial load and a thrust load, the loading on the two rows is shared unequally depending on the ratio of thrust to radial load. The use of the X (radial factor) and Y (thrust factor) from Table 1 converts the applied thrust load and radial loads to an equivalent radial load having the same effect on the life of the bearing as a radial load of this magnitude.

The equivalent radial load  $P = XF_R + YF_A$

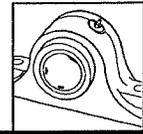
Where:  $P$  = Equivalent radial load, lbs.  
 $F_R$  = Radial load, lbs. (see Table 1 for allowable slip fit maximum)  
 $F_A$  = Thrust (axial) load, lbs.  
 $e$  = Thrust load to radial load factor (Table 1)  
 $X$  = Radial load factor (Table 1)  
 $Y$  = Thrust load factor (Table 1)

To find X and Y, calculate  $F_A/F_R$  and compare to  $e$  for the selected bore size. Determine X and Y from Table 1, pg. B5-14 depending on whether  $F_A/F_R$  is equal to or less than  $e$ , or  $F_A/F_R$  is greater than  $e$ . Substitute all known values into the equivalent radial load equation. P (equivalent radial load) can be used in the life formula to determine  $L_{10}$ , or it can be compared to the allowable equivalent radial load ratings for the speed and hours life desired in the easy selection Table 2, pg. B5-15.

\*The DODGE Bearing Evaluation and Selection Technique (BEST) is a menu driven computer program that calculates bearing loads, fatigue life and operating temperature for a two bearing shaft system based on user supplied input parameters. To order, call (864) 287-4800.

SELECTION/DIMENSIONS TYPE E PAGE B5-11/B5-22	SELECTION/DIMENSIONS TYPE K PAGE B5-11/B5-34	SELECTION/DIMENSIONS DOUBLE-INTERLOCK PAGE B5-11/B5-44	SELECTION/DIMENSIONS TAF PAGE B5-11/B5-52
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# SELECTION



## Type E, Type K, DOUBLE-INTERLOCK and TAF

### SELECTING BEARINGS SUPPORTING ONLY THRUST LOADS

Tapered Roller Bearings perform extremely well under pure thrust load applications. Use  $P = YF_A$  for the equivalent radial load. The value of Y is obtained from Table 1, pg. B5-14 for  $F_A/F_R > e$ . Substitute Y and  $F_A$  into the equivalent load equation. P (equivalent radial load) can be used in the life formula to determine  $L_{10}$  or it can be compared to the allowable equivalent radial load ratings for the speed and hours life desired in the easy selection Table 2, pg. B5-15.

### LUBRICATION

DODGE E, K, DI, and TAF tapered roller bearings up to 5" bore are lubricated at the factory with Shell Alvania #2 grease. Above 5" bore they are lubricated with Mobil Mobilux #2EP.

Shell Alvania #2 and Mobil Mobilux #2EP greases are superior industrial greases using a lithium hydroxystearate thickener and highly refined base oil. These greases will adequately handle low and medium speeds with low and medium loads at normal temperatures as defined on Table 5, pg. B5-18. For very low and high speeds, for heavy loads and for low and high temperatures, special greases must be used. Contact DODGE Application Engineering (864) 297-4800. DODGE engineers will recommend bearings and lubricants for the above unusual conditions. DODGE also has the expertise to custom design and build special bearings for your needs. The only maintenance requirement for DODGE Tapered Roller Bearings is periodic relubrication at regular intervals as outlined in the appropriate instruction manuals.

### RELUBRICATION SCHEDULE

Hours Run per Day	SUGGESTED LUBRICATION PERIOD IN WEEKS							
	1 to 250 RPM	251 to 500 RPM	501 to 750 RPM	751 to 1000 RPM	1001 to 1500 RPM	1501 to 2000 RPM	2001 to 2500 RPM	2501 to 3000 RPM
8	12	12	10	7	5	4	3	2
16	12	7	5	4	2	2	2	1
24	10	5	3	2	1	1	1	1

**High Speed Operation** --- In the higher speed ranges too much grease will cause overheating. The amount of grease that the bearing will take for particular high speed application can only be determined by experience --- see "Operating Temperature" below. If excess grease in the bearing caused overheating, it will be necessary to remove grease fitting (also drain plug when furnished) to permit excess grease to escape. When establishing a relubrication schedule, note that a small amount of grease at frequent intervals is preferable to a large amount at infrequent intervals.

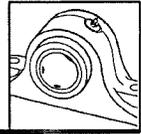
**Operation in Presence of Dust, Water or Corrosive Vapors** --- Under these conditions the bearing should contain as much grease as speed will permit, since a full bearing with consequent slight leakage is the best protection against entrance of foreign material. In the higher speed ranges too much grease will cause overheating --- see "High Speed Operation". In the lower speed ranges, it is advisable to add extra grease to a new bearing before putting into operation. Bearings should be greased as often as necessary (daily if required) to maintain a slight leakage at the seals.

### INSTALLATION AND MAINTENANCE

In nearly all applications good design practice requires two bearings supporting the shaft. In cases where three or more bearings are installed, unless precautions are taken to line the bearings up, both vertically and horizontally, it is possible to induce heavy loads. In the case of two bearings, alignment is not as critical, especially with DODGE K, DI, and TAF Tapered Roller Bearings. K, DI, and TAF bearings are designed to allow as much as 2° to 7° of static misalignment depending on bore size. To ensure good alignment, mounting surfaces must be checked for flatness and must lie in the same plane. When tightening base bolts and cap bolts, each bolt should be alternately tightened in incremental torque values until full torque is achieved to prevent the angular shifting of the pillow block that occurs when one bolt is tightened to its full torque. Shimming may be required to minimize misalignment.

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# SELECTION



## Type E, Type K, DOUBLE-INTERLOCK and TAF

TABLE 1 - E, K, DI, AND TAF TAPERED ROLLER BEARINGS RADIAL AND THRUST FACTORS

SHAFT SIZE	e	F <sub>A</sub> /F <sub>R</sub> ≤e		F <sub>A</sub> /F <sub>R</sub> >e		DYNAMIC CAPACITY C <sub>90</sub> *		MAXIMUM RPM	MAXIMUM RPM	MAXIMUM ALLOWABLE SLIP FIT RADIAL LOAD, F <sub>R</sub> ** , LBS	
		X	Y	X	Y	LBS.	NEWTONS	R-SEAL	E-TECT	E,DI,&TAF	K
1-3/16 1-1/4	.49	.87	1.77	.70	2.14	2,980	13,260	4,490	3,100	3,100	2,100
1-3/8 1-7/16	.46	.87	1.89	.70	2.28	4,760	21,180	3,820	2,675	5,000	3,300
1-1/2 1 5/8 1-11/16	.44	.87	1.96	.70	2.37	6,140	27,320	3,320	2,325	6,400	4,300
1-3/4 1-7/8 1-15/16 2	.33	.87	2.64	.70	3.18	8,070	35,908	3,050	2,135	8,400	5,600
2-3/16	.36	.87	2.38	.70	2.87	8,550	38,044	2,730	1,900	8,900	5,900
2-1/4 2-7/16 2-1/2	.40	.87	2.17	.70	2.63	9,090	40,447	2,420	1,700	9,500	6,300
2-11/16 2-3/4 2-15/16 3	.46	.87	1.87	.70	2.26	9,600	42,716	2,060	1,440	10,000	6,700
3-3/16 3-1/4 3-7/16 3-1/2	.50	.87	1.71	.70	2.07	15,300	68,078	1,640	1,145	16,000	10,500
3-15/16 4	.49	.87	1.77	.70	2.14	21,000	93,440	1,530	1,070	22,000	14,600
4-7/16 4-1/2	.53	.87	1.63	.70	1.97	25,800	114,799	1,360	950	27,000	----
4-15/16 5	.47	.87	1.83	.70	2.21	35,500	157,959	1,200	840	35,000	----
5-7/16 5-15/16 6	.49	.87	1.76	.70	2.12	40,700	181,097	915	640	42,400	----
6-7/16 6-1/2 6-15/16 7	.54	.87	1.61	.70	1.95	69,200	307,910	790	550	72,000	----

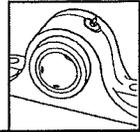
**Comparing Spherical To Taper Roller Bearings:** The dynamic capacity C (spherical) and C90 (taper) are not to the same base. To compare basic dynamic capacities, multiply C x .259 and compare to C90.

\* C<sub>90</sub> - Dynamic capacity based on a rated life of 90 million revolutions or 3000 hours at 500 RPM.

\*\* If load exceeds maximum allowable slip fit radial load, (F<sub>R</sub>), line-to-line, to light press fit of shaft required. Application up to maximum slip fit radial load may be applied if recommended shaft tolerances are used.

SELECTION/DIMENSIONS TYPE E PAGE B5-11/B5-22	SELECTION/DIMENSIONS TYPE K PAGE B5-11/B5-34	SELECTION/DIMENSIONS DOUBLE-INTERLOCK PAGE B5-11/B5-44	SELECTION/DIMENSIONS TAF PAGE B5-11/B5-52
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# SELECTION



## Type E, Type K, DOUBLE-INTERLOCK and TAF

TABLE 2 – EASY SELECTION TABLE TYPE E, K, DI, AND TAF

Shaft Size	L10 Hours Life	Allowable Equivalent Radial Load Rating (Lbs.) at Various Revolutions Per Minute														
		50	100	150	250	500	750	1000	1250	1500	1750	2000	2500	2700	3000	3500
1-3/16 1-1/4	10,000	4145	3365	2980	2555	2075	1840	1685	1575	1495	1425	1370	1280	1250	1215	1160
	30,000	2980	2420	2145	1840	1495	1320	1215	1135	1075	1025	985	920	900	870	835
	40,000	2735	2220	1965	1685	1370	1215	1110	1010	985	940	905	845	825	800	765
	60,000	2420	1965	1740	1495	1215	1075	985	920	870	835	800	750	730	710	675
	100,000	2075	1685	1495	1280	1040	920	845	790	750	715	685	640	625	610	580
1-3/8 1-7/16	10,000	6620	5375	4760	4085	3315	2935	2695	2520	2385	2275	2190	2045	2000	1935	1850
	30,000	4760	3865	3425	2935	2385	2110	1935	1810	1715	1640	1575	1470	1440	1395	1330
	40,000	4365	3545	3140	2695	2190	1935	1775	1660	1575	1500	1445	1350	1320	1280	1220
	60,000	3865	3140	2780	2385	1935	1715	1575	1470	1395	1330	1280	1195	1170	1130	1080
	100,000	3315	2695	2385	2045	1660	1470	1350	1260	1195	1140	1095	1025	1000	970	925
1-1/2 1-5/8 1-11/16	10,000	8535	6935	6140	5265	4280	3790	3475	3250	3075	2940	2820	2640	2580	2500	
	30,000	6140	4985	4415	3790	3075	2725	2500	2335	2215	2115	2030	1900	1855	1795	
	40,000	5630	4575	4050	3475	2820	2500	2290	2145	2030	1940	1860	1740	1700	1650	
	60,000	4985	4050	3585	3075	2500	2215	2030	1900	1795	1715	1650	1540	1505	1460	
	100,000	4280	3475	3075	2640	2145	1900	1740	1630	1540	1470	1415	1325	1290	1250	
1-3/4 1-7/8 1-15/16 2	10,000	11220	9115	8070	6925	5625	4980	4565	4270	4045	3860	3710	3470	3390	3285	
	30,000	8070	6555	5805	4980	4045	3580	3285	3070	2910	2775	2670	2495	2440	2360	
	40,000	7400	6010	5325	4565	3710	3285	3015	2820	2670	2545	2445	2290	2235	2165	
	60,000	6555	5325	4715	4045	3285	2910	2670	2495	2360	2255	2165	2025	1980	1920	
	100,000	5625	4565	4045	3470	2820	2495	2290	2140	2025	1935	1860	1740	1700	1645	
2-3/16	10,000	11885	9655	8550	7335	5960	5275	4840	4525	4285	4090	3930	3675	2590		
	30,000	8550	6945	6150	5275	4285	3795	3480	3255	3080	2940	2825	2645	2585		
	40,000	7845	6370	5640	4840	3930	3480	3190	2985	2825	2700	2595	2425	2370		
	60,000	6945	5640	4995	4285	3480	3080	2825	2645	2505	2390	2295	2145	2100		
	100,000	5960	4840	4285	3675	2985	2645	2425	2270	2145	2050	1970	1840	1800		
2-1/4 2-7/16 2-1/2	10,000	12640	10265	9090	7800	6335	5610	5145	4810	4555	4350	4180	3910			
	30,000	9090	7385	6535	5610	4555	4035	3700	3460	3275	3130	3005	2810			
	40,000	8340	6770	5995	5145	4180	3700	3395	3175	3005	2870	2755	2580			
	60,000	7385	5995	5310	4555	3700	3275	3005	2810	2660	2540	2440	2285			
	100,000	6335	5145	4555	3910	3175	2810	2580	2410	2285	2180	2095	1960			

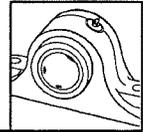
For maximum RPM see Table 1 on page B5-14.

In the shaded area, E, DI, and TAF mounted units require a line-to-line to light press fit of shaft.

In the boxed area, Type K mounted units require a line-to-line to light press fit of shaft.

NOMENCLATURE PAGE B5-10	EASY SELECTION TYPE E, METRIC PAGE B5-64	SELECTION/DIMENSIONS TYPE E, METRIC PAGE B5-61/B5-68	ENGINEERING/TECHNICAL PAGE B5-17
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# SELECTION



## Type E, Type K, DOUBLE-INTERLOCK and TAF

TABLE 2 (continued) – EASY SELECTION TABLE TYPE E, K, DI, AND TAF

Shaft Size	L10 Hours Life	Allowable Equivalent Radial Load Rating (Lbs.) at Various Revolutions Per Minute														
		50	100	150	250	500	750	1000	1250	1500	1750	2000	2500	2700	3000	3500
2-11/16 2-3/4 2-15/16 3	10,000	13345	10840	9600	8235	6690	5925	5435	5080	4810	4595	4415				
	30,000	9600	7795	6905	5925	4810	4260	3910	3655	3460	3305	3175				
	40,000	8805	7150	6335	5435	4415	3910	3585	3350	3175	3030	2910				
	60,000	7795	6335	5610	4810	3910	3460	3175	2970	2810	2685	2580				
3-3/16 3-1/4 3-7/16 3-1/2	10,000	21370	17280	15300	13125	10665	9440	8660	8100	7670	7320					
	30,000	15300	12425	11005	9440	7670	6790	7230	5825	5515	5625					
	40,000	14035	11400	10095	8660	7035	5230	5715	5345	5060	4830					
	60,000	12425	10095	8940	7670	6230	5515	5060	4730	4480	4275					
3-15/16 4	10,000	29200	23715	21000	18015	14635	12955	11885	11115	10525						
	30,000	21000	17055	15105	12955	10525	9320	8550	7995	7570						
	40,000	19265	15645	13855	11885	9655	8550	7840	7335	6945						
	60,000	17055	13855	12270	10525	8550	7570	6945	6495	6150						
4-7/16 4-1/2	10,000	35870	29135	25800	22135	17980	15920	14605	13655							
	30,000	25800	20955	18555	15920	12930	11450	10500	9820							
	40,000	23665	19225	17020	14605	11860	10500	9635	9010							
	60,000	20955	17020	15070	12930	10500	9300	8530	7980							
4-15/16 5	10,000	49360	40090	35500	30455	24740	21905	20095	18790							
	30,000	35500	28835	25530	21905	17790	15755	14450	13515							
	40,000	32565	26450	23420	20095	16320	14550	13255	12400							
	60,000	28835	23420	20740	17790	14450	12795	11740	10980							
5-7/16 5-15/16 6	10,000	56590	45965	40700	34915	28360	25115	23035								
	30,000	40700	33060	29270	25115	20400	18060	16570								
	40,000	37335	30325	26850	23035	18710	16570	15200								
	60,000	33060	26850	23775	20400	16570	14670	13455								
6-7/16 6-1/2 6-15/16 7	10,000	96215	78150	69200	59365	48220	42700									
	30,000	69200	56205	49770	42700	34680	30710									
	40,000	63480	51560	45655	39170	31815	28170									
	60,000	56205	45655	40425	34680	28170	24945									
100,000	48220	39170	34680	29755	24170	21400										

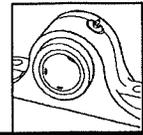
For maximum RPM see Table 1 on page B5-14.

In the shaded area, E, DI, and TAF mounted units require a line-to-line to light press fit of shaft.

In the boxed area, Type K mounted units require a line-to-line to light press fit of shaft.

FEATURES/BENEFITS PAGE B5-2	SPECIFICATIONS PAGE B5-7	HOW TO ORDER PAGE B5-8	
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# SELECTION



## Type E, Type K, DOUBLE-INTERLOCK and TAF

TABLE 3 - PERMISSIBLE THRUST LOAD, LBS. \*

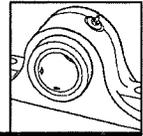
SHAFT SIZE INCHES	*E		K/DI		TAF	
	2-Bolt	4-Bolt	2-Bolt	4-Bolt	2-Bolt	4-Bolt
1-3/16	2000		2000			
1-1/4	2000		2000			
1-3/8	2590		2100			
1-7/16	2590		2100		2100	
1-1/2	2590		2100			
1-5/8	2590		2100			
1-11/16	2590		2100		2100	
1-3/4	3454		2900			
1-7/8	3454		2900			
1-15/16	3454		2900		2900	
2	3454		2900			
2-3/16	3454		2900		2900	
2-1/4	3454	3454	3454	3454		
2-7/16	3454	3454	3454	3454	3454	3454
2-1/2	3454	3454	3454	3454	3454	3454
2-11/16	5181	5181	5181	5181	5181	
2-3/4	5181	5181	5181	5181	5181	
2-15/16	5181	5181	5181	5181	5181	5181
3	5181	5181	5181	5181	5181	5181
3-3/16	5181	5181	5181	5181		
3-1/4	5181	5181	5181	5181		
3-7/16	5181	5181	5181	5181	5181	5181
3-1/2	5181	5181	5181	5181	5181	5181
3-15/16		6908		6908		6908
4		6908		6908		6908
4-7/16		6908		6908		6908
4-1/2		6908		6908		6908
4-15/16		6908		6908		6908
5		6908		6908		6908
5-7/16		8635		8635		8635
5-15/16		8635		8635		8635
6		8635		8635		8635
6-7/16		8635		12282		12282
6-1/2		8635		12282		12282
6-15/16		8635		12282		12282
7		8635		12282		12282

Note: The limits above apply to set screw shaft mounting or pillow block over turning force. Under heavy thrust loads it is always wise to use shear bars. At all times the L10 life of the bearing should be checked for proper selection and life requirements. For thrust loads larger than listed or heavy thrust loading on other style housing, contact DODGE Engineering for recommendation.

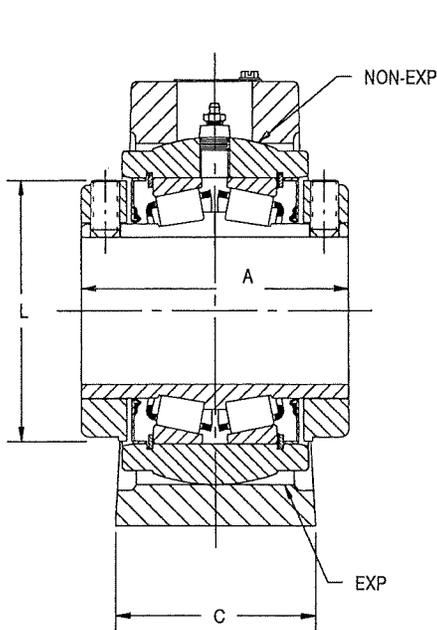
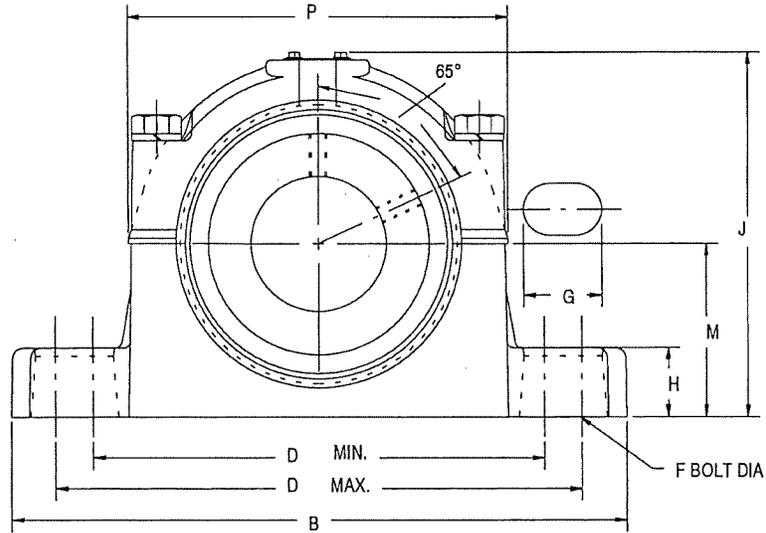
\* Does not include Piloted Flange.

SELECTION/DIMENSIONS TYPE E PAGE B5-11/B5-22	SELECTION/DIMENSIONS TYPE K PAGE B5-11/B5-34	SELECTION/DIMENSIONS DOUBLE-INTERLOCK PAGE B5-11/B5-44	SELECTION/DIMENSIONS TAF PAGE B5-11/B5-52
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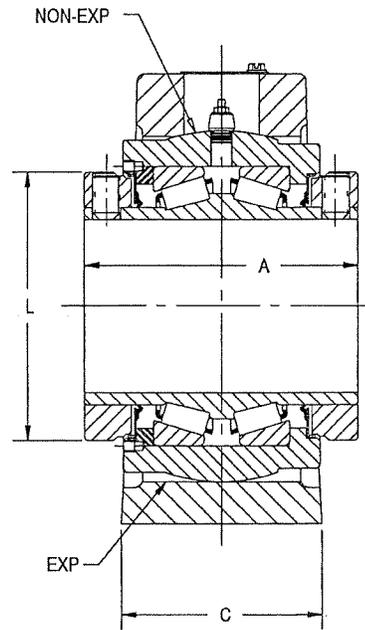
# SELECTION/DIMENSIONS



## TAF Pillow Block – Inch 2-BOLT BASE

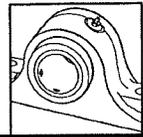


1-7/16" THRU 3" CONSTRUCTION



3-7/16" THRU 3-1/2" CONSTRUCTION

FEATURES/BENEFITS PAGE B5-2	SPECIFICATIONS PAGE B5-7	HOW TO ORDER PAGE B5-8	NOMENCLATURE PAGE B5-10
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# SELECTION/DIMENSIONS

## TAF Pillow Block – Inch 2-BOLT BASE

GRAY IRON NON-EXPANSION †						
SHAFT SIZE INCHES #	SHAFT SIZE SYMBOL	SAF HOUSING NUMBER	PILLOW BLOCK P/N	HSG ASSEM. P/N	UNIT P/N	PIL. BLK. WT. APRX LBS
1-7/16	107	509	037580	037540	037632	12
1-11/16	111	510	037581	037541	037633	15
1-15/16	115	511	037582	037542	037634	17
2-3/16	203	513	037583	037543	037635	25
2-7/16	207	515	037584	037544	037636	30
2-1/2	208	515	037585	037544	037637	30
2-11/16	211	516	037586	037545	037638	38
2-3/4	212	516	037587	037545	037639	38
2-15/16	215	517	037588	037546	037640	45
3	300	517	037589	037546	037641	44
3-7/16	307	520	037590	037547	037642	71
3-1/2	308	520	037591	037547	037643	70

† Furnished Unless Otherwise Specified.  
Description = P2b-taf-207re For 2-7/16" Size  
# Consult DODGE For Sizes Not Shown

GRAY IRON EXPANSION						
SHAFT SIZE INCHES #	SHAFT SIZE SYMBOL	SAF HOUSING NUMBER	PILLOW BLOCK P/N	HSG ASSEM. P/N	UNIT P/N	PIL. BLK. WT. APRX LBS
1-7/16	107	509	037592	037555	037632	12
1-11/16	111	510	037593	037556	037633	15
1-15/16	115	511	037594	037557	037634	17
2-3/16	203	513	037595	037558	037635	25
2-7/16	207	515	037596	037559	037636	30
2-1/2	208	515	037597	037559	037637	30
2-11/16	211	516	037598	037560	037638	38
2-3/4	212	516	037599	037560	037639	38
2-15/16	215	517	037600	037561	037640	45
3	300	517	037601	037561	037641	44
3-7/16	307	520	037602	037562	037642	71
3-1/2	308	520	037603	037562	037643	70

Description = P2b-taf-207re For 2-7/16" Size  
# Consult DODGE For Sizes Not Shown

SHAFT SIZE INCHES	SAF SERIES	A	B	C	D		F BOLT DIA	G	H	J	L	M	P	EXP*
					MIN.	MAX.								
1-7/16	509	3	8-1/4	2-3/16	6-1/4	7	1/2	15/16	7/8	5-7/64	2-3/4	2-1/4	5-33/64	3/32
1-11/16	510	3-3/8	8-1/4	2-3/8	6-1/2	7	1/2	7/8	1-1/32	5-5/8	3-3/16	2-1/2	5-13/16	3/32
1-15/16	511	3-1/2	9-5/8	2-3/4	7-3/8	8-1/4	5/8	1-13/64	1-1/32	6-9/64	3-7/16	2-3/4	6-23/64	9/32
2-3/16	513	3-3/4	11	3-1/4	8-21/32	9-1/2	5/8	1-7/16	1-1/32	6-33/64	3-3/4	3	6-61/64	9/32
2-7/16	515	4	11-1/8	3-1/8	8-5/8	9-5/8	5/8	1-17/64	1-1/4	7-1/32	4-1/16	3-1/4	7-3/8	9/32
2-1/2														
2-11/16	516	4-1/2	12-19/32	3-1/2	9-7/8	11	3/4	1-7/16	1-1/4	7-43/64	4-23/32	3-1/2	8-5/16	9/32
2-3/4														
2-15/16	517	4-1/2	12-19/32	3-1/2	9-7/8	11	3/4	1-7/16	1-1/4	7-59/64	4-23/32	3-3/4	8-5/16	9/32
3														
3-7/16	520	5	14-1/4	4-11/32	11-13/16	13-1/8	7/8	1-21/32	1-21/32	9-27/64	5-5/16	4-1/2	10-3/32	9/32
3-1/2														

\*EXP Total Expansion Divided Equally On Both Sides Of Bearing (Expansion Bearing Only).

Dowel Hole Locations For Precision Positioning – See Page B9-30 – B9-31

EASY SELECTION PAGE B5-15	SELECTION/DIMENSIONS TYPE E PAGE B5-11/B5-22	SELECTION/DIMENSIONS TYPE K PAGE B5-11/B5-34	SELECTION/DIMENSIONS DOUBLE-INTERLOCK PAGE B5-11/B5-44
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# *air-x-limited*

## INSTALLATION INSTRUCTIONS POLYESTER VINYL BUG SCREEN PANELS

### SERIES 1.1-1194

All "soft" bug screen panels are designed to provide ease of installation, quick removal, convenient storage, and are designed for optimum panel inter-changeability.

Panels are constructed of vinyl coated polyester 8 X 10 mesh trimmed with polyester/vinyl binding and attached using Velcro fastener material. They are designed for extended life and performance in all weather conditions for temperatures ranging from 120 degrees to minus 40 degrees Fahrenheit.

### **CAUTION: READ INSTRUCTIONS FULLY BEFORE PROCEEDING**

1. To avoid damage in shipping, shop handling, subsequent paintings, etc., each panel has been PRE-FITTED with a matching Velcro "hook" tape that must be initially removed and bonded to the structural frame. This is done by using the special pressure sensitive back adhesive on the "hook" tape.
2. The perimeter or 1" edge of the bug screen frame has been specifically "masked off" in preparation for installation of the Velcro "hook" tape. The structural frame surface should be clean, dry, and free of oil. The best adhesive bonding results will be obtained when installed at or above 60 degrees Fahrenheit.

**CAUTION:** A newly painted surface should have cured for a least 72 hours prior to application.

**NOTE:** In field retrofit, applications to the surface should be thoroughly clean to remove any "dead" paint with either 50/50 isopropanol/water, MEK or similar solution prior to applying the permanent Velcro "hook" tape.

3. The back of the "hook" is prepared with a special pressure sensitive adhesive. Peel the clear protective backing from the "hook", being careful not to touch the adhesive, and install the Velcro tape immediately on the 1" metal frame surface area around the perimeter of the panel opening. In joining the two surfaces, use finger pressure to firmly smooth the tape in place (especially important at corners and along edges).
4. For best results, round off (trim) the outside corners to prevent snagging.
5. Then using the hard rubber roller supplied, go over the tape, exerting firm pressure to insure complete contact between the adhesive back and the frame.

6. Allow adhesive to dry for 48 to 72 hours before cycling (attaching and removing panels). If necessary, drying time can be speeded up by applying heat up to 200 degrees Fahrenheit (example: hair dryer or heat gun).
7. A can of 3M #90 high strength spray contact adhesive has also been included for future "touch-up" should any loosening of the Velcro "hook" tape ever occur. Additional directions for its use are shown on the can.

**OPERATION:** Individual panels should be kept **CLEAN** to insure adequate air flow and maximum cooling performance, especially in hot weather. As with any filtration medium, dirty or clogged screens or fin tubes can adversely affect the cooler operation.

### GENERAL CHARACTERISTICS

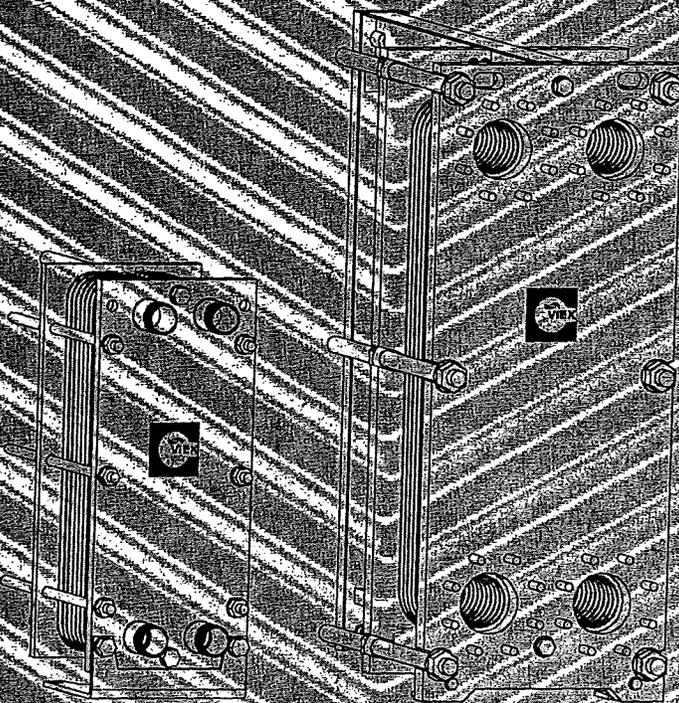
- Highly resistant to water, oil, ultraviolet rays (sun light) and chemicals
- Vibration or pressure increases closure and holding strength
- Quick panel placement by simply pressing panel edges to permanent Velcro "hook" material on frame
- Quick panel removal by simply "peeling" perimeter edges from permanent "hook" material on frame
- Exceptionally strong and treated to meet State of California Fire Code Bulletin 117-Class 1 (most stringent in the U.S.)
- Flexible and light weight for ease of handling and storage





# Viexplate<sup>®</sup> Gasketed Plate Heat Exchangers

**INSTALLATION OPERATION and MAINTENANCE MANUAL**



**Your Right Choice in Heat Exchangers!**

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# 1

# GENERAL

## 1.1 INTRODUCTION

This manual is intended as your general guide for the proper installation, operation and maintenance of your Viexplate® Gasketed Plate Heat Exchangers. We advise you to study it thoroughly and follow the instructions.

ViEX accepts no responsibility or liability for damage caused by incorrect installation, operation or maintenance due to failure to observe these instructions.

## 1.2 DESCRIPTION

A Viexplate® Heat Exchanger consists of a plate pack of thin metal plates specially designed to transfer heat from one fluid to another. These thin metal plates are separated and sealed by a set of rubber gaskets that provide the desired distribution of the fluids through the plate pack. The plate pack is installed in a frame, which provides the nozzles for the fluids, and the proper compression of the plates by means of a set of tightening rods.

## 1.3 FRAME

### 1.3.1 TYPICAL FRAME COMPONENTS

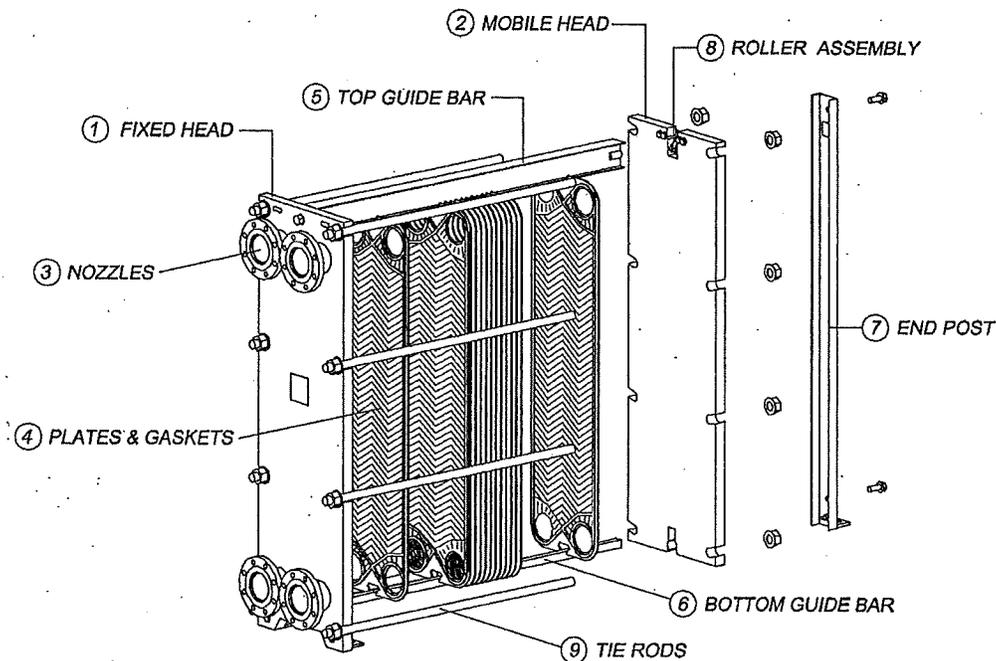


Figure 1.1 Exploded view

#### (1) Fixed Head and, (2) Mobile Head

Made of thick, rigid, pressure-vessel quality steel plates. They are used to compress the plate pack.

#### (3) Nozzles

There are three types nozzles :

**NPT Nipples:** for Model VX20 and smaller, size from 1" to 2 1/2". Rated from Sch40 to Sch80.

**Studded ports:** for Model VX28 and larger, size to fit 4" ANSI flanges and up, rated from 150# to 300 #.

**ANSI flanges:** available for all models. Size from 1" ANSI and up, rated from 150# and 300# slip on, lap joint and weld neck.

Standard exchanger consists of one inlet and one outlet for each flow. Special designed exchangers could have more than 4 nozzles with different types on different ports. See section 1.3.3 for nozzle terminology

#### (4) Plates and Gaskets

See section 1.4 for detail.

#### (5) Top Guide Bar and (6) Bottom Guide Bar

Attached to the fixed head and the end post. It supports the plate pack and mobile head allowing easy disassembly of the exchanger for maintenance.

#### (7) End Post

Available on Series FF, FS and FN for full support. Keeps the exchanger in rigid position.

#### (8) Roller Assembly

Installed on Mobile head of Model VX28 and larger, helping the movement of Mobile Head along Top Guide Bar during assembly of the exchanger.

#### (9) Tie Rods

Evenly spaced around the periphery of the exchanger to clamp the plate pack between the fixed and mobile head. Hydraulic cylinders may be used for tightening and loosening of the plate pack.

### 1.3.2 FRAME SERIES

Viexplate® frame types are titled with two or three letters. The first letter indicates the type of footprint, the second letter indicates the type of nozzles and the last letter indicates frame revision number.

The first letter:	F:	With end post
	P:	Without end post
The second letter:	S:	With studded port nozzles
	N:	Threaded nipple nozzles
	F:	With flanged nozzles

The following frame series are available:

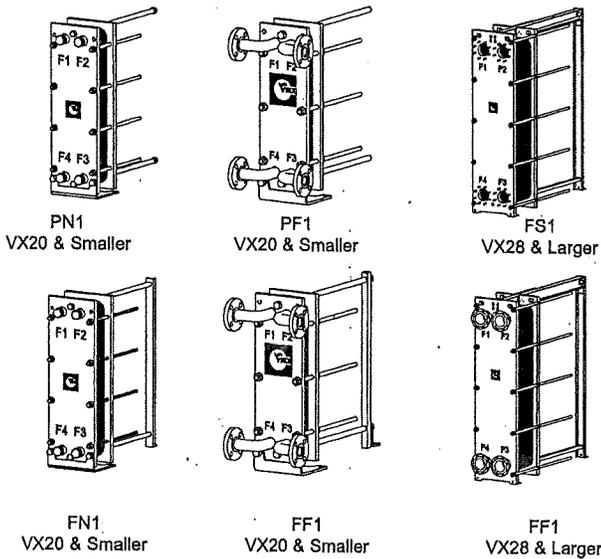


Figure 1.2 Available Frame Series

### 1.3.3 NOZZLES TERMINOLOGY

The nozzle locations in the frame heads are identified using the following convention of a letter followed by a number:

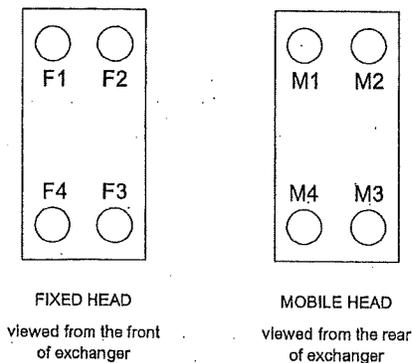


Figure 1.3 Nozzle Terminology

## 1.4 PLATES & GASKETS

### 1.4.1 THE PLATE PACK

The General Assembly Drawing, supplied with each Viexplate® Heat Exchanger provides all of the information regarding the composition of your plate pack. However, the following conventional rules must be observed when performing maintenance work to your exchanger.

- All plates have the letters "N" and "S" stamped at opposite ends to assist in orienting them correctly during hanging.
- The plates are referred to as EVEN PLATE or ODD PLATE depending on the orientation of their gasket with respect to the N and S ends, and the ports that it blocks off.
- ODD and EVEN plates control the orientation of flow of the fluids in the exchanger (See figures 1.7 and 1.8 for details.)
- ODD PLATES (3, 5, 7...) by convention are installed with the letter "N" at the top. EVEN PLATES (2, 4, 6...) are installed with the letter "S" at the top.
- The first, last and pass plates are considered SPECIAL PLATES and are installed with the letter "N" at the top.

### 1.4.2 Plate Corrugation Patterns

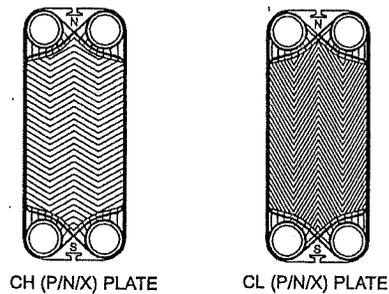


Figure 1.4 Plate Corrugation Patterns

All plates are identified with three letter code. The first two letters identify High Theta (CH), Medium Theta (CM) and Low Theta (CL). The last letter identifies plate gap – process gap (P), narrow gap (N), and mixed gap (X).

### 1.4.3 TYPES OF GASKETS

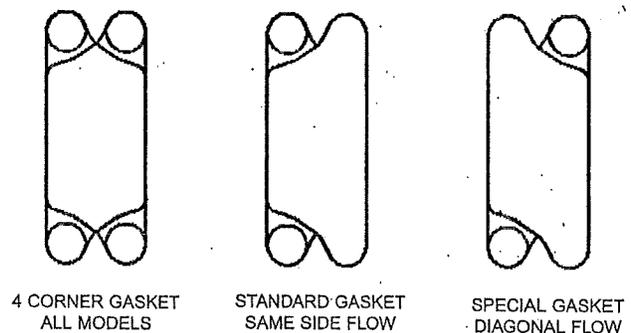


Figure 1.5 Types of Gaskets

**NOTES:**

- The first plate is equipped with a special 4 CORNER GASKET which isolates the four ports, preventing fluid passage between the first plate and the fixed head.
- All other plates are equipped with standard gaskets.
- Multi-pass units are supplied with one or more port gaskets (Ring gaskets) which are glued in place on the reverse side of the last plate.
- Port gaskets are also used in exchangers with nozzles in the mobile head, such as multi-pass or triple fluid units.
- All gaskets have a double safety feature to prevent fluid intermixing. The isolated port has a double retaining gasket, which forms a leakage chamber. This leakage chamber is connected to the atmosphere by three notches in the gasket. (See Figure 1.6 Below.)

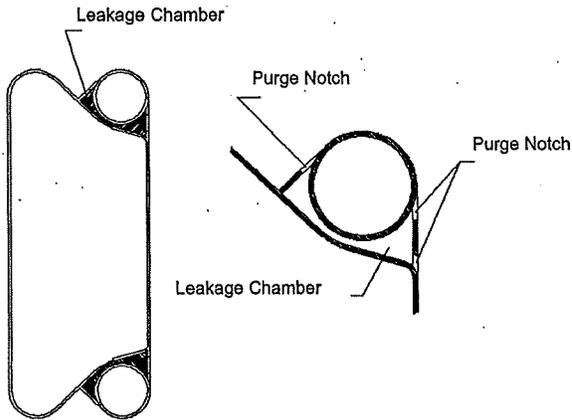


Figure 1.6 Corner Gasket Leakage Chamber

**1.4.4 GASKETED PLATES**

A standard plate is classified as ODD or EVEN depending on the orientation of the ports isolated by the gasket and the location in the plate pack with reference to the fixed head.

ODD plates mounted "N" side on top, with port F2 isolated by gasket.  
 EVEN plates mounted "S" side on top, with port F1 isolated by gasket.

**Model-Same Side Flow:** ODD and EVEN plates are physically identical, thus could be interchangeable by hanging in opposite direction. (See figure 1.7 below.)

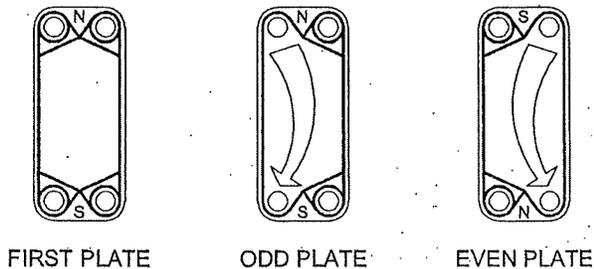


Figure 1.7 - Models Same-Side Flow - VIEX standard design

**Model-Diagonal Flow:** ODD and EVEN plates are different from each other and are not interchangeable without replacing the gaskets. (See figure 1.8 below.)

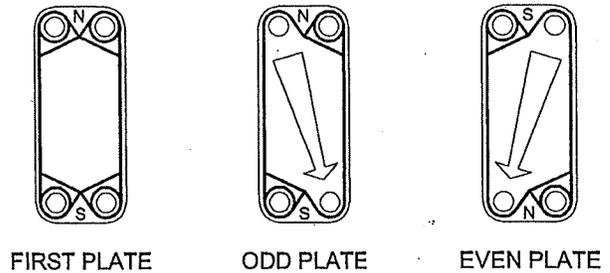


Figure 1.8 Models with Diagonal Flow - VIEX special designs

**1.4.5 SPECIAL PLATES**

A standard plate is a plate with four port openings. Plates with any or all ports blanked off are called Special Plates and are designated as such in the heat exchanger drawing.

Plates are named according to the position of their "filled" ports. (See Figure 1.9 below.)

- Examples:
- 4F = 4 Filled ports
  - 2FN = 2 Filled North
  - FNW = 1 Filled North-West
  - 2FN FSW = 2 Filled North & 1 Filled South-West

NOTE: Special Plates are typically ODD plates.

Here are the names of the various Special Plates:

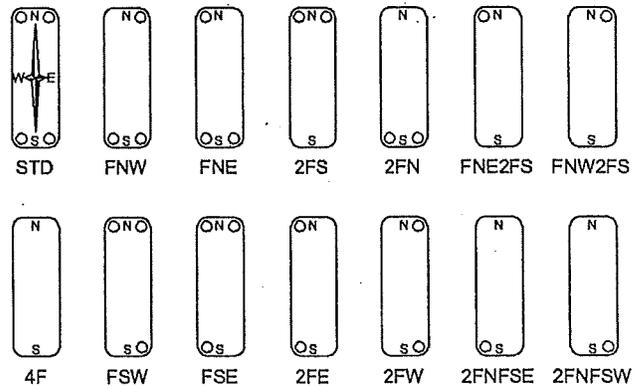
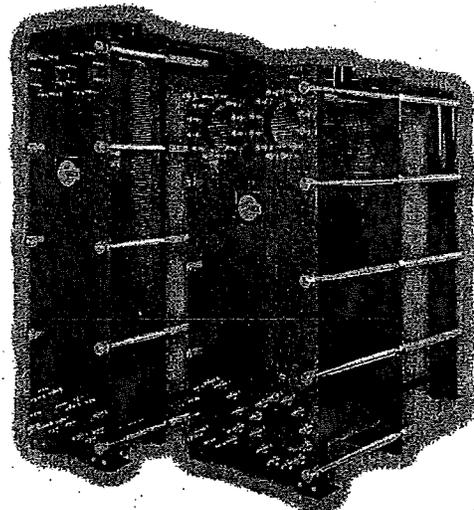


Figure 1.9 Special Plates



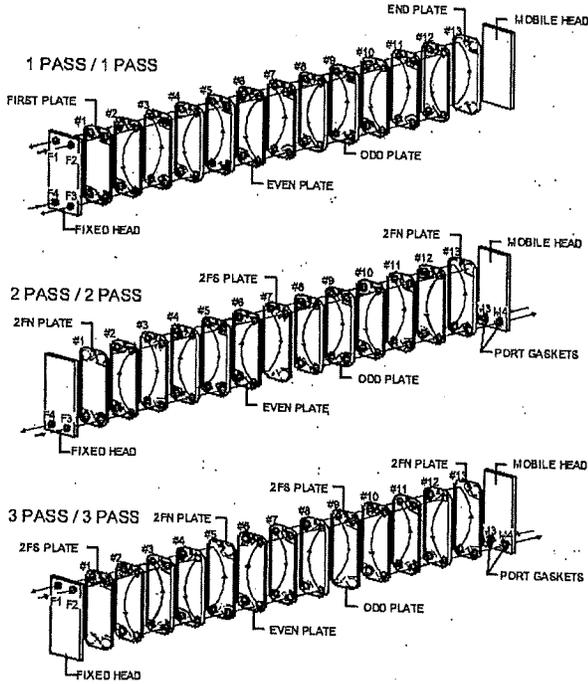
### 1.4.6 REINFORCED PLATES

Plates with reinforced port areas are provided for units with higher operating/design pressures. This reinforcement consists of a corrugated strip of the same material as the plate which is welded into

the gasket groove, around the section of the port that is not supported by the gasket.

### 1.4.7 TYPICAL PASS ARRANGEMENTS FOR STANDARD MODELS

#### ViEX Standard Models

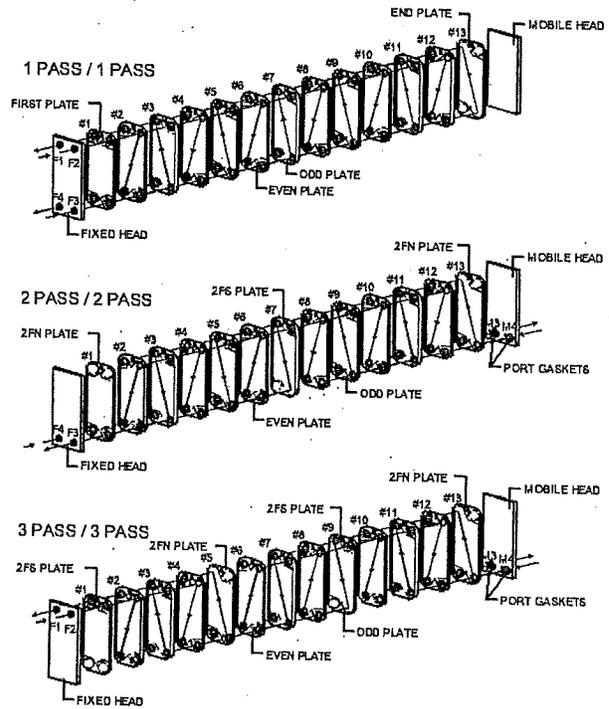


(Same side flow)

Figure 1.10 Typical Pass Arrangements for all Standard Models

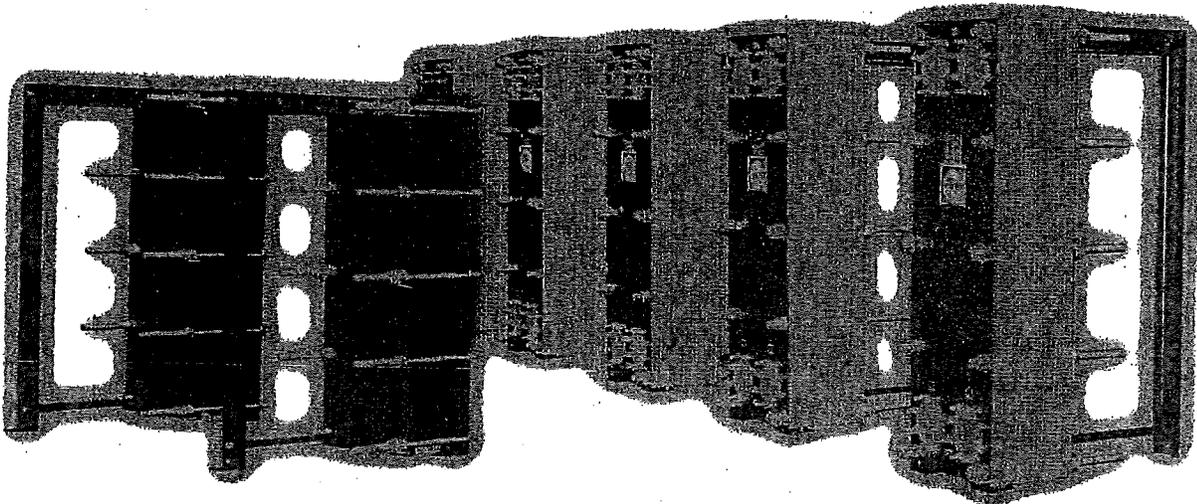
### 1.4.8 TYPICAL PASS ARRANGEMENTS FOR SPECIAL MODELS

#### ViEX Special models



(Diagonal Flow)

Figure 1.11 Typical Pass Arrangements for special models.



## 2.5 ALLOWABLE NOZZLE LOADS

Care must be taken not to damage the nozzles of a heat exchanger. Damage can occur in a number of common ways that excessively push, pull or twist the nozzles. For example:

- If piping has insufficient play in it (or too much play) it can pull on or push against the nozzle, or twist the nozzle
- Inappropriate use of a wrench on the nozzle can twist the nozzle
- An exchanger may be seriously damaged if its nozzles are used as lifting points, so always use lifting holes and the procedure given in 2.1.

Unless specifically allowed for in your heat exchanger's design, the maximum external nozzle loads should not exceed those given in the following table. Please note that these values apply only to studded-ports and nozzles welded to the frame.

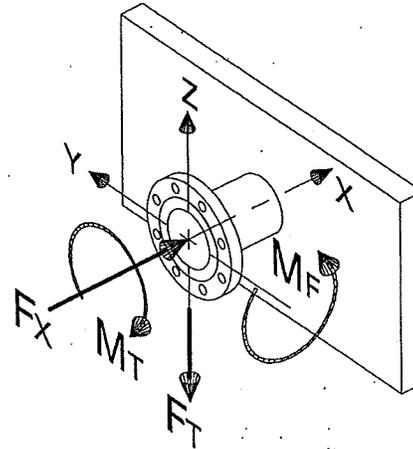


Figure 2.4 Nozzle Loads & References Axes

# CAUTION

Make sure that the piping system reconnected to the exchanger is free from any stress. Do not use nozzles as lifting points. Always use lifting holes and the procedure given in 2.1.

Nozzle Size		Fx (direct force)		Ft (radial force)		Mt (torision moment)		Mf (bending moment)	
		N	lbf	N	lbf	Nm	Ft lbf	Nm	Ft lbf
DN 60	2"	600	135	600	135	160	120	80	60
65	2 1/2"	750	170	750	170	260	190	130	95
80	3"	1000	225	1000	225	300	220	150	110
100	4"	1400	315	1400	315	740	540	370	270
150	6"	2700	605	2700	605	1600	1180	800	590
200	8"	4400	990	4400	990	4500	3320	2200	1660
250	10"	5800	1300	5800	1300	7600	5600	3800	2800
300	12"	7000	1570	7000	1570	12000	8850	6000	4425
400	16"	8900	2000	8900	2000	20360	15000	10180	7500

N = newton, Nm = newton meters, lbf = pound force, Ft lbf = foot pound force

Fx = resultant direct force on nozzle  
Ft = resultant radial force on nozzle

Mt = resultant torsion moment on nozzle  
Mf = resultant bending moment on nozzle

TABLE 1 - Maximum Allowable Nozzle Loads

# 2

# INSTALLATION

Viexplate® Heat Exchangers are delivered pre-assembled and tested. They should be rigidly fixed on the floor by means of anchor bolts.

## 2.1 LIFTING THE PLATE HEAT EXCHANGER

To lift the Viexplate®, use the lifting holes provided in the fixed head and wrap the lifting cable around the upper guide bar next to the mobile head, as shown in figure 2.1 below. Please note that exchangers with shrouds might require the removal of the shroud prior to lifting.

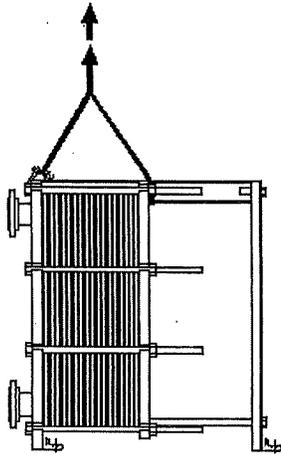


Figure 2.1 Lifting the Plate Heat Exchanger

## 2.2 DRIP TRAY

A drip tray with a volume capacity of at least the capacity of the heat exchanger is recommended for exchangers operating with corrosive liquids.

## 2.3 INSTALLATION AND PIPING

The following steps are recommended for the correct installation of the heat exchanger:

- Locate the exchanger in an area not congested by piping or other equipment.
- Provide approximately 3 feet (1 meter) of free space around the exchanger for easy maintenance.

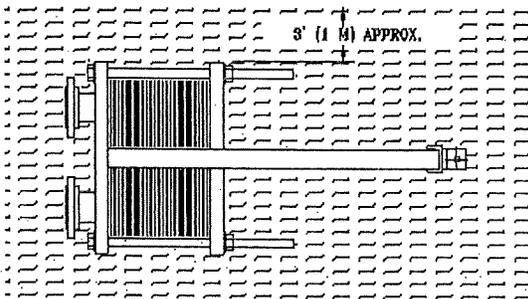


Figure 2.2 - Clearance for Viexplate® Installation

- Ensure that the exchanger is level when installed.
- Ensure flexibility in piping system. Thermal expansion in restricted piping can cause overloading of the heat exchanger nozzles, leading to leakage and/or over-stressing.
- Piping should be adequately supported to minimize misalignment or overloading of the exchanger nozzles.
- Nozzles located at the mobile head must be installed with spool pieces as shown in figure 2.3, to allow the head to move fully backward.

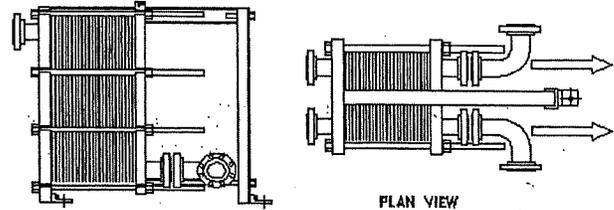


Figure 2.3 Mobile Head Fitted with Spool Nozzles

- Shut-off valves are recommended for all nozzles so that Viexplate® can be shut down and opened without disturbing adjacent systems. Quick action valves should be avoided to prevent water hammer.

## CAUTION

Models 2/20 and smaller are provided with alloy insert nozzles which are not welded to the frame. The nozzles must be held in position with a nut and washers connecting the exchanger to the piping system. Failure to do so will cause damage to the gasket between the nozzle inner face and the adjacent plate.

- Pumps sending fluids to the heat exchanger should be equipped with throttling valves. Where the maximum pump discharge pressure might exceed the maximum working pressure of the exchanger, a safety relief valve should be provided. Pressure control valves (when installed) should be located at the inlets to the exchanger. Positive displacement pumps (especially reciprocating pumps), must be equipped with vibration dampers.

## 2.4 STORING VIEXPLATE®

If it is necessary to store Viexplate® for a long period of time, before commissioning or after extensive maintenance and decommissioning, the following procedure is recommended.

To avoid deterioration of the gaskets, protect the plate pack from UV radiation by covering it with a dark plastic sheet. Avoid storing Viexplate® in a room with ozone generating equipment, such as electric motors, arc welding, etc.

Apply a coat of rust preventative to all carbon-steel machined surfaces, such as bolts and flange faces.

Cover over nozzles with wooden or metal covers, using rubber gaskets.

# 3

# OPERATION

## 3.1 INITIAL OPERATION

- a) Make sure that the tightening dimension 'a' (distance between the inner faces of the fixed and mobile heads) is within the limits specified in the General Assembly Drawing, otherwise see section 4.2.1 or 4.2.2 of this manual for tightening instructions.

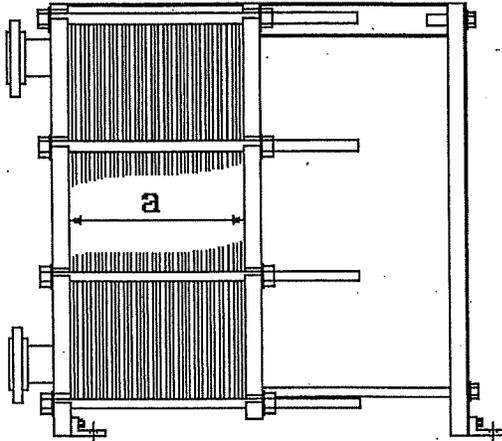


Figure 3.1 - Plate Pack Dimension 'a'

- b) Before start-up, especially after a long period of stoppage, ensure that the piping system connected to Viexplate® is free of scaling or any other foreign matter that will clog the plate pack. The exchanger will act as a filter for solid particles of any considerable size.
- c) Make sure that all nozzles are properly fastened.
- d) Ensure that your system set up is within the heat exchanger's design limits for temperature and pressure as allowed by the nameplate.

## 3.2 START-UP

To start up the heat exchanger, follow steps 'a' to 'f'. Begin with the circuit with the least severe operating conditions, and then repeat the procedure for the second circuit. (Steam should always be turned on last.)

- a) Close the feed valve between the pump and Viexplate®.
- b) Fully open the shut-off valve at the outlet (if one was installed).
- c) Open the vent valve.
- d) Start the pump.
- e) Slowly open the feed valve.
- f) Close the vent valve when all air has been removed.

### NOTE FOR STEAM APPLICATIONS:

- i) The steam must be turned on last and off first. Do not leave the steam on with the liquid side turned off.
- ii) Sudden opening and closing of the valves may deform plates to the point of being non-serviceable. Valves must be set to open gradually.
- iii) Start-up and shut-down must be controlled to protect the exchanger from shocks. The amount of heating or cooling should be controlled using throttling valves in conjunction with the process thermometers.

## 3.3 SHUT DOWN

### 3.3.1 BRIEF STOPPAGE

If Viexplate® is to be shutdown for a short period of time, such as for inspection, service or pump stoppage, proceed as follows:

1. Slowly close the feed valves, starting with the most severe circuit
2. Switch off the pumps.
3. Close the valves at the outlet nozzles.

### 3.3.2 PROLONGED STOPPAGES

For long term stoppages of one month or longer, proceed as above and follow the additional recommendations below:

4. Vent and drain Viexplate®
5. Flush the plate pack and perform the appropriate cleaning procedure. Beware of any residual chlorine, either from the process fluids or the rinse water, since this can cause pitting of the plates.
6. Slacken the plate pack by 10 to 20% of the existing dimension 'a': (a + 10 to 20%).
7. Refer to section 2.4 of this manual, Storing Viexplate®.

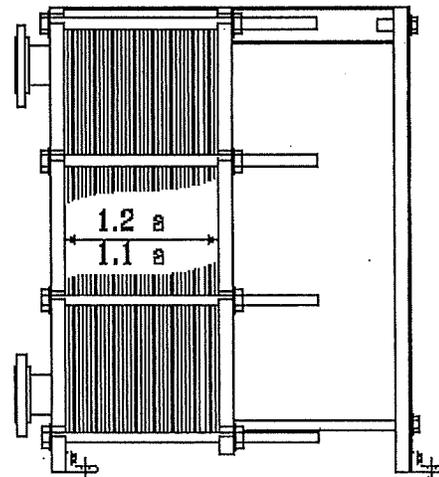


Figure 3.2 Slackening the Plate Pack for Storage

# CAUTION

When starting Viexplate®, make sure to retighten the plate pack to the 'a' dimension and proceed as per INITIAL OPERATION and STARTUP.

# 4

# MAINTENANCE

## 4.1 OPENING VIEXPLATE®

Prior to opening Viexplate®, proceed as follows

- Shut-down as per instructions in 3.3
- Disconnect any nozzles on the mobile head.
- Clean the exposed section of the upper guide bar, to allow easy movement of the plates
- Clean the mobile head roller so that it can move easily
- Clean and lubricate the tightening rod threads
- Record the current tightening dimension 'a'.
- Paint a diagonal line across the side of the plate pack to facilitate the correct sequencing on re-assembly.

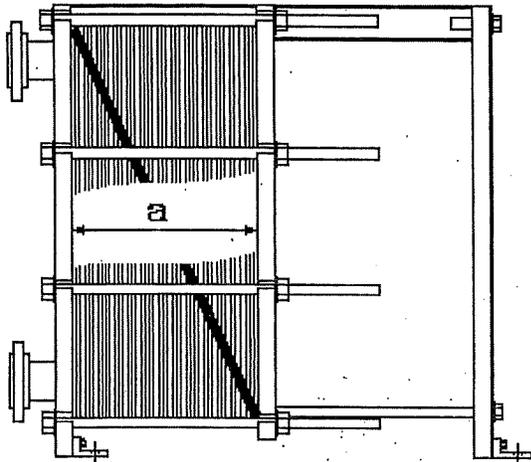


Figure 4.1 Paint a diagonal line across the Plate Pack

### 4.1.1 MANUAL OPENING

- Release the tension on the tie rods in a diagonal pattern, alternating sides (e.g. top right followed by bottom left). Loosen each nut by only 1/4" to 1/2", and no more. It's important that the heads remain parallel to avoid damaging (crushing) the plates between them.
- When all tie rods have been fully loosened, they may be removed. Push the Mobile Head fully away from the plate pack, up against the end post.
- Remove the plates one by one and place on a flat surface.

### 4.1.2 HYDRAULIC OPENING

- With a wrench, loosen the hexagonal nuts (Item J, Figure 4.2) from the two pairs of tie rods (Item O) in positions 2 & 5 (also shown in Figure 4.2)
- Loosen the four nuts (Item J) to a length corresponding to the opened length of the hydraulic cylinder.
- Push the four tie rods (Item O) forward toward the fixed head.
- Mount the four hydraulic cylinders with rams extended to 6 mm (1/4") less than their full length of travel.
- Put all cylinders under pressure. This will tighten the plate pack slightly, by about 6 mm (1/4").
- Hold cylinders under pressure and remove the pair of tie rods in positions 3 & 4.
- Loosen the nuts (Item J), by ('Y' minus 6 mm (1/4")) on the remaining pair of tie rods in positions 1 & 6. The Y dimension represents the hydraulic ram travel distance (typically either 100 mm (4") or 150 mm (6")).
- Release the pressure from the cylinders and allow the plate pack to expand against tie rod pairs in positions 1 & 6.
- Repeat the above operations until the plate pack is fully opened
- The gaskets sometimes stick to the adjacent plate. In this case use a plastic or wooden wedge to carefully pry the plates apart.

**DO NOT USE A SCREW DRIVER OR ANY METAL OBJECT.**

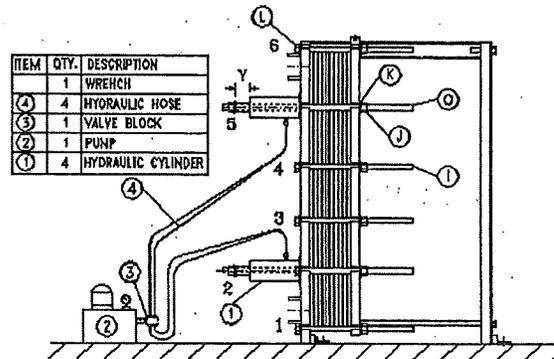
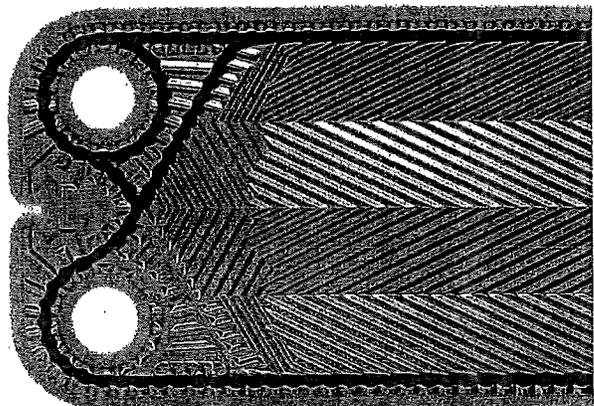


Figure 4.2 - Hydraulic Opening of Viexplate®

# CAUTION

The plates have sharp edges.  
Wear safety gloves when handling plates.



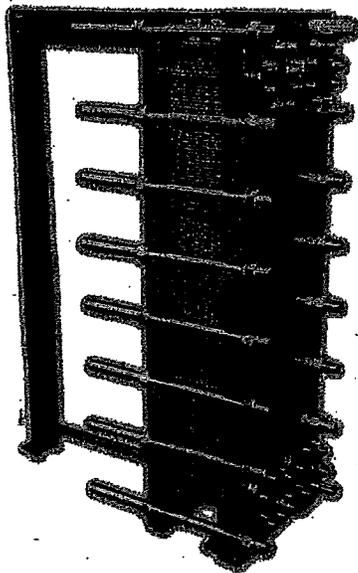
## 4.2 CLOSING VIEXPLATE®

Prior to closing Viexplate®

- Make sure that the plates and gaskets are free of foreign matter or contaminants. If necessary clean with a soft cloth or brush.
- Clean the guide bars to ensure easy movement of the plates when installing and tightening.
- Install all plates in the correct sequence in accordance with the general assembly drawing. The diagonal line painted on the plate pack side must reappear unbroken.

### NOTE:

- When closing plate packs with a very large number of plates (300+), allow the plate pack to relax for at least one hour after every 4 to 6 inches of displacement for the last 12" of tightening. This will help to prevent deformation of the plates closest to the covers by distributing the thrust force more evenly along the plates and gaskets. This is particularly important for plates made of softer metals.
- If Viexplate® does not seal at the recorded tightening dimension 'a', further tightening is allowed. However, the following rule must be observed:



**CAUTION**

Never tighten Viexplate while it is under pressure.

**CAUTION**

Never tighten the plate pack to a dimension smaller than the minimum indicated in the General Assembly Drawing (as advised by VIE) when the number of plates has been modified, or alter to observe this rule, or it will result in permanent damage to the plates.

### 4.2.1 MANUAL CLOSING

- Push the mobile head into contact with the plate pack.
- For large units select and install a minimum of 50% of the tie rods, evenly distributed in the frame.
- Tighten the plate pack using diagonally opposite tie-rod pairs, in a sequence similar to that given in Figure 4.3 below. Ensure during closing that the fixed and mobile heads are kept parallel to each other to within 1/4" to 1/2".
- Install and tighten the remaining tie rods and ensure that all tie rods are under tension.

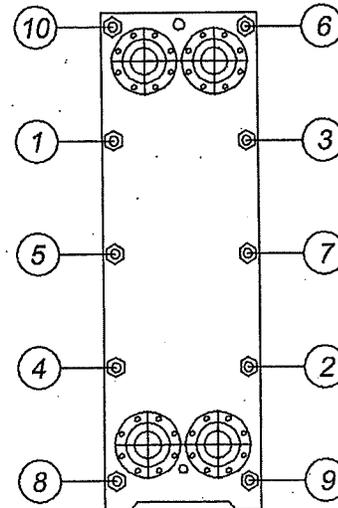
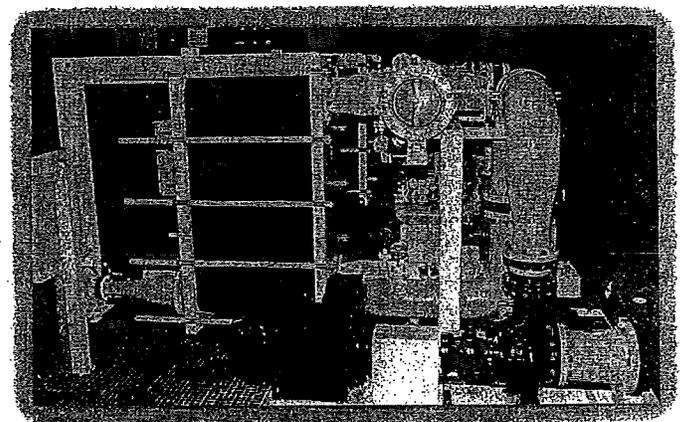


Figure 4.3 Example of Manual Tightening Sequence

- If old gaskets are still used, the tightening dimension should be between the recorded dimension 'a' and the minimum tightening dimension indicated in the General Assembly Drawing (provided that the number of plates remains as per the original design). If new gaskets have been applied, then the tightening dimension should be between the minimum and maximum values specified on the General Assembly Drawing.
- After final tightening, the fixed and mobile heads must be parallel to within 1/16" in all directions, to ensure proper plate pack alignment.
- The unit is now ready for hydrotest.



## 4.2.2 HYDRAULIC CLOSING

1. Push the mobile head into contact with the plate pack.
2. Install the four tie rods (Item O, Figure 4.2) and adjust them so that they project at least 18" out from the face of the fixed head, to allow installation of the hydraulic cylinders.
3. Mount the four hydraulic cylinders (fully closed) at the fixed-head end.
4. Install the nuts (Item L, Figure 4.2).
5. Activate the hydraulic pump and allow the cylinders to tighten the plate pack.
6. Shut off the hydraulic pump, maintaining the cylinders under pressure.
7. Install the remaining tie rods and tighten them by hand.
8. Release the pressure from the hydraulic cylinders. When rams have fully retracted from the nuts, tighten the nuts against the mobile head.
9. Re-activate the hydraulic pump and repeat the procedure until the required tightening dimension is reached. If old gaskets are still used, the tightening dimension should be between the recorded dimension 'a' and the minimum tightening dimension indicated in the General Assembly Drawing (provided that the number of plates remains as per the original design). If new gaskets have been applied, then the tightening dimension should be no larger than the maximum specified on the General Assembly Drawing, and no smaller than the minimum specified.
10. Finish tightening the tie rod nuts (Items L or J) with a wrench. The fixed and mobile heads must be parallel to within 1/16" in all directions, to ensure proper plate pack alignment.
11. Remove the hydraulic cylinders and tighten the four remaining tie rods.
12. The unit is ready for hydrotest.

## 4.3 RE-GASKETING

VIEX gasketed plate heat exchangers, depending on model and materials of construction, are available with glued or glueless gasketing systems. Please consult the general assembly drawing of your unit to verify the gasketing system used.

### NOTE:

**When replacing a significant number of gaskets, consider replacing the entire set. The sealing properties of gaskets under compression diminish over time, and this determines the amount of tightening that will need to be applied to the plate pack when closing the exchanger. Mixing of old and new gaskets, therefore, will cause over-compression of the new gaskets, severely reducing their service life.**

### 4.3.1 GASKET GLUING

When gaskets are supplied loose for on-site installation, the plates must be properly cleaned and prepared, and the gaskets attached to the plates according to the following instructions:

#### a) PLATE PREPARATION:

Old gaskets and glue must be completely removed. If the removal of the gasket proves difficult, use a hot air gun to heat the gasket groove from the back of the plate. As the adhesive softens, pull the gasket off with pliers. As an alternative, the plates may be dipped in liquid nitrogen and then knocked; the gaskets should crumble off.

The gasket groove must be completely clean. Any remaining traces of old adhesive should be removed by rubbing with a non-abrasive cloth. If solid particles remain in the gasket groove, remove them carefully with an abrasive cloth.

#### b) GLUING THE GASKETS

We recommend for cold gluing, the use of 3M's 3MEC1099 adhesive or its equivalent (glue can be 1 or 2 parts).

## CAUTION

Care must be taken not to scratch the gasket groove or leaks may develop underneath the gasket.

### NOTE:

**For best results, carefully follow the manufacturer's instructions for the glue that you select.**

- Prior to gluing, review section 1.4.3 of this manual for a good understanding of the VIEX gasket terminology, e.g. 4 corner gasket (4 Cr), and the standard gasket in odd or even position.
- Perform a visual inspection and make sure that the gasket grooves are clean, and dry, and that there is no visible damage to the gasket groove.
- Roughen the side of the gasket to be glued with an emery cloth or sand paper. Do not roughen the reverse side of the gasket.

### NOTE:

- a) Do not roughen fibre gaskets.
  - b) For models using gaskets that have one side flat and one curved, the flat side is to be glued against the plate.
- Glue should be applied evenly in the plate's gasket groove with a tube, glue gun or small, round pure bristle brush.
  - Use a minimum amount of glue, evenly applied over the entire gasket groove and roughened side of the gasket.
  - Allow the glue to dry for about 5 to 10 minutes (refer to manufacturer's instructions). When the glue is tacky, carefully line up the gasket with the groove and press the gasket into place.
  - Do not force or stretch the gaskets.
  - To ensure proper seating, tap the gasket lightly into place with a soft faced mallet.
  - Glue must be completely dry before the plate pack is placed into service.
  - Stack the plates horizontally on a support that assures that the plates are centered. Ensure that the gaskets remain in the grooves.
  - Place a uniform weight on the top plate and allow the pack to sit and dry per the manufacturer's instructions.

## CAUTION

Glue must be compatible with both the plate material and the gasket material. In doubt, consult the glue manufacturer.

### 4.3.2 GLUELESS GASKET REPLACEMENT

ViEX glueless gasket systems allows gasket to be snapped in place in the groves on the plate perimeter.

Please contact your nearest ViEX office or representative for additional instructions, if required.

### 4.3.3 STORING SPARE GASKETS AND GLUE

It is recommended that spare gaskets be readily available for each heat exchanger. As a guideline for two years of operation, stock 10% of the total number of gaskets. Stock a complete set of gaskets if they are of special materials with long lead times.

Gaskets should be stored in an area sheltered from any sources of ultra violet light, such as fluorescent lights, or ozone generating equipment such as electric motors. Normal shelf-life for gaskets is about three years, but exposure can lead to premature deterioration. When storing in exposed areas, wrapping the gaskets in dark plastic is recommended.

Storage temperature should be maintained between 32 °F (0 °C) and room temperature to ensure ease of handling the gaskets. Whenever gaskets have been exposed to temperatures lower than recommended, they should be warmed to room temperature before handling.

Whenever practical, the gaskets should be stored flat. Large gaskets may be stored lightly folded in half, as long as any sharp bends are avoided, since these will cause the gaskets to crack.

It is advisable to stock glue for emergency repairs. The glue should be stored as per the glue manufacturer's instructions. (The average shelf life of glue is 6 months.)

## 4.4 PLATE MOUNTING

Refer to the General Assembly Drawing provided with your unit for the proper sequencing of the plates. The diagonal line in Figure 4.1 (if painted prior to disassembly) must reappear at the side of the plate pack as the plates are hung on the frame.

## 4.5 HANGING THE PLATES ON THE FRAME

Proper handling during hanging of the plates on the frame is very important to protect the integrity of the plates. Proceed with the following steps, referring to Figure 4.4:

- Put plate in position 1 and hook it onto upper guide bar.



- Hold up the bottom of the plate so that it will clear the lower guide bar, and rotate the plate around the upper guide bar into position 2.
- Lower the bottom of the plate over the lower guide bar, to a vertical position 3.
- Slide plate toward the stationary head, against plates already installed.

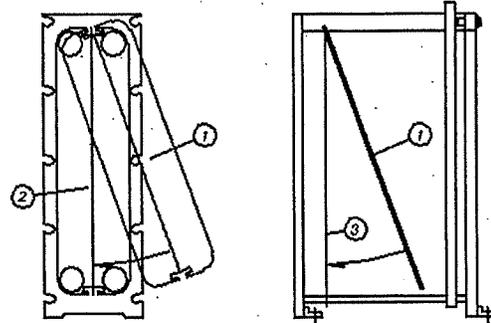


Figure 4.4 - Hanging the Plates

The plates must be correctly positioned on the guide bars in order to achieve proper alignment of the plate pack (See figure 4.5 below).

If before or during tightening the plate-pack appears misaligned at the sides or in the port holes, re-check and correct the positioning of each plate.

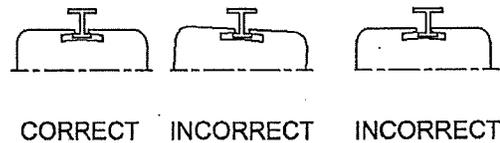


Figure 4.5 - Correct position of plates

## 4.6 HYDROSTATIC TESTING

After each disassembly, it is necessary to perform a hydrostatic test to the pressures indicated on the nameplate.

New units are hydrostatically tested separately on each circuit to the pressures indicated on the nameplate. (i.e., 1 circuit under pressure and the other open to the atmosphere).

Hydrostatic tests are performed to detect gasket leaks. Leaks from gaskets would appear either at the side of a plate-pack or at drainage points (near nozzle). Gasket leaks always drain to the outside. It is not possible for one fluid to enter the opposite circuit due to gasket failure. To simplify repairs, the location of a leak should be marked prior to disassembly of the plate pack.

Hydrostatic testing of one circuit (i.e. A) enables detection of defective plates. A hole in a plate would allow leakage between circuits. This is visible by water draining into the open circuit (B). When the plate pack is opened, the defective plate would be 1 of the 2 which are wet on circuit B, which was open to the atmosphere.

**Note:** All tie rods must be in place and properly tightened before a hydrostatic test is made.

# 5

# CLEANING

The need to clean the heat exchanger and the method to be employed will depend on the type of fouling associated with each particular application.

Accumulation of deposits inside the plate pack will reduce the heat transfer rate and may cause excessive pressure drops through the system. Therefore it is extremely important to establish:

- a) the appropriate cleaning frequency
- b) the method of cleaning, and
- c) the suitable cleaning chemical solution (if required) to dissolve the hard deposits but not damage the plates or gaskets.

## 5.1 HOW TO MINIMIZE FOULING

### 5.1.1 PERIODIC FLOW-RATE INCREASES

One of the factors that determine the rate of fouling of the plates is the velocity of the fluids through the plate pack. It is recommended, especially for low fluid velocities, to increase the velocity at regular intervals, if possible. This will slow down the fouling process since the increased turbulence will remove some of the loose scale deposits from the heat transfer surfaces.

Typical intervals and duration of this preventive cleaning practice is four to six hours, every two to three weeks.

### 5.1.2 FILTRATION

Viexplate® should not be used as a filter for process fluids. Viexplate® design is specifically suited to clean fluids, and can become clogged by fibers or particulate matter. Filtration is advisable when solids are present in the fluids. Two options are available, the use of external filters connected in series with Viexplate®, and also integral filters fitted within the ports of Viexplate®.

For more information on filters, consult your nearest VIEX office.

## CAUTION

Ensure that the cleaning fluid is compatible with the plate and gasket materials. Your cleaning solution supplier should be contacted for recommendations.

## 5.2 CLEANING WITHOUT OPENING VIEXPLATE®

### 5.2.1 BACK-FLUSHING METHOD

This method is recommended for fluids containing coarse particles such as fibres and debris that might accumulate in the port areas and distribution zones on the plates.

By briefly reversing the flow direction of the fluid these particles can be removed and carried away from the exchanger. A special piping configuration is required for this method. (Contact your nearest VIEX office for advice.)

### 5.2.2 CLEANING-IN-PLACE (CIP) METHOD

This method is recommended for high fouling processes where frequent cleaning is required. It is especially recommended where highly corrosive fluids are handled.

#### CIP PROCEDURE:

1. Drain both sides of the exchanger and flush the process circuit with cold water. If the cooling media contains common salt solutions, make sure that both circuits are well flushed with cold water before any cleaning operation.
2. Flush both sides of the exchanger with warm water 100-120 °F, 38-49 °C), until the effluent water is clear and free of process fluids.
3. Optionally, the plate pack tightening may be relaxed to about 3/16" (5 mm) per each 100 plates. This will relieve and allow the cleaning of the gaskets as dripping will occur. Make sure to record the actual distance "a" between heads prior to any loosening of the plate pack.
4. The choice of cleaning solution, the temperature and duration of cleaning procedure will depend on the type of deposits to be removed and must be compatible with the plate and gasket materials. Confirmation of material compatibility should be obtained from the cleaning fluid supplier.
5. When mixing the cleaning solution, use chloride free, or low chloride water, with a low hardness value. Concentrated cleaning solution must be added to the water before circulation begins.
6. It is recommended to pump the cleaning solution at flow-rates of up to 1.5 times the normal working flow-rate, where possible, without exceeding reasonable nozzle velocity (e.g. Carbon Steel nozzles: 15 ft/sec, or lined nozzles: 25 ft/sec). If possible, the cleaning solution should be pumped in the opposite direction to the normal flow. This will provide the advantages of back-flushing.
7. For units with high working flow-rates it might be difficult to attain high CIP flow-rates. In such cases, a solution capable of dissolving the deposits at lower circulating flow-rates should be used and/or the duration of the CIP process must be appropriately extended.
8. Centrifugal pumps should be used for circulating the cleaning solution. The flow-rate and operating pressure of the cleaning solution must be reached gradually to avoid pressure shocks that might result in gasket or plate damage.

## CAUTION

Never inject chemicals while CIP in process!

## CAUTION

When mixing acid and water, always add acid to water. Do not use hydrochloric acid for cleaning stainless steel plates. The edges of plates are sharp. Wear safety gloves when handling them. Caustic soda and concentrated nitric acid can cause serious injuries to skin and mucous membrane when handling these substances. Always use protective goggles and rubber gloves.

9. After the cleaning solution has been circulated, the exchanger and the adjacent piping must be flushed with clean water.
10. If the plate pack tightening has been relaxed, re-tighten to the recorded dimension 'a' before bringing the exchanger back on line.

### CIP FOR REMOVAL OF LIME SCALE AND SIMILAR DEPOSITS.

One common type of fouling is the precipitation of calcium compound from cooling water and other sources.

- a) Proceed as per the applicable instructions, circulating a solution of 2 to 3% phosphoric acid solution at 70°F (20°C) for two hours.
- b) Flush with cold water until the cleaning solution has been completely removed from the plate pack.

### 5.3 CLEANING THE OPEN HEAT EXCHANGER

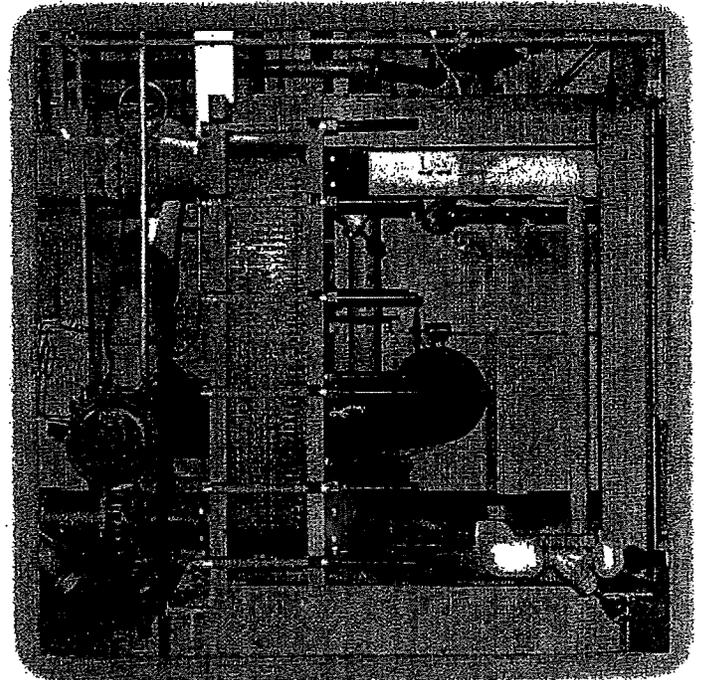
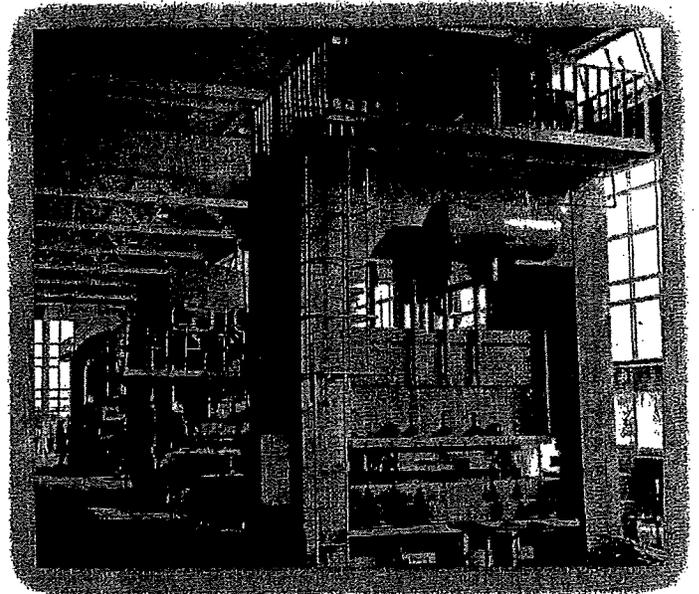
Although CIP is a very efficient way of maintaining the heat exchanger in good operating order, it is sometimes necessary to dismantle the unit for cleaning.

For manual cleaning of the plates proceed as follows:

1. Open Vlexplate® as indicated in section 4.1 of this manual.
2. Slide plates apart to allow cleaning by brush or water rinsing.
3. For cleaning with high-pressure water jet, it is recommended to lay the plates flat on a firm surface to avoid damage. To avoid dislodging of gaskets, always direct the water jet at right angles to the gasket face.
4. NEVER use a steel brush or steel wool on the plates. If required, a fibre brush should be used.
5. Be careful not to scratch the gasket surfaces.
6. After brushing rinse well with water and wipe dry.
7. After completion of manual cleaning and careful inspection of all components, proceed to assemble the unit as per section 4.2 of this manual.

#### TO REMOVE HARD DEPOSITS SUCH AS CALCIUM COMPOUNDS, OXIDE OR CARBONATE DEPOSITS:

- a) Prepare a solution of 10% nitric acid:  
1 part volume: 65 % HNO<sub>3</sub> (specific weight 1.4)  
9 parts volume: water
- b) Apply the cleaning solution to the plates and let stand for 10 minutes. Brush and rinse with water. If necessary, repeat this operation several times.
- c) Neutralize with a diluted caustic solution followed by a thorough rinse with water.



## CAUTION

Always follow the safety recommendations from the cleaning agent manufacturer.

# 6 TROUBLE SHOOTING

This section will assist users in trouble shooting problems that arise with the heat exchanger. This table is meant to serve as a guide only. If further assistance is required please contact VIEX.

## **Symptom 1:** **External leakage between plate pack and fixed head or mobile head**

### **Possible Causes:**

- Gasket failure (most common cause)

### **Finding The Problem:**

- Mark the point where the leak occurs.
- Open Viexplate® (see page 8)
- Examine the condition of the gasket and plate alignment

### **Corrective Action:**

- Defective gaskets: Defective gaskets must be replaced.

### **Remarks:**

- When a significant number of gaskets need replacement, it is recommended that a complete new gasket set be installed. This will result in easy sealing and will ensure longest operating life.

### **Possible Causes (2):**

- Nozzle liner failure (rare)

### **Finding The Problem:**

- If the gasket appears to be in good condition, check nozzle liner for any visible cracks or perform a dye penetrant test to locate failure.

### **Corrective Action:**

- Tig weld the crack in the liner if accessible. If not accessible, the liner must be replaced.
- Contact Viex for advice.

## **Symptom 2:** **External leakage between nozzle and fixed or mobile head**

### **Possible Causes:**

- Nozzle liner failure

### **Finding The Problem:**

- Check nozzle bolting tension, piping alignment, etc. to make sure piping loads are not causing the leak.
- If the leak persists, disconnect flange, examine nozzle gasket and replace if necessary.
- If the nozzle gasket is found in good condition, open exchanger and check nozzle liner for any visible cracks or perform a dye-penetrant test to locate failure.

### **Corrective Action:**

- Tig weld the crack in the liner if accessible. If not accessible, the liner must be replaced.
- Contact VIEX for advice.

## **Symptom 3:** **External leakage between plates**

### **Possible Causes:**

- Extremely high pressure and/or temperature
- Incorrect tightening dimension
- Gasket failure

### **Finding The Problem:**

- Check the operating pressure.
- Check tightening dimension and alignment of heads.
- If pressure is within limits and tightening dimension is correct, leak is due to gasket failure.

### **Corrective Action:**

- Restore pressure and temperature to within acceptable levels.
- Re-tighten plate pack, see page 10 of this manual.
- Open the plate pack, see page 8 of the manual and replace the damaged gaskets.
- Alternatively, remove the plates containing the damaged gasket.
- Close the plate pack. Make sure to obtain the new tightening dimension if any plates have been removed.



## **Symptom 4:** **Internal leakage (Cross Leak)**

### **Possible Causes:**

- Hole in plate

### **Finding The Problem:**

- Shut the exchanger down (See page 7) of the manual and drain both sides.
- Disconnect the nozzles of one circuit and apply a slight water pressure to the other circuit.
- By looking into the open circuit, it is possible to locate the approximate location of the leak.
- Open Viexplate® (see page 8)
- Pinpoint the leaking plate(s) by:
  1. Visual inspection of gaskets and plates close to the leak. Look for cracks, pin holes, discoloration of the plate, etc.
  2. Holding the plate against the light might reveal cracks or pin holes in the plate.
  3. Dye penetrant test: Spray the back side of the plate with the dye-penetrant liquid and the other side with the developer. Cracks will be visible after 5-10 minutes.

### **Corrective Action:**

- Replace any defective plates.

### **Remarks:**

- If the failure is due to corrosion, inspect all plates since corrosion will occur normally along the entire plate pack.

## **Symptom 5:** **Extremely low thermal performance** **and very high pressure drop**

### **Possible Causes:**

- Channel throat blocked with debris
- Blocked channels
- Plates installed incorrectly

### **Finding The Problem:**

These conditions typically cause high pressure drops or low flow rates.

- Accurately measure the inlet and pressures as close as possible to the exchanger.
- Compare recorded values to the design values.

### **Corrective Action:**

- If accumulation of debris inside the port and throat areas is suspected, back-flushing at high flow-rate is recommended.
- If back-flushing is not possible or does not solve the problem, the blocking particles might be lodged in the channels. Open the unit and remove debris.

### **Remarks:**

- If problem is not identified, contact VIEX for assistance.

## **Symptom 6:** **Impaired performance associated** **with heat transfer decline**

### **Possible Causes:**

- Fouling
- Actual physical properties of fluids different from those of design
- Lower flow-rates
- Presence of non-condensable gases
- Steam condensate flooding the channels.

### **Finding The Problem:**

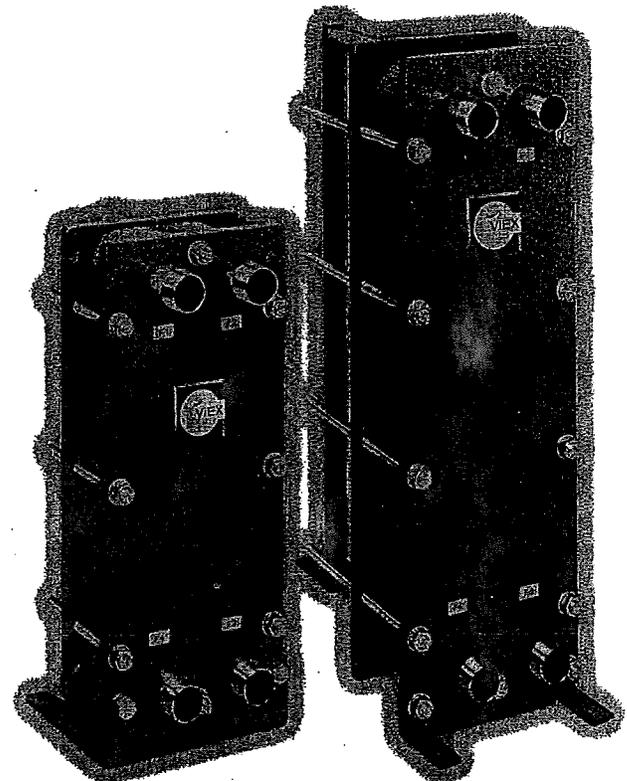
- Accurately measure the inlet and outlet temperatures and pressures as close as possible to the exchanger.
- Accurately measure the flow-rates.
- Compare recorded values to the design values.
- Confirm the physical properties of the fluids.

### **Corrective Action:**

- If the heat transfer decline is due to fouling, clean the heat exchanger according to an appropriate method.
- If low performance is due to different physical properties or low operating flow rates, contact VIEX for advice.
- If the problem is caused by flooding of the plates, the steam traps/vacuum pump may need to be repaired or resized and replaced.

### **Remarks:**

- If problem is not identified, contact VIEX for assistance.



# NOTES



# ViEX Inc

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e-mail: info@viex.com • www.viex.com

## SPARE PARTS INQUIRY / ORDER FORM

PO# \_\_\_\_\_

**SHIPPING ADDRESS:**

Company Name: \_\_\_\_\_

Address: \_\_\_\_\_

City, Province / State: \_\_\_\_\_

Postal / Zip Code: \_\_\_\_\_

Purchasing Contact: \_\_\_\_\_

Phone Number: \_\_\_\_\_

**INVOICING ADDRESS:**

Company Name: \_\_\_\_\_

Address: \_\_\_\_\_

City, Province / State: \_\_\_\_\_

Postal / Zip Code: \_\_\_\_\_

Purchasing Contact: \_\_\_\_\_

Phone Number: \_\_\_\_\_

**HEAT EXCHANGER MODEL:** \_\_\_\_\_ **SERIAL #:** \_\_\_\_\_ **WO #:** \_\_\_\_\_

If the heat exchanger has been modified since installation, please provide the following information:

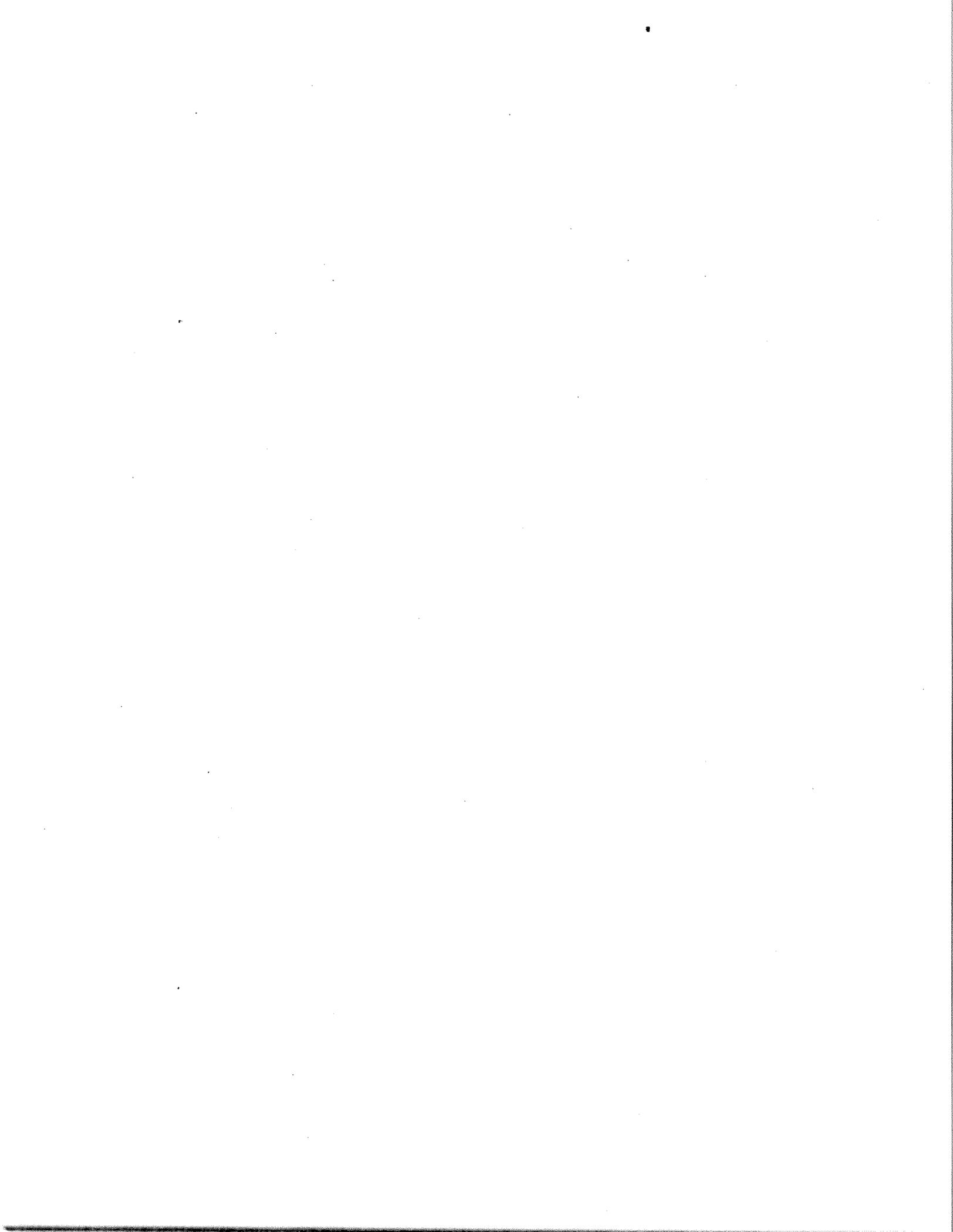
- Present number of plates: \_\_\_\_\_
- Present plate material and thickness: \_\_\_\_\_
- Present gasket system (glueless or glued): \_\_\_\_\_
- Present gasket material: \_\_\_\_\_

**MATERIAL REQUESTED:**

- Complete Gasketed Plate Pack
- Complete Set of Gaskets
- Other (please provide details)

ITEM	QUANTITY	MATERIAL
gasketed plates		
standard gaskets		
4CR gaskets		
port gaskets		







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Address: \_\_\_\_\_

City, Province / State: \_\_\_\_\_

Postal / Zip Code: \_\_\_\_\_

Purchasing Contact: \_\_\_\_\_

Phone Number: \_\_\_\_\_

**INVOICING ADDRESS:**

Company Name: \_\_\_\_\_

Address: \_\_\_\_\_

City, Province / State: \_\_\_\_\_

Postal / Zip Code: \_\_\_\_\_

Purchasing Contact: \_\_\_\_\_

Phone Number: \_\_\_\_\_

**HEAT EXCHANGER MODEL:** \_\_\_\_\_ **SERIAL #:** \_\_\_\_\_ **WO #:** \_\_\_\_\_

If the heat exchanger has been modified since installation, please provide the following information:

● Present number of plates:

\_\_\_\_\_

● Present plate material and thickness:

\_\_\_\_\_

● Present gasket system (glueless or glued):

\_\_\_\_\_

● Present gasket material:

\_\_\_\_\_

**MATERIAL REQUESTED:**

● Complete Gasketed Plate Pack

● Other (please provide details)

● Complete Set of Gaskets

ITEM	QUANTITY	MATERIAL
gasketed plates		
standard gaskets		
4CR gaskets		
port gaskets		

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



# ADDITIONAL INFORMATION

## ORDERING PARTS

When ordering parts and service, always provide the manufacturer's serial number of the exchanger. This information appears in the General Assembly Drawing and on the exchanger's nameplate.

CERTIFIED BY ViEX Inc.	
CHANNEL "A" _____ psig AT _____ °F	
MDMT _____ °F AT _____ psig	
CHANNEL "B" _____ psig AT _____ °F	
MDMT _____ °F AT _____ psig	
SERIAL NUMBER _____	
YEAR BUILT _____	
CRN _____	OIN _____

Figure 7.1 Standard Name Plate

## DAMAGED SHIPMENT

Our equipment is carefully packaged and shipped in good condition. Shipments are made at the consignee's risk. Upon receipt of shipments, carefully inspect the packaging and equipment for damage. In the event of loss or damage all claims should be made to the carrier.

## RETURNING MATERIALS

Units or parts are not to be returned without first obtaining permission from your nearest ViEX Plant. Parts authorized for return must be properly packaged and labeled and in good condition at the ViEX plant. All credits for returned materials will be subject to restocking and transportation charges.

## TECHNICAL INFORMATION AND CUSTOMER SUPPORT

To obtain additional information on the operation, maintenance and care of ViEX equipment you may contact your local ViEX representative or the nearest ViEX facility.

Additional copies of this manual are available at \$10.00 each. Please contact your nearest ViEX representative.

This manual is also available on-line at  
[www.viex.com](http://www.viex.com)

ViEX Group Headquarters - Canada

ViEX Europe

# Compact Heat Exchangers Engineered by ViEX

Viexcoil®  
Plate Coil  
Heat Exchangers

Viexblock®  
Welded Plate  
Heat Exchangers

ViEX provides all customers with top quality products and services,  
intelligent solutions and the most dependable and flexible  
heat transfer vendor resource in the world.

Our business was founded on a long heritage of  
design and build the highest quality, most productive  
and cost-efficient solutions for our customers.

ViEX has strategic supply and sales alliances around the world.

Viexbank®  
Plate Coil Banks

Viexplates®  
Spiral Plate  
Heat Exchangers

We invite your inquiry and questions on any  
ViEX product or specific project.

## ViEX - Your Right Choice In Heat Exchangers!

Viexshell®  
Welded Plate & Shell Heat Exchangers

Viexbox®  
Welded Plate Heat Exchangers



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