NLB MODELS
35201DB, 36201DB & 40201DB
35,000 PSI (2,400.7 bar)
36,000 PSI (2,482.7 bar)
40,000 PSI (2,758.6 bar)

OPERATION, MAINTENANCE & PARTS MANUAL

NLB CORP.

Manufacturer of the National Liquid Blaster

29830 BECK ROAD
WIXOM, MI 48393-2824
(248) 624-5555
FAX (248) 624-0908

PARTS:
IN THE U.S.A., CALL
1-800-227-7652

GENERAL INFORMATION

Every effort has been made to include the most up-to-date information at the time of publication of this manual. However, the possibility exists that subsequent product changes made by NLB Corporation may cause the information in this manual to be rendered inaccurate. In the event that an information conflict is found to exist between this manual, other publications or the condition and function of your equipment, NLB must be contacted for clarification prior to operating or servicing the equipment.

Caution:

The information contained in this manual may be rendered inaccurate if the equipment described herein is modified in any way, without the authorization of NLB, or that said equipment is not maintained or operated in a proper manner as instructed in this manual. NLB assumes no responsibility or liability for equipment that has been modified, for equipment that incorporates any non-NLB manufactured parts as components or for equipment that has not been maintained or used in the manner set forth in this manual. In that event, all NLB warranties, either express or implied, are void.

WARNING:

THE EQUIPMENT DESCRIBED IN THIS MANUAL AND THE INFORMATION CONTAINED IN THIS MANUAL SHOULD ONLY BE USED BY PERSONS WHO ARE KNOWLEDGEABLE AND HAVE BEEN TRAINED IN THE OPERATION AND/OR MAINTENANCE OF EQUIPMENT OF THE TYPE DESCRIBED HEREIN. THE EQUIPMENT OWNER AND/OR USER SHOULD INSPECT THE EQUIPMENT PRIOR TO ITS USE OR SERVICE IN ORDER TO MAKE CERTAIN THAT IT IS IN GOOD WORKING ORDER AND FREE FROM DEFECT. ALL APPLICABLE OPERATION, USE AND SERVICE MANUALS DESCRIBING THE FORESEEABLE USES OF THE EQUIPMENT MUST BE READ AND UNDERSTOOD. THE EQUIPMENT MUST ONLY BE USED IN THE MANNER SET FORTH IN THIS MANUAL, AS SUPPLEMENTED BY ALL APPLICABLE FEDERAL, STATE AND LOCAL LAWS, ORDERS AND REGULATIONS THAT PERTAIN TO THE OPERATION AND USE OF THE EQUIPMENT. IF THIS EQUIPMENT IS OPERATED BEYOND ITS INTENDED CAPACITY OR FORESEEABLE USE, IS MISUSED, MODIFIED OR ABUSED IN ANY WAY WHATSOEVER, OR IF IT IS NOT MAINTAINED IN ACCORDANCE WITH THE INSTRUCTIONS CONTAINED IN THIS MANUAL, WITH NLB APPROVED PARTS; DEATH, SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT.

NLB WARRANTY WILL BE VOIDED IF NON-NLB MANUFACTURED REPLACEMENT PARTS ARE USED. NLB'S WARRANTY IS VOID AS TO ANY DAMAGES CAUSED TO THE EQUIPMENT OR BY THE EQUIPMENT AND TO EXCLUDE ANY LIABILITY AS A RESULT OF INJURY, IF SUCH DAMAGE OR INJURY CAN BE LINKED TO THE SUBSTANDARD REPLACEMENT PART.

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CALIFORNIA

PROPOSITION 65 WARNING

DIESEL ENGINE EXHAUST AND SOME OF ITS CONSTITUENTS ARE KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER, BIRTH DEFECTS, AND OTHER REPRODUCTIVE HARM.

FOREWORD

YOUR **NLB** HIGH PRESSURE WATER JETTING UNIT WAS DESIGNED AND MANUFACTURED TO PROVIDE OPTIMUM PERFORMANCE OVER A LONG LIFE. IT HAS BEEN CAREFULLY INSPECTED AND TESTED AT ITS SPECIFIED RATING.

THE PURPOSE OF THIS MANUAL IS TO PROVIDE INFORMATION CONCERNING THE OPERATION AND MAINTENANCE OF YOUR HIGH PRESSURE WATER JETTING UNIT. THIS MANUAL WILL BE YOUR GUIDE TO PERFORM MAINTENANCE THAT WILL KEEP YOUR UNIT PERFORMING AT PEAK EFFICIENCY WITH A MINIMUM OF REPAIRS; AND WILL GUIDE YOU WHEN REPAIRS ARE NECESSARY.

THIS MANUAL IS DIVIDED INTO NINE SECTIONS, 1-10 WITHOUT SECTION 9 (SECTION 9 IS RESERVED FOR FUTURE ADDITIONS). THE SECTIONS ARE AS FOLLOWS:

SECTION 1	DESCRIPTION AND SPECIFICATIONS
SECTION 2	SAFETY
SECTION 3	OPERATING
SECTION 4	TROUBLE SHOOTING
SECTION 5	MAINTENANCE
SECTION 6	REPAIR
SECTION 7	SPECIAL TOOLS
SECTION 8	PARTS
SECTION 10	CUSTOMER SUPPORT
	MANUFACTURERS' LITERATURE

Section 1

DESCRIPTION & SPECIFICATIONS

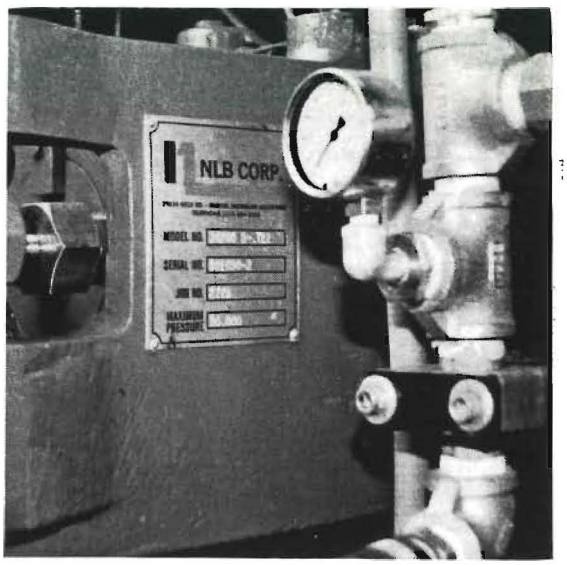
SECTION 1

DESCRIPTION & SPECIFICATIONS

INDEX

MODEL AND SERIAL NUMBER

THE MODEL AND SERIAL NUMBERS ARE THE IDENTIFICATION OF THE MAJOR COMPONENTS. NLB CONTINUOUSLY STRIVES TO IMPROVE EQUIPMENT AS NEW DEVELOPMENTS OCCUR. WITH THE MODEL AND SERIAL NUMBER INFORMATION, THE EXACT CONFIGURATION OF YOUR UNIT CAN BE DETERMINED. A STAMPED PLATE IS PERMANENTLY RIVETED TO THE HIGH PRESSURE PUMP AND THE ENGINE HOUSING OR CONTROL PANEL. THEY ARE LOCATED AS SHOWN IN THE FOLLOWING PICTURE. IT IS IMPORTANT, WHEN ORDERING REPLACEMENT PARTS FOR EACH UNIT, THAT THE MODEL AND SERIAL NUMBERS BE INCLUDED IN THE ORDER.



MODEL AND SERIAL NUMBER ON PUMP

FEATURES OF THE HIGH PRESSURE PUMP

THE **NLB** MODEL 36201/40201 HIGH PRESSURE PUMP IS A HORIZONTAL, TRIPLEX, PLUNGER-TYPE POWER PUMP WITH A V-BELT DRIVE OR AN OPTIONAL BOLT-ON GEAR PAC, FOR DIRECT CONNECTION (THROUGH A FLEXIBLE COUPLING TO AN ENGINE).

THE TRIPLEX POWER END IS THE SAME AS USED ON THE **NLB** 10150, 20150, 20156 AND 30200 PUMPS. THIS DESIGN HAS BEEN PROVEN BY YEARS OF FIELD OPERATION.

THE OPTIONAL GEAR-PAC HAS THE FOLLOWING FEATURES:

A. BOLTS TO A STANDARD POWER END. A SMALLER COUPLING IS REQUIRED THAN FOR AN ENGINE MOUNTED GEAR.

B. CAN BE MOUNTED ON THE OPPOSITE SIDE OF THE HIGH PRESSURE PUMP IF EVER NECESSARY TO REVSE ROTATION.

C. GEAR AND PINION ARE CROWN-SHAVED, MADE OF FORGED ALLOY STEEL.

D. GEARS HAVE AN AGMA SERVICE FACTOR OF 2.

E. HIGH THERMAL POWER RATING – WILL OPERATE IN AN AMBIENT AIR TEMPERATURE OF 104°F *(40°C).*

THE LIQUID END IS A RUGGED, SIMPLE DESIGN, WITH ADVANCED CONCEPTS FOR HIGH EFFICIENCY, LONG LIFE, AND EASY MAINTENANCE. FEATURES INCLUDE THE FOLLOWING:

A. THE FRAME PLATE BOLTS AND ALIGNS TO THE FACE OF THE POWER FRAME. IT IS THE BACK BONE OF THE LIQUID END. IT SUPPORTS ALL OTHER COMPONENTS OF THE LIQUID END. THE FRAME PLATE IS MADE OF HIGH-GRADE CARBON STEEL AND IS NICKEL-PLATED TO MINIMIZE CORROSION.

B. LIQUID END COMPONENTS ARE RETAINED BY HIGH STRENGTH STEEL BOLTING THAT THREADS INTO THE CARBON STEEL FRAME PLATE. EXCEPT FOR THE SUCTION AND DISCHARGE CONNECTIONS, THERE ARE NO THREADS IN ANY OF THE STAINLESS STEEL PARTS, MINIMIZING THE POSSIBILITY OF GALLING THE STAINLESS STEEL.

C. ALL PRESSURE-CONTAINING PARTS ARE MADE OF HIGH-STRENGTH STAINLESS STEEL, CERTIFIED FOR CHEMICAL AND PHYSICAL PROPERTIES.

D. THE MANIFOLD IS SEPARATED FROM THE AREAS OF THE LIQUID END EXPOSED TO FULL PRESSURE EXCURSIONS. (IT SEES A STEADY DISCHARGE PRESSURE IN THE DISCHARGE PORT AND A STEADY SUCTION PRESSURE IN THE SUCTION PORT.)

E. THE VALVE SEATS CLAMP BETWEEN THE MANIFOLD AND THE PRESSURE SLEEVES.

F. THE SUCTION AND DISCHARGE VALVES ARE CONCENTRIC. THE SUCTION VALVE IS A DISC-TYPE VALVE. THE DISCHARGE VALVE IS A BEVEL-SEAT WING-GUIDED VALVE.

G. O-RINGS ARE USED ONLY ON THE PUMP MANIFOLD. THEY ARE EXPOSED TO STEADY PRESSURES ONLY.

H. A RAISED METAL-TO-METAL SEALING FACE IS PROVIDED AT EACH END OF THE PRESSURE SLEEVE. THESE SEALS ARE THE ONLY STATIC SEALS EXPOSED TO THE FULL PRESSURE EXCURSIONS AS THE PUMP RUNS.

I. THE PACKING CARTRIDGE IS EASILY REMOVED FOR CONVENIENT PACKING REPLACEMENT ON A WORK-BENCH.

J. THE PACKING IS SPRING-LOADED, ELIMINATING REQUIREMENTS FOR ADJUSTMENT. (THERE IS NO GLAND.)

K. THE PLUNGER IS SOLID TUNGSTEN CARBIDE. IT IS CLAMPED AND ALIGNED TO THE CROSSHEAD STUB WITH A NUT AND CIRCULAR SNAP RING.

L. OIL OR OPTIONAL WATER LUBRICATION FOR THE PACKING IS PROVIDED ON THE ATMOSPHERIC SIDE, FROM A MECHANICAL LUBRICATOR DRIVEN FROM THE END OF THE PUMP CRANKSHAFT.

M. THE OIL OR WATER FLOWS THROUGH CLEAR TUBES TO THE PACKING, ALLOWING VISUAL MONITORING OF THE FLOW. THE SMALL-DIAMETER TUBES FILL QUICKLY DURING INITIAL OPERATION, AND THE SMALL COPPER TUBE, AT THE FLANGE, INHIBITS LOSS OF OIL FROM THE TUBE DURING IDLE PERIODS. WATER SPRAY ON THE PLUNGERS IS NOT REQUIRED, MINIMIZING DISPOSAL REQUIREMENTS.

FEATURES OF THE SYSTEM

THE SYSTEM IS DESIGNED TO LENGTHEN THE LIFE OF BOTH PUMP COMPONENTS AND SYSTEM COMPONENTS. FEATURES INCLUDE:

A. A WATER TANK AT ATMOSPHERIC PRESSURE. THIS ALLOWS MUCH OF THE DISSOLVED AIR TO FLASH OUT OF SOLUTION AND SEPARATE FROM THE WATER. (DISSOLVED AND ENTRAINED AIR CAUSE SERIOUS PROBLEMS WITH RECIPROCATING PUMPS.)

B. A LOW-WATER-LEVEL SHUT-DOWN SWITCH TO STOP THE ENGINE IF THE WATER DROPS TO A LOW LEVEL.

C. TANDEM INLET FILTER: A 10 MICRON FILTER IN SERIES WITH A SIX MICRON FILTER. (SOLIDS SHORTEN THE LIVES OF MANY SYSTEM COMPONENTS - ESPECIALLY PUMP PACKING AND PLUNGERS.)

D. A CENTRIFUGAL CHARGING PUMP WHICH:

   1. IS DRIVEN FROM THE INPUT SHAFT. (IT RUNS ONLY WHEN THE POWER PUMP RUNS.)

   2. PROVIDES A POSITIVE SUCTION PRESSURE TO THE POWER PUMP.

   3. MAKES PRIMING EASY. IT QUICKLY FILLS THE POWER PUMP AND DISCHARGE SYSTEM.

E. A CLEAR, FLEXIBLE HOSE BETWEEN THE CENTRIFUGAL AND POWER PUMP WHICH

   1. ENABLES THE OPERATOR TO SEE THE WATER FLOWING INTO THE POWER PUMP.

   2. ABSORBS PULSES FROM THE POWER PUMP, SO THAT THE CENTRIFUGAL PUMP AND GAUGE ARE EXPOSED TO MINIMAL PULSATIONS.

F. AN ACOUSTIC TYPE (NO MOVING PARTS) DISCHARGE PULSATION DAMPENER WHICH REDUCES THE POWER PUMP DISCHARGE PULSE. THIS REDUCES STRESSES ON BOTH THE PUMP AND DISCHARGE SYSTEM.

G. A REMOTELY MOUNTED ACCESSORY MANIFOLD WHICH CONTAINS THE DISCHARGE GAUGE, RUPTURE DISC, AND CONNECTIONS FOR THE BY-PASS VALVE AND DISCHARGE HOSE. MOUNTING THIS MANIFOLD DOWNSTREAM OF THE PULSATION DAMPENER EXTENDS THE LIVES OF THE AUXILIARY EQUIPMENT.

H. A LIQUID-FILLED DISCHARGE PRESSURE GAUGE.

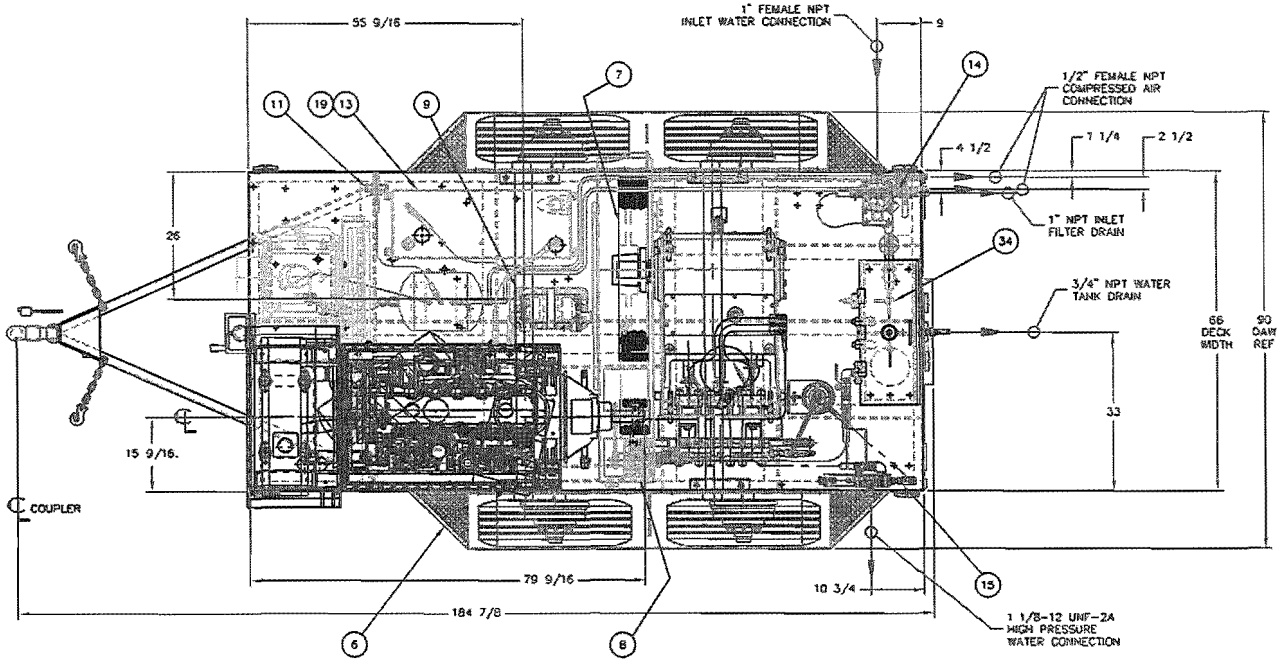
I. AN OIL-DAMPED BY-PASS VALVE.

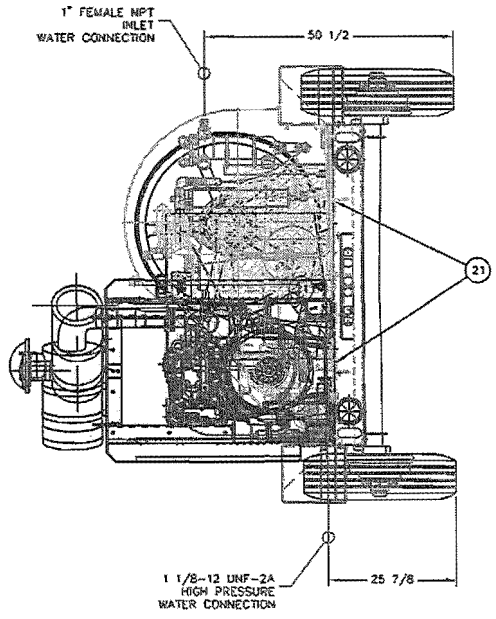
J. TWO RUPTURE DISCS: ONE AT THE PUMP AND ONE AT THE ACCESSORIES MANIFOLD.

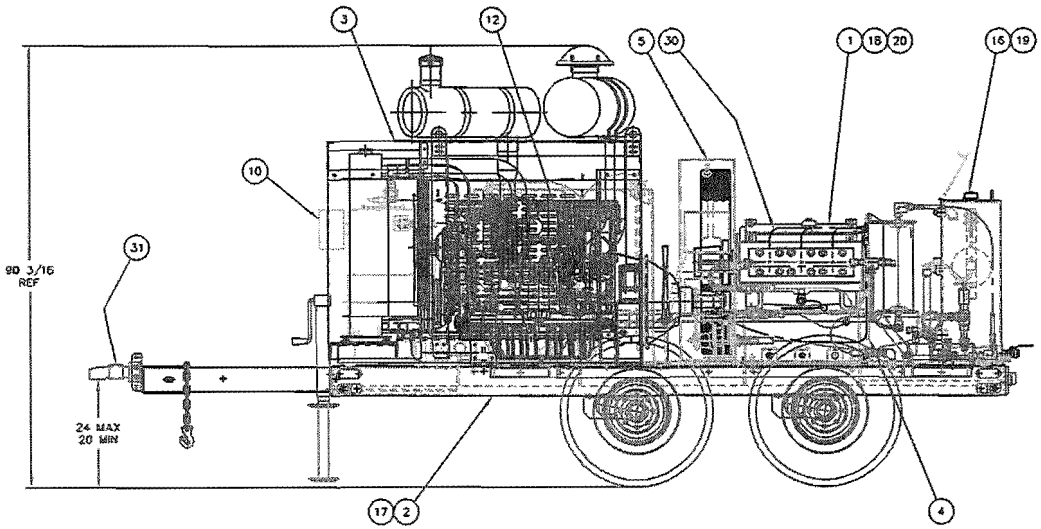
SPECIFICATIONS AND RATINGS

LIQUID END

PLUNGER DIA:	0.660" *(16.7MM)*
STROKE LENGTH:	4.25" *(10.8 CM)*
MAXIMUM WORKING PRESSURE (PSI):	35,000 *(2,400.7 BAR)* 36,000 *(2,482.7 BAR)* 40,000 *(2,758.6 BAR)*
DISPLACEMENT (US GPM):	6.0 *(22.7 LPM)*
HIGH PRESSURE PUMP CRANKSHAFT RPM:	431
VOLUMETRIC EFFICIENCY AT MAXIMUM PRESSURE:	90%
MAXIMUM OPERATING TEMPERATURE (OF WATER):	100°F (38°C)
MINIMUM REQUIRED SUCTION PRESSURE (PSIG):	30 *(2.1 BAR)*
CONNECTIONS	
SUCTION:	1/2" NPT
DISCHARGE:	9/16" 60,00PSI *(4,137.9 BAR)*
MATERIALS OF CONSTRUCTION, ALL WETTED PARTS:	STAINLESS STEEL
PACKING:	SQUARE-RING SEALS
PACKING LUBRICATION:	ATMOSPHERIC-PRESSURE WATER FROM PLANT INLET WATER SUPPLY ATMOSPHERIC-PRESSURE OIL FROM MECHANICAL LUBRICATOR (OPTIONAL)
GEAR-PAC RATIO (OPTIONAL):	7.16:1







NOTE:
HOLE PATTERNS IN TRAILER MAY NOT BE THE INTENDED LOCATION OF COMPONENTS. REFER TO DIMENSIONS ON THIS DRAWING AND COMPONENT ASSEMBLY DRAWINGS.

REV	DESCRIPTION	DATE	BY

MATERIAL: SEE BOM
40201DBA-TRA

TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED
.00 ±.010 MACHINED SURFACES 63
.000 ±.005 OTHER SURFACES 125
.0000 ±.0005
FRACTIONS ±1/32 ANGLES ± 0°
REMOVE ALL BURRS AND SHARP EDGES

DO NOT SCALE DRAWING

NLB Corp.

DR.	DEARNLEY	DATE 6/12/06
CK.	JPE HEYNER	DATE 06/12/06
SCALE	1"=12"	SHEET 1 OF 1

TITLE
40201DBA-TRA
LIQUID BLASTER
CAT C6.6

DRAWING NO. DM23928 REV.

40201DBA-TRA
DM23928

ITEM #	PART #	DESCRIPTION	QTY
1	36200A	PUMP, BARE	1 EA
2	MFS4508	TRAILER	1 EA
3	BM23239	ENGINE, DIESEL 213 HP	1 EA
4	DM12027	BASE, PUMP	1 EA
5	DM23926	GUARD, BELT, V-BELT DRIVE	1 EA
6	DM9957	TRAILER, COMPONENTS	1 EA
7	DM15951	DRIVE, COMPONENTS	1 EA
8	DM23884	PUMP, COMPONENTS, BOOST	1 EA
9	CM19248	BATTERY, COMPONENTS	1 EA
10	DM23873	COMPRESSOR, ASSEMBLY	1 EA
11	DM23917	PIPING, PNEUMATIC	1 EA
13	DM24530	PIPING, FUEL TANK	1 EA
14	DM15955	PIPING, INLET/SUCTION	1 EA
15	DM23931	PIPING, DISCHARGE	1 EA
16	DM15957	PIPING, WATER TANK	1 EA
17	BM4224	TAGS, CONNECTION & DRAIN	1 ST
18	NLE7290-1	TAGS, SUB-BOM	1 EA
19	PM13863	DECAL, ULTRA CLEAN 40	2 EA
20	CP9118	COVER, INSPECTION	1 EA
21	BM11623	PLATE, MOUNTING	4 EA
30	CM23030	PIPING, WATER LUBE	1 EA
31	PM15497	COUPLER, TRAILER	1 EA
34	301-BB	SHUTDOWN, LOW WATER LEVEL	1 EA
48	DE21611	DIAGRAM, ELECTRICAL	1 EA

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SECTION 2

SAFETY

IMPORTANT:

PLEASE READ THIS SECTION COMPLETELY BEFORE OPERATING ANY OF THE HIGH PRESSURE WATER JETTING EQUIPMENT.

WARNING:

NLB WARRANTY WILL BE VOIDED IF NON-NLB MANUFACTURED REPLACEMENT PARTS ARE USED. NLB'S WARRANTY IS VOID AS TO ANY DAMAGES CAUSED TO THE EQUIPMENT OR BY THE EQUIPMENT AND TO EXCLUDE ANY LIABILITY AS A RESULT OF INJURY, IF SUCH DAMAGE OR INJURY CAN BE LINKED TO THE SUBSTANDARD REPLACEMENT PART.

I. Safety Precautions That Must Be Observed By User

Refer to the *SAFETY* section before operating any high pressure water jetting components. **Do not** operate this or any high pressure water jetting component or system without first reading and understanding the *SAFETY* section. If the *SAFETY* section is missing from this binder, call NLB at 1-800-226-7652 for a free copy.

Safety Signs:

All NLB high pressure water jetting equipment have safety signs strategically placed on the equipment. If any become marred, painted over, or in any manner unreadable, contact NLB for free replacements. These signs are furnished as an aid to training employees and as a reminder to operators and their fellow employees. The safety signs are not intended to be used as a substitute for a specific company training program covering the operation and safety of the equipment. It is supervision's responsibility to call these signs to the attention of all personnel.

A. Operator Safety Equipment

NLB offers complete operator safety suits for high pressure waterblasting operations and recommends the use of all operator and jobsite safety equipment that is available. NLB also offers operation, maintenance & parts manuals and jobsite barrier marking tape.

Caution:

The use of hearing protection is advised when operating this equipment.

TURTLESKIN® WATERARMOR™

TurtleSkin® and WaterArmor™ are trademarks of Warwick Mills.

Item	Part Number	Description
1	**TWA**	TurtleSkin® WaterArmor™
2	**TWA-vest**	Vest
3	**TWA-chaps**	Chaps
4	**TWAG**	Gaiters
5	**MB-951-size (07 through 13)**	Boots, with steel metatarsal guard, sizes 7-13 available
6	**HC-69**	Hard Hat
7	**7**	Face Shield Holder
8	**10**	Face Shield
9	**1100**	Goggles

Item	Part Number	Description
10	**6780**	Rubber Gloves
11	**MX-01**	Wet Suit, Small
	MX-02	Wet Suit, Medium
	MX-03	Wet Suit, Large
	MX-04	Wet Suit, X-Large
	MX-05	Wet Suit, XX-Large

Jackets and pants are also available separately. To order a jacket, simply add "01" to the part number of the suit size you need. To order pants, add "02".

EXAMPLES: Large suit: MX-03
Large jacket: MX-03-01
Large pants: MX-03-02

B. Pre-Service Safety Check List

The Pre-Service Safety Check List (*Figure 2-1*) is attached to all NLB high pressure water jetting units. If it becomes marred, painted over, or in any manner unreadable, contact NLB for a free replacement.

Identical printed forms are available from NLB. In addition to checking off the information on the unit decal, the job foreman should also fill out and sign one (1) of the printed forms to be maintained in the company.

PRE-SERVICE SAFETY CHECK LIST – HIGH PRESSURE WATER CLEANING

DATE:_____LOCATION:_____

EQUIPMENT BEING SERVICED:_____

		YES	NO	N/A
1	IN THE AREA, INCLUDING OTHER END OF UNIT BEING SERVICED, CLEAN, ROPED OFF, AND PROPER SAFETY SIGNS POSTED?			
2	HAVE PRECAUTIONS BEEN TAKEN TO PROTECT ELECTRICAL EQUIPMENT FROM WATER?			
3	IS THERE ANY HAZARD TO PERSONNEL FROM POSSIBLE DAMAGE TO EQUIPMENT SUCH AS RELEASE OF CORROSIVE CHEMICALS, FLAMMABLE LIQUIDS OR GASES, ETC.?			
4	ARE ALL FITTINGS OF THE CORRECT PRESSURE RATING?			
5	ARE ALL HOSES OF THE CORRECT PRESSURE RATING?			
6	ARE ALL HOSES IN GOOD OPERATING CONDITION?			
7	ARE ALL FITTINGS IN GOOD OPERATING CONDITION?			
8	ARE ALL NOZZLES FREE FROM PLUGGING? AND IN GOOD OPERATING CONDITION?			
9	HAVE PRECAUTIONS BEEN TAKEN TO PREVENT LINEMOLE REVERSAL?			
10	IS THE FILTER ON THE PUMP SUCTION CLEAN AND IN GOOD OPERATING CONDITION?			
11	IS THERE A MINIMUM 20 PSIG FRESH CLEAN WATER SUPPLY AT PUMP SUCTION?			
12	HAVE PRECAUTIONS BEEN TAKEN AGAINST FREEZING?			
13	DO ALL PERSONNEL HAVE THE PROPER SAFETY EQUIPMENT FOR THIS JOB?			
14	DO ALL PERSONNEL HAVE THE PROPER SAFETY TRAINING FOR THIS JOB?			
15	ARE ALL MEN QUALIFIED TO PERFORM THIS WORK?			
16	ARE EXPLOSIVE OR FLAMMABLE VAPORS POSSIBLE AND ARE MONITORING PROVISIONS ESTABLISHED?			
17	IF ANSWER TO 16 IS "YES", DO NOT USE DEMINERALIZED WATER OR CONDESATE AND GROUND LANCE EQUIPMENT BEING CLEANED.			
18	IS THERE ANY DANGER FROM THE WASTE WATER OR FROM THE REACTION OF THE SCALE AND WATER?			
19	IF ANSWER TO 18 "YES", HAS PROPER PERSONAL PROTECTIVE EQUIPMENT BEEN SUPPLIED TO PREVENT INJURY, AND HAS PERSONNEL BEEN INFORMED OF THIS ADDITIONAL HAZARD?			
20	HAS COMPLETE HOOK-UP BEEN FINISHED PRIOR TO INSTALLING NOZZLES?			
21	HAS HOOK-UP, INCLUDING PIPES, HOSES AND CONNECTIONS, BEEN PRESSURE TESTED WITH WATER AT MAXIMUM OPERATING PRESSURE?			
22	IS DUMP SYSTEM OPERATING PROPERLY? (WILL IT DUMP WHEN RELEASED)?			
23	ARE SAFETY SYSTEMS OPERATIONAL?			

Figure 2-1. Pre-Service Safety Check List.

C. Recommended Safety Procedures Decal

The recommended Safety Procedures Decal (*Figure 2-2*) is attached to all NLB high pressure water jetting units. If it becomes marred, painted over or in any manner unreadable, contact NLB for a free replacement.

IMPORTANT RECOMMENDED SAFETY PROCEDURES

AS WITH ALL POWER TOOLS, THE NATIONAL LIQUID BLASTER MUST BE USED IN ACCORDANCE WITH SPECIFIED SAFETY PROCEDURES AND COMMON SAFETY SENSE. TO AID IN INSURING THAT THIS EQUIPMENT IS OPERATED WITH A MAXIMUM AMOUNT OF SAFETY. WE HAVE PREPARED THE FOLLOWING LIST OF RECOMMENDATIONS. THIS LIST IS NOT INTENDED TO BE ALL INCLUSIVE AND ADDITIONAL SAFETY PRECAUTIONS SHOULD BE FOLLOWED. AS THEY ARE DICTATED BY THE APPLICATION. PLANT SAFETY PROCEDURES AND PARTICULAR WORKING CONDITIONS.

1. SAFETY EQUIPMENT TO BE WORN BY OPERATORS.
   A. GOGGLES
   B. HARD HELMET WITH EAR PROTECTION
   C. STEEL TOED SHOES
   D. HEAVY-DUTY RUBBER UNIFORMS AND GLOVES

2. THE LANCE MUST ALWAYS BE DIRECTLY POINTED AT THE WORK AREA.

3. THE OPERATOR MUST MAINTAIN GOOD FOOTING.

4. NON OPERATORS MUST REMAIN A SAFE DISTANCE FROM THE OPERATOR. THE DISTANCE SHOULD BE A MINIMUM OF 25 FEET.

5. NON OPERATORS SHOULD NEVER APPROACH THE OPERATOR WITHOUT FIRST TURNING THE SAFETY ELECTRICAL SWITCH OFF AT THE UNIT.

6. THE OPERATING PRESSURE SHOULD NEVER EXCEED THAT WHICH IS NECESSARY TO ACCOMPLISH THE JOB.

7. NO UNAUTHORIZED ATTACHMENTS OR MODIFICATIONS SHOULD BE MADE TO THE UNIT. THE CLEANING GUN, OR THE ACCESSORIES.

8. OPERATORS SHOULD BE CHANGED ON FREQUENT INTERVALS TO AVOID FATIGUE.

9. OPERATORS AND ALL PERSONS WITHIN THE OPERATING AREA SHOULD NOT ENGAGE IN "GOOFING OFF" PRACTICES.

10. EQUIPMENT SHOULD BE PROPERLY MAINTAINED AS OUTLINED IN THE MAINTENANCE MANUAL.

11. ALL OPERATORS SHOULD BE PROPERLY TRAINED AS OUTLINED IN THE MAINTENANCE MANUAL.

12. EQUIPMENT SHOULD BE CLEANED OFTEN TO PREVENT DIRT AND OTHER BUILD-UPS.

Figure 2-2. Recommended Safety Procedures Decal.

II. Safety Aspects of High Pressure Water Cleaning Systems

For maximum operational safety, the following equipment and manual procedures must be used where applicable:

A. Equipment

High Pressure Pump
The principal component of the high pressure water jetting cleaning system is usually a positive displacement high pressure pump which discharges water into a common manifold to which flexible hoses or lances with nozzles or other cleaningor cutting accessories are attached. The pumps are appropriately powered and can be either mobile or permanently mounted. They shall never be operated above NLB's recommended operating pressure.

Relief System
The system shall be equipped with an automatic relief device on the discharge side of the pump, adjusted so that the maximum allowable working pressure of the system is not exceeded by more than 3%.

Pressure Gauge
The system shall be equipped with a gauge to indicate the pressure being developed.

Filter or Strainer
The water system shall be equipped with a filter or strainer to prevent particles from entering the high pressure pump and damaging the plungers.

Dump System
The system shall be equipped with a device which will by-pass the flow or dump the discharge pressure to a safe level immediately when actuated. An operator shall control this dump system.

Hose Assembly
Hose assemblies used on the discharge side of the pump shall have a safety factor of 3.0 based on the manufacturer's rated minimum burst pressure.

Fittings/Valves
All fittings and valves used in the discharge side of the pump shall have a safety factor of 3.0 based on the tensile strength of the materials.

Electrical Controls
All electrical controls handled by personnel shall be either fail safe, low voltage or protected with an approved ground fault circuit interrupter.

B. Personal Protective Equipment

It is essential that each operator wear the appropriate protective equipment to accomplish the job safely. The following is a list of NLB recommended safety equipment:

Body Protection
Liquid resistant suits

Head Protection
Head protection equipment – hard hats

Eye and Face Protection
Protective eye and face equipment – face shields

Foot Protection
Steel-toed boots

Hand Protection
NLB safety gloves

Ear Protection
Ear plugs or other suitable protection shall be worn when noise level exceeds OSHA recommended levels.

Recommendation
The safety engineer or someone thoroughly familiar with the potential hazards to be found at the location where the work is being performed should be consulted prior to starting work to determine potential environmental and/or personal problems peculiar to that specific task. If any are determined to exist, appropriate action must be taken prior to starting the job.

C. Pre-Operational Procedures

Planning
Pre-job planning shall take place prior to start of any job. Personnel familiar with the equipment to be cleaned and the environment of the work area shall meet with the personnel who will be doing the cleaning or cutting and outline the potential hazards of the work area, environmental problems and safety standards.

Check List
A safety and equipment check list shall be used.

Barricades
Barricades shall be erected to enclose hazardous areas. Barricades may be rope, safety tapes, barrels, etc., as long as an effective visible barrier is provided.

Hook-Up
Inspect all hoses and fittings for evidence of excessive wear and damage prior to installing.

Hoses should be laid out in a safe and orderly manner.

Hoses, pipes and fittings shall be supported to prevent excessive sway, vibration or stress on end connections. Hoses should be protected to prevent kinking or excessive wear.

Nozzles
Before installing the nozzle, the system shall be completely flushed with sufficient water to remove air and foreign particles.

Inspect all nozzles for damage and/or plugged orifices before installing. The high pressure water jetting unit should be shut off and disconnected before installing nozzles.

D. Operational Procedures

Work Area
All personnel working or entering the barricaded area while cleaning or cutting is in progress shall wear the required protective equipment in accordance with the job conditions.

Pressuring System
Pressure shall be increased slowly on the system while being inspected for leaks and/or faulty components. All leaks or faulty components shall be repaired or replaced. System shall be de-pressurized to effect repairs.

Caution:
Never leave the system unattended when pressurized.

E. Training

Cutting Action
Demonstrate the cutting action and potential hazard involved through the use of audio-visual aids or actual use of the equipment. Cut through a piece of lumber, dissect a grapefruit, etc.

Personal Protective Equipment
Explain the minimum personal protective equipment required. Instruct *when* and *how* specific limb guards, special clothing and other types of devices should be worn per type of work performed, locations, etc.

System Operation
Explain the operation of the system, pointing out potential problems and proper corrective action.

Safety Devices
Explain the reason for, and operation of, safety devices. Stress the importance of not tampering with any safety devices.

Hose
Explain the proper method of connecting hoses, including laying out without kinks, protection from excessive wear and proper tools to use on couplings and fittings.

General
The system shall be de-pressurized any time the system is not in use.
The system shall be de-pressurized any time an unauthorized person enters the barricaded area.
The system shall be de-pressurized when any replacement or repairs are made to the system.

III. Recommended Practices For The Use Of Manually Operated High Pressure Water Jetting Equipment

A. Introduction

These recommended practices cover the personnel requirements, operator training, operating procedures, and recommended equipment for the proper operation of all types of high pressure water jetting equipment as normally used by industries concerned with construction, maintenance, repair, cleaning, and demolition work. Attention is drawn to the relevant or proposed OSHA, ASTM and ANSI standards. It is intended that extension to this code will be produced in due course to cover specialist applications (e.g., multiple-gun operation, pulsed jets, cutting with the use of abrasives and high pressure intensifiers) but in the meantime, these practices should be used as afar as practicable.

The use of high pressure water jets for cutting and cleaning is a rapidly evolving technology with current developments occurring. For this reason, these practices are dated and the association shall bi-annually review these practices for any required changes.

B. Scope

1. The recommended practices are intended to provide guidance on the proper operation of high pressure water jet cleaning and cutting equipment.

2. In this document, the word "shall" indicates a requirement that is to be adopted in order to comply with these recommended practices.

3. The term "high pressure water jetting" covers all water jetting, including the use of additives or abrasives at pressures above 1000 psi (*70 bar*) approximately.

4. These recommended practices are also applicable at lower pressures where there is foreseeable risk of injury. As a guideline, the recommended practices are applicable where the product of pressure- measured in psi (*bar*), times flow- measured in gallons per minute (*liters per minute*) exceeds 2,000 psi times gpm (*560 bar* times *lpm*).

5. Any person required to operate or maintain high pressure water jetting equipment shall have been trained and have demonstrated the ability and knowledge to do so.

C. Definition of Terms

1. **High pressure water jet systems** – High pressure water jet systems are water delivery systems which have nozzles or other openings whose function is to increase the speed of liquids. Solid particles or additional chemicals may also be introduced, but the exit in all cases will be a free stream.

   In terms of these recommended practices, the "system" shall include the pumps (pressure producing devices) and the hoses, lances, nozzles, valves, and safety devices, as well as any heating elements or injection systems attached thereto.

2. **High pressure water cleaning** – The use of high pressure water, with or without the addition of other liquids or solid particles, to remove unwanted matter from various surfaces where the pressure of the liquid jet at the orifice exceeds 1,000 psi (*69 bar*).

Caution:

The lower limit of 1000 psi (69 bar) does not mean that pressures below 1000 psi (69 bar) cannot cause injury or require any less attention to the principles of these recommended practices. Adequate precautions, similar to those of these recommended practices, are required at all pressures.

3. **High pressure water cutting** – The use of high pressure water, with or without the addition of other liquids or solid particles, to penetrate into the surface of a material for the purpose of cutting that material, and where the pressure of the liquid jet exceeds 1,000 psi (*69 bar*).

4. **Lancing** – An application whereby a lance and nozzle combination is inserted into and retracted from the interior of a pipe or tubular product.

5. **Dump system** – An operator controlled, manually operated device or system that rapidly reduces the pressure to a level that yields a pressure flow at the nozzle that is considerably below the risk threshold.

6. **Moleing** – Moleing is an application whereby a hose, fitted either with a nozzle or with a nozzle attached to a lance, is inserted into and retracted from the interior of a tubular product. It is a system commonly intended for cleaning the internal surfaces of pipes or drains.

   It can be self-propelled by its backward directed jets, and is manufactured in various shapes, sizes and combinations of forward and backward directed jets.

7. **Nozzle** – A device with one (1) or more openings where the fluid discharges from the system. The nozzle restricts the area of flow of the liquid, accelerating the water to the required velocity and shaping it to the required flow pattern and distribution for a particular application. Combinations of forward and backward nozzles are often used to balance the thrust. Such nozzles are commonly referred to as tips, jets, orifices, etc.

8. **Operator** – A person who has been trained and has demonstrated the knowledge and experience to perform the assigned task.

9. **Operator trainee** – A person not qualified due to the lack of knowledge and/or experience to perform the assigned task without supervision.

10. **Shotgunning** – An application whereby a lance and nozzle combination can be manipulated in virtually all planes of operation.

11. **Hose Assembly** – A hose with coupling attached in accordance with manufacturer's specifications.

12. **Lance** – A rigid metal tube used to extend the nozzle from the end of the hose.

D. Equipment Definition and Standards

1. **Pressurizing high pressure pump** – A unit designed to deliver high pressure water or other fluid. This is usually based on positive displacement pistons or rubber diaphragm/hydraulic systems, and discharges water into a common manifold to which either flexible hoses, or rigid tubing, connecting to lances and nozzles are attached. These high pressure pumps can be either mobile or permanently mounted.

   The pump should have a permanently mounted tag or tags providing the following information:

- Product and supplier
- Production model and serial number or year of production
- Maximum performance in terms of flow– measured in gpm (*lpm*), and pressure– measured in psi (*bar*)
- An outline of recommended safety procedures

2. **Relief system** – The system shall be equipped with an automatic relief device on the discharge side of the high pressure pump.

3. **Automatic pressure relief devices** – These may take the form of:

a. **Pressure relief valve (by–pass valve) or bursting disc (rupture disc) in holder** – Usually mounted on the pump discharge chamber to prevent the pressure exceeding the rated maximum pressure of the whole system.

b. **Automatic pressure regulating valve (unloading valve)** – Limits the pressure at which the high pressure pump operates by releasing a preset proportion of the generated flow back to the pump suction chamber or to waste. It may be used to regulate the water pressure from the pump and is individually set for each operation. This device may be integral with the pump hydraulic assembly. Where there is no demand for pumpage, the water pressure is brought down to zero.

c. **By–pass valve** –A device which can be adjusted to control the flow, and thus the pressure, of the jet stream issuing from the nozzle by by–passing the excess flow to another circuit.

4. **Pressure gauge** - The system should be equipped with a gauge indicating the pressure being developed. Gauges shall have a scale range of at least 50% above the maximum working pressure of the system.

5. **Filter or strainer** - The water system should be equipped with a filter or strainer to prevent particles from restricting the orifices in the nozzle. The filter or strainer should be capable of removing particles smaller in size than the smallest orifice in the nozzle, and usually smaller to protect high pressure pumps, etc.

6. **Dry shut-off control valve** - This operator-controlled valve, normally hand-controlled, automatically shuts off flow to the lance and/or nozzle assembly when released by the operator, but retains the operating pressure within the supply line when so shut-off. This valve shall be used in systems with an automatic pressure regulating valve (IIID#3b above).

Caution:

Care should be taken to release the pressure in the dry shut-off valve and line when the pump is shut down, otherwise the valve operating lever may remain alive.

This valve may alternatively be actuated by solenoid or pilot pressure mechanism.

7. **Dump system** - The system should be equipped with a device which will either shut down the unit, idle it to a safe rpm, by-pass the flow, or reduce the discharge pressure to a low level. The dump system actuator device should be shielded to preclude inadvertent operation. This device should immediately shut off the high pressure water stream if the operator loses control.

a. **Dump control valve** - This operator-controlled valve, normally hand-controlled, automatically terminates significant flow to the lance and/or nozzle assembly when released by the operator, thus relieving the operating pressure within the whole system by diverting the flow produced by the pump to atmosphere. A valve size should be selected that will not cause generation of or significant back pressure at the maximum possible pumping rate of the pump. This valve may alternatively be actuated by solenoid or pilot pressure mechanism.

b. **Solenoid and electronically operated control dump systems**- All electrically controlled dump systems should be of fail safe design. Voltage of an alternating current (AC) or direct current (DC) dump system handled by personnel should not exceed 24 volts.

8. **High pressure hose** - This is a flexible hose which connects two (2) components and which delivers the high pressure fluid to the gun or nozzle components. The hose should have a burst rating of a minimum of two and one half (2.5) times the intended working pressure. Operating levels below this ratio should require a protective shielding around that hose. The hose should be marked on one (1) end with the manufacturer's symbol, the serial number and the maximum permissible operating pressure and test pressure. The high pressure hose should be tested at one and a half (1.5) times the working pressure.

9. **End fittings and couplings** – High pressure hose and end fittings and couplings shall be manufactured to be compatible with the hose and tested as a unit.

10. **Jetting gun extension** – This is a length or lengths of tube carrying high pressure fluid to the nozzle. Each shall be manufactured from suitable material for the application. End connections shall be suitable for the application. The extension is used in conjunction with a control valve (IIID#6 and IIID#7 above). The extension shall have a minimum burst strength of at least two and a half (2.5) times the highest actual operating pressure being used.

11. **Nozzle** – The nozzle creates the water jet, or jets, at the required velocity, flow rate, pressure, shape, and distribution for a particular application. Combinations of forward and backward directed water jets are often used to balance the thrust. Such nozzles may be referred to as tips, jets or orifices.

12. **Water jet** – A jet stream of water produced from the individual outlet orifice of a nozzle. The shape of the jet is determined by the form of the orifice while the speed at which it travels is determined by the orifice design, orifice area and flow. The pressure drop at the orifice is a result of an increase in velocity. The most commonly used jet shapes are the straight-jet and fan-shaped jet.

a. **Straight jet** – Concentrates the stream of water over a small area of the workpiece by minimizing the spread. A typical application is for cutting or for general cleaning of matter with higher shear and/or bond strength.

b. **Fan jet**– Spreads the stream of water in one (1) plane, so giving a wide band coverage of the work piece. A typical application is for cleaning larger areas requiring less energy to remove unwanted matter.

13. **Jetting hand manifold and spray bars** – These are pieces of equipment into which individual nozzles are fitted.

14. **Foot control valve** – The lance/gun operator's control valve (IIID#6 and IIID#7 above) may be arranged for actuation by the operator's foot if desired, either in place of, or in addition to the hand-control.

    An adequate guard should be fitted to prevent accidental operation and the base plate area should be sufficient to ensure stability in use. If on the dump type (IIID#7 above), the layout should ensure that the dump line, if used, is restrained from whipping when the valve is released.

15. **Jetting gun** – A portable combination of operator's control valve (IIID#6 and IIID#7 above) and nozzle (#11 above) which resembles a gun in layout and outline.

    The control valve is hand-operated, generally by a squeeze action of the hand of the operator, who should always have control of this device and may be of the dry shut off (IIID#6 above) or dump (IIID#7 above) type, the gun being named accordingly. The hand-control normally takes the form of a trigger or lever which should be provided with either a guard adequate to prevent accidental operation, or the means of being

immobilized in the "OFF" position by means of a safety catch. The gun may be fitted with a shoulder pad or hand grips to facilitate back thrust control.

16. **Retro gun** – A retro safety gun is fitted with forward and backward facing jets. This reduces the thrust experienced by the operator. This type of gun is used mainly for underwater high pressure water jetting operations. The retro balance jet protection tube should be sufficiently long or constructed so as to prevent the operator from directing a retro balance jet at himself.

17. **Changeover valve** – An operator-controlled valve designed to properly direct high pressure water flow from the pump (IIID#1 above) to one (1) or another items of equipment at the operator's choice. It shall be designed to withstand the maximum pressure and can be power operated.

E. Care and Maintenance of Equipment

1. **High Pressure Water Jetting Unit** – The unit shall be maintained in accordance with NLB's instructions. Where applicable, this should include daily checks on the following items:

a. **Drive** – Lubricating oil, water, hydraulic fluid, and fluid levels

b. **High pressure pump** – Lubricating oil and gear box oil levels

c. **Hydraulic hose reel** – Lubricating oil and fluid levels

d. **Condition of guards and shields** – Wear and/or damage

2. **Filters and strainers** – All water filters should be checked at regular intervals, dependent upon the supply water conditions and in accordance with NLB's recommendations.

   Extreme care should be taken to filter the water source through proper micron filtration, to prevent foreign particles from cutting changeover valves and seating surfaces and to prevent clogging the changeover valve operating mechanism. Such clogging can cause a loss of control, which can be dangerous to the lance/gun operator.

3. **Hose assemblies** – All hose assemblies shall be inspected prior to use with respect to the following:

a. Correct pressure rating and size

b. Free from external damage – e.g., exposed or broken wires

c. All end fittings and couplings are in good order and of the correct pressure rating for the unit operating pressure

4. **Nozzles** – All jetting nozzles shall be kept clean and the orifice shall be checked to ensure that it is not obstructed or damaged before installation. Defective nozzles shall not be used but should be replaced or repaired before installation. During the start-up,

prior to operation, the nozzle should be removed from the lance and the system flushed thoroughly to remove air and foreign particles.

5. **Jetting guns and lances** – Jetting guns and lances shall be checked daily and the trigger mechanism and guard given a thorough visual examination to ensure correct operation. All high pressure connections should be observed during operation of the equipment at pressure. If a leak is observed, the high pressure water jetting unit shall be shut down and the connection repaired or replaced before further operation.

6. **Foot control valves** – All foot control valves shall be checked and cleaned daily and the foot mechanism and guard given a thorough visual examination to ensure correct operation.

7. **Electrical Equipment** – All electrically operated high pressure water jetting units shall be checked daily for external damage with special emphasis placed on connection, junction boxes, switches, and supply cables. Care should be taken to ensure that the electrical system is protected from the ingress of water. Correct direction of rotation of the electric motor should be checked on initial installation and after every re–connection.

8. **Trailers** – Mounted high pressure water jetting units shall be checked daily examining tires, braking systems, jacking points, towing hitch, lights, safety chains, structural damage, and general cleanliness. The units should only be towed by vehicles fit for the purpose.

9. **Engine controls** – All throttle cables and engine stop devices shall be checked daily to ensure that they are functioning properly.

10. **Maintenance servicing and repair**

The following operations should only be carried out by competent personnel:

a. NLB's servicing requirements

b. The following items should be overhauled and checked for correct functioning at manufacturer's recommended intervals:

- Pressure relief valve (by–pass valve)
- Bursting discs (rupture discs)
- Pressure control valve
- Hand or foot operated dump control valve, shut off control valve
- Dry shut off valve or dump system
- Changeover valve

11. **Tools** – When maintaining or assembling high pressure water jetting systems, the correct size tools must be used. The use of adjustable tools with serrated gripping jaws,

(e.g., pipe wrenches) which can damage equipment, is not recommended, particularly on the crimped portion of a hose fitting.

12. **Compatibility** – All component parts and fittings should be checked to ensure they are of the correct size and rating for the unit.

F. Protective Clothing and Personnel Protection

1. **OSHA compliance** – All applicable OSHA regulations covering personal protective equipment shall be followed.

2. **Head protection** – All operators shall be issued with suitable head protection which shall be worn, where possible. This should also include a full face shield.

3. **Eye protection** – Suitable eye protection (i.e., adequate for the purpose and of adequate fit on the person) shall be provided to all operators of high pressure water jetting equipment, and must be worn within the working area. Additionally, several states have regulations governing eye protection which must be conformed with.

Caution:

Where liquids liable to cause eye damage are encountered, it may be necessary to use either a combination of visor and goggles or a full face shield.

Where liquids liable to cause eye damage are encountered, it may be necessary to use either a combination of visor and goggles or a full hood shield.

4. **Body protection** – All operators should be supplied with suitable waterproof clothing having regard to the type of work being undertaken. Garments should provide full cover to the operator–including the arms. Liquid or chemical resistant suits shall be worn when there is a reasonable probability of injury that can be prevented by such equipment.

5. **Hand protection** – Adequate hand protection should be supplied to all operators and shall be worn when there is a reasonable probability of injury that can be prevented by such equipment.

6. **Foot protection** – All operators should be supplied with waterproof boots with steel or aluminum toe–caps. A metatarsal guard should also be used by water jetting lance/gun operators.

7. **Hearing protection** – Most high pressure water jetting operations produce noise levels in excess of 90 dB (A), consequently, suitable ear protection issued in accordance with OSHA standards must be worn and provision should be made for its regular inspection and maintenance. All personnel and operators should receive instruction in the correct use of ear protectors so that noise exposure lies within the limits as specified by OSHA.

8. **Respiratory protection** – A respiratory protection program shall be implemented where there is a reasonable probability of injury that can be prevented by such a program.

9. **Equipment limitations** – It should be recognized that protective equipment may not necessarily protect the operator from injury by direct high pressure water jet impact.

G. Pre-Operating Procedures

1. **Planning** – Each job shall be preplanned. Personnel familiar with the equipment to be cleaned or the material to be cut and the work environment shall meet with the personnel that will be doing the work and outline potential hazards of the work area, environmental problems, safety standards, and emergency aid procedures.

2. **Check List** – A check list shall be used to assure that the proper procedures and proper equipment selection are followed. (See page 2–5.)

3. **Dump Valve** – All systems shall incorporate at least one (1) fluid shut off or dump device. The lance operator must always be able to shut down the water jet by releasing pressure on the trigger, switch or foot valve pedal.

4. **Warning barriers** – Barricades shall be erected to encompass the hazard area and signs posted to warn personnel that they are entering a hazardous area. The perimeter should be outside the effective range of the water jet wherever possible. Barriers may be of rope, safety tape, barrels, etc., as long as they give an effective warning and are highly visible.

5. **Hook-up**

a. **Hose** – Hose shall be arranged so a tripping hazard does not occur. Hoses, pipes and fittings shall be supported to prevent excessive sway and/or wear created by vibration or stress of the end connections when laid on the ground, over sharp objects or on vertical runs.

b. **Fittings** – All fittings shall be cleaned and lubricated before installing in the system. Be sure all fittings, hoses and nozzles are fit for the purpose.

c. **Hose** – All hoses shall be checked for evidence of damage, wear or imperfection. The check shall be made periodically during the operation.

d. **Pre-flushing** – The system shall be completely flushed with sufficient water to remove any contaminants before installing the nozzle.

e. **Nozzle** – All orifices shall be checked in all nozzles for any stoppage, damage or imperfections.

f. **Electrical equipment** – Any electrical equipment in the immediate area of the operation that presents a hazard to the operator shall be de-energized, shielded or otherwise made safe.

H. Procedures

1. **Work area** – Where practical, work pieces to be jetted should be removed from plant areas to a high pressure water jetting area. Where this is impractical, cutting or cleaning in place, or adjacent to the installed position, can be done with the necessary clearance and permission of the occupier.

a. **Area limits** – Area limits applicable to the cutting or cleaning operations shall be defined and the team shall mark these limits by barriers and notices to warn against access to other personnel. Suitable barriers shall be an approved form of hazard warning, rope or tape, as a minimum. Alternatively, a suitable barrier shield is acceptable at any reasonable distance. Notices should state the following (or in other suitable wording):

"DANGER
KEEP CLEAR,
HIGH PRESSURE WATER JETTING IN OPERATION"

b. **Corrosive materials** – Where there is a possibility of encountering corrosive or toxic materials, the occupier shall be requested to inform the person in charge of high pressure water jetting of any precautions that may be necessary, including the collection and disposal of waste materials.

c. **Work surface** – Operators should have good access to the work piece, a safe working platform and secure footing. The area in which work is to proceed shall be kept clear of loose items and debris to prevent tripping and slipping hazards.

d. **Access** – Access by unauthorized persons into the area where high pressure water jetting is taking place shall be prevented. The area shall be cordoned off and warning notices displayed in prominent positions. The perimeter should be outside the effective range of the water jet wherever possible.

e. **Approaching the operator** – The occupier shall be requested to inform all personnel likely to require access to the area that high pressure water jetting is in progress. Personnel having reason to enter the water jetting area should wait until the water jet is stopped and his presence is made known. Personnel wishing to have the jet stopped shall approach a team member other than the lance/gun operator. The lance/gun operator shall not be distracted until the water jet has been stopped.

f. **Side protection** – Target and side shields shall, where feasible, be suitably placed to safeguard personnel and equipment against contact with grit or solids removed by water jets.

g. **Protective equipment** – All personnel working or entering the barricaded area while cleaning or cutting is in progress shall wear the required protective equipment.

2. **Pressurizing the system** – Pressure shall be increased slowly on the system while being inspected for leaks and/or faulty components. All leaks or faulty components shall be repaired or replaced. System shall be de-pressurized for repairs.

3. **Team operations** – In most water jetting operations, it is accepted practice to employ a minimum of two (2) persons.

a. **Supervision** – All high pressure water jetting operations shall be controlled by a supervisor who is trained in all aspects of the high pressure water jetting operation.

b. **Number of operators** – The operation of the high pressure water jetting equipment should be by two (2) or more operators according to the equipment being used and the nature of the job. These operators shall work as a team with one (1) member in charge. The operator of the gun or lance (as defined below) shall take the lead role while jetting is in progress.

c. **Lance/Gun operator** – One (1) operator from the team shall hold the lance/gun or delivery hose with the nozzle mounted on it. His primary duty is to direct the water jet.

d. **Second operator** – The second operator of the team shall attend the high water jetting unit, keep close watch on the first operator for signs of difficulty or fatigue and watch the surrounding area for intrusion by other persons or unsafe situations. If required, he will shut off the pressure until it is safe to continue. Caution should be exercised in shutting off the pressure rapidly as this can cause the loss of footing by the lance/gun operator.

e. **Additional operators** – Further operators are required in the following circumstances:

- To assist the first operator with the handling of the lance if it is too long or too heavy for one (1) man.
- To provide communication if the lance operator is out of sight of the high pressure water jetting unit operator.

f. **Job rotation** – The team members should rotate their duties during any job to minimize fatigue to the operator holding the lance/gun.

g. **Team leader** – The team leader is responsible for basic equipment checks (as detailed below), the preparation of the working area for safe operation and for obtaining a permit to work where and when required.

h. **Code of signals** – Before starting a high pressure water jetting operation, the team members (one [1] of whom must be in charge) shall agree on a code of signals to be used during the operation of the equipment.

i. **Fitness** – The operator and other team members shall be physically and mentally capable of performing the required operations.

4. **Single person operation** – Single person operation is allowed where the pressure does not exceed 2,000 psi (*137.9 bar*) and the flow is less than 20 gpm (*5.2 lpm*).

a. **Single operator guidelines** – All other recommendations pertaining to team operations shall hold.

5. **Shotgunning**

a. **Attendance** – The system shall never be left unattended when pressurized.

b. **Multiple operation** – When more than one (1) shotgunning operation is being performed within the same area, a physical barrier shall be installed or adequate spacing between operators shall be maintained to prevent the possibility of injury from the high pressure water.

c. **Target holding** – Objects to be cleaned shall never be held manually.

d. **Connection protection** – The point where the hose connects to the gun shall be shrouded by a protective device, (e.g., heavy duty hose, shoulder guard, etc.,) so as to prevent injury to operator should hose, pipe or fitting rupture.

e. **Minimum length**– Where practicable, the minimum length of the shotgun lance extension should be four (4) feet (*1.8 m*) from the triggering device to the nozzle.

f. **Hose protection** – Steel braided hoses should be used on air operated fail safe systems to keep the system from being activated by someone stepping on the hose or running over it.

6. **Moleing or Flex lancing**

a. **Control** – The operator inserting the nozzle shall have direct control of the dump system.

b. **Reversing** – A positive method shall be used to prevent the nozzle from reversing direction inside the item being cleaned, such as using a pipe nipple behind the nozzle which has a length larger than the inside diameter of the item being cleaned. This pipe nipple is known as a "stinger" (*Figure 2-3*).

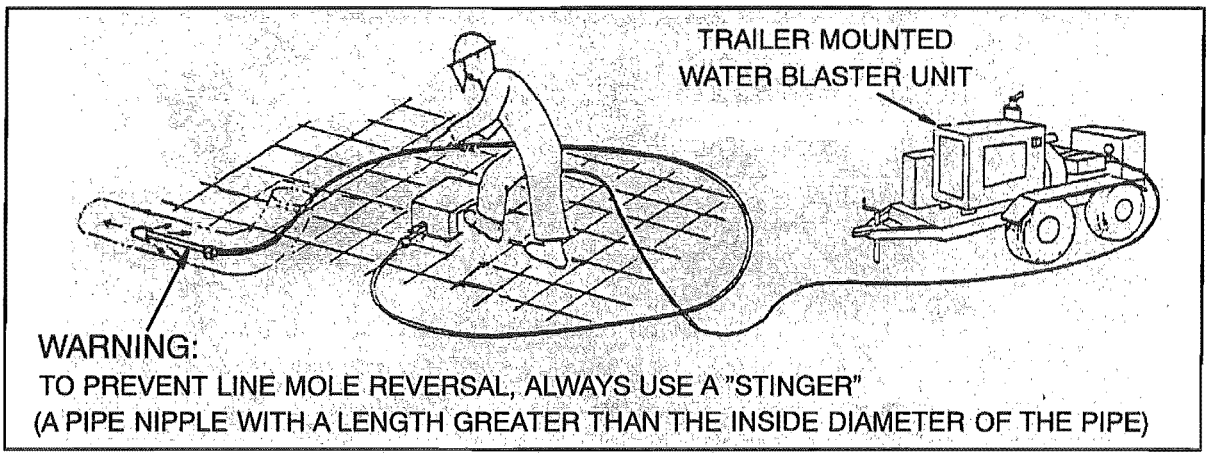


Figure 2-3. Moleing or Flex lancing

c. **Retrojets** – During manual operations, the entrance to a line or pipe shall not be cleaned with a nozzle containing back water jets without adequate shielding.

d. **Clearance** – The clearance between the outside diameter of the hose, lance and nozzle assembly and the inside wall of the item being cleaned shall be sufficient to allow adequate washout of water and debris.

e. **Pressurization** – During manual operation, the nozzle shall be inserted into the tube prior to pressurizing. Conversely, the system shall be de-pressurized before removal of the nozzle from the tube.

f. **End identification** – Hoses shall be conspicuously marked no closer than 24" (*0.6 m*) from the nozzle to warn the operator of the nozzle location.

g. **Nozzle support** – Where the length of the nozzle and rigid coupling is less than the inside diameter of the pipe, a length of rigid pipe (i.e., stinger) not less than the diameter of the pipe being cleaned should be fitted directly behind the nozzle or a suitable safety shield should be provided to protect the operator. This is to prevent the nozzle turning around 180 degrees and doubling back towards the operator.

7. **Rigid lancing**

a. **Control** – The operator inserting the nozzle shall have direct control of the dump system.

b. **Clearance** – The clearance between the outside diameter of the lance and nozzle and the inside wall of the item being cleaned shall be sufficient to allow adequate washout of water and debris.

c. **Pressurization** – When under manual operation, the nozzle shall be inserted into the tube prior to pressurizing. Conversely, the system shall be de-pressurized before removal of the nozzle from the tube, unless proper shielding is provided.

d. **Shields** – When lancing tubes with a rigid lance, a guard should be installed, where practicable, around the lance, to prevent a lance nozzle from being inadvertently withdrawn and causing injury.

8. **Additives**

a. **Additives** – Any water additive (e.g., chemical, detergent or solid particle) shall be used in accordance with the manufacturer's recommendations.

9. **Proper operation**

a. **Start up** – The high pressure water jetting unit shall not be started and brought up to pressure unless each team member is in his designated position, the nozzle is held in, or directed at, the work piece and the lance/gun securely held.

b. **Adjustments** – Apart from operational procedures, no attempt shall be made to adjust any nut, hose connection, fitting, etc., while the system is under pressure. The high pressure water jetting unit shall be stopped and any pressure in the line discharged prior to making any such adjustments.

Caution:

Care should be taken to release the pressure in the dry shut off gun and the line when the unit is switched off.

c. **Equipment malfunction** – If for any reason the water flow does not shut off when the trigger or foot pedal is released, work shall cease until the item has been serviced, repaired or changed by properly trained personnel.

d. **Reaction force** – The lance/gun operator should be allowed to experience the reaction force of the water jet progressively until the required operating pressure is reached. The lowest pressure should be used compatible with the work to be done. The pressure shall not be adjusted without the lance/gun operator's awareness.

e. **Effect of line impulses** – Lance/gun operators should be made aware of the reactive effect of pressure in the line which can transmit a severe jolt to the operator when the dump valve or dry shut off valve is operated. To minimize this effect, total hose lengths should be kept as short as possible. Damping devices can be introduced into the system.

f. **Thermo-plastic hoses** – Thermo-plastic hose should not be used for water jetting unless specifically designed for this purpose.

g. **Operator positioning** – The team members shall be safely positioned while operating the system and if any person should encroach into the working area, high pressure water jetting shall be stopped.

h. **Work stoppage** – Work shall stop when the following occurs:

- In the event that leaks or damage become apparent.
- If any person becomes aware of any change in conditions or any hazards be introduced or exist.
- If plant or work alarms are sounded.
- If any of the recommended practices in this document are not followed.

i. **Hose protection** – All hoses should be protected from being run over and crushed by vehicles, fork lift trucks, etc.

j. **Back thrust** – The back thrust from a linearly directed jet can be calculated from the following equation:

$$\text{Back thrust (lb.)} = 0.052\ Q\ (P)^{0.5}$$

Where: Q is the flow rate in U.S. gallons per minute
P is the jet pressure measure in psi

Caution:

It is not recommended that any one (1) person be required to withstand a back thrust of more than one third (1/3) of their body weight for any extended period of time.

I. Use of Lances and Nozzles

1. **Lances** – Lances which are rigid or semi–rigid having nozzles fitted to with any combination of forward, backward or 90 degree angle jets shall be used with either a dump system or dry shut off control valve. When a flexible lance or nozzle mounted on a hose is in use, the jet should not be operated at pressure unless the nozzle is properly positioned inside the work piece, or the lance operator is protected by screens or proper shielding from rear facing jets. If necessary, the lead–in to the work piece should be cleaned by other methods.

2. **Flexible lances** – Flexible lances used to clean pipes, where the inside diameter of the pipe is not small enough to prevent the lance from turning back on itself, shall have a piece of rigid straight tube, slightly longer than the diameter of the pipe, fitted immediately behind the nozzle to prevent this from happening.

3. **Distance indicator** – When an assembly is used which allows the nozzle to enter the work piece with restricted visibility, the lance, hose or floor should be clearly marked in a manner which enables the lance operator to judge how far the nozzle is in the work piece before pressure is applied and, conversely, so that pressure is released before the apparatus is completely withdrawn from the work piece.

4. **Lance length** – The length of a rigid lance or combination of lances shall be such that the lance operator can maintain control at all times.

5. **Jet pressure** – The nozzle and minimum operating pressure shall be selected by the lance operators to allow effective and efficient high pressure water jetting.

6. **Improper use** – Should a lance operator enter a manhole or access port for any purpose (preferably with the high pressure water jetting unit turned off), the hose shall not be used to support his weight when climbing up or down.

7. **"T" pieces** – When using a "T" piece or nozzle carrier "T" (devices for producing two (2) equal and opposite water jets at the end of the lance and at right angles to the normal flow), it should be inserted into a tube, a vessel, or between two (2) surfaces before the system is pressurized. This is necessary to ensure that should one (1) water jet be larger than the other, or one (1) water jet become blocked or partially blocked, the operator of the lance will not be spun out of control. When a "T" piece is used to provide a balancing jet on a long lance to clean a single surface, it is not always possible to check for equal thrust from both jets in the manner described above, therefore these lances should be checked by progressive pressure increases. This restraint shall also apply to any form of multi–jet nozzle, the jets issuing from which having a radial component.

8. **Confined working** – Before entry into a confined work space for high pressure water jetting, a certificate of clearance shall be obtained to ensure that access is safe.

J. Operational & Training Requirements

1. **Qualified operators** – Only trained personnel shall operate high pressure water jetting equipment and supervise the training of new operators.

2. **Training** – A personnel training program shall be developed by each employer and be presented to each employee before assignment to employee's first high pressure cleaning or cutting job. Such training shall include, as a minimum, coverage of all items listed in these recommended practices.

3. **Cutting action** – The cutting action of a high pressure water jet and the potential hazard it poses to the human body shall be demonstrated through the use of audio/visual aids or actual use of equipment (i.e., by cutting through a piece of lumber, concrete block, etc.).

4. **Personal protective equipment** – The minimum personal protective equipment shall be explained. Instructions shall be given as to when and how specific clothing and other types of protective devices shall be worn according to the type of work performed, locations, etc.

5. **System operation** – The operation of the system shall be explained with potential problems pointed out and proper corrective action.

6. **Control devices** – The operation of all control devices shall be explained. The importance of not tampering with any control devices as well as the importance of keeping them in proper working order shall be stressed.

a. **Equipment maintenance** – It should be pointed out that valves and seating surfaces in pressure regulating devices encounter high wear during high pressure water jetting. These items require frequent inspections, maintenance and/or replacements in order to provide operation.

7. **Hose** – The proper method of connecting hoses, including laying out without kinks, protection from excessive wear, and proper tools to use on couplings and fittings shall be explained.

8. **Stance** – The proper stance for sound footing and how to use the various devices for lancing, shotgunning and moleing shall be demonstrated. The trainee, under close supervision, shall use the various devices while the unit is slowly pressurized.

9. **Proficiency** – Personnel shall demonstrate knowledge and skill in the proper operation of equipment through practical application.

10. **General**

a. System shall be de-pressurized when:

- Not in use
- An unauthorized or inadequately protected person enters the barricaded area

- Replacement or repairs are made to the system
- Any recommended practices are violated

11. **Refresher training** – Operator retraining shall be on an annual basis or more frequently, if needed.

K. Permanent Cleaning Areas

1. **Enclosure** – The areas shall be suitably enclosed and warning notices prominently displayed at the access points and perimeters.

2. **Access** – Access by persons other than the high pressure water jetting team shall be strictly prohibited while work is in progress. If any unauthorized entry is made, all work shall cease immediately.

3. **Hazards** – The working area shall be free from hazards likely to trip personnel and be provided with adequate drainage and lighting fixtures.

L. Freeze Precautions

1. **Freeze precautions** – During the periods where there is a risk of freezing, follow NLB's recommendations or take the following precautions on shutting down:

a. Remove gun or nozzle from delivery hose.

b. Pump water from supply tank until level of water is just above the filter.

c. Add recommended quantity of anti-freeze into water tank.

d. Place delivery hose into water tank and secure.

e. Run the pump until the anti-freeze works through the system.

f. Move selector lever to dump or recycle position until the anti-freeze shows in the water tank.

g. If no supply tank is fitted, follow NLB's recommendations.

WARNING:

IF A HIGH PRESSURE PUMP OR HOSE APPEARS FROZEN, ON NO ACCOUNT MUST THE PUMP BE ENGAGED OR THE ENGINE STARTED IF THERE IS DIRECT DRIVE TO THE PUMP, UNTIL THE SYSTEM HAS BEEN THAWED OUT AND LOW PRESSURE WATER HAS BEEN ALLOWED TO FLOW THROUGH THE SYSTEM TO THE NOZZLE END OF THE LANCE (THE LANCE HAVING BEEN REMOVED).

M. Accidents

1. **Personal injuries** – In the event that a person is injured by the impact of a high pressure water jet, the injury caused may appear insignificant and give little indication of the extent of the injury beneath the skin and damage to deeper tissues. Large quantities of water may have punctured the skin, flesh and organs through a very small hole that may not even bleed.

2. **Operator identification** – Immediate hospital attention is required and medical staff must be informed of the cause of the injury. To ensure that this is not overlooked, all lance/gun operators engaged in high pressure water jetting should carry an immediately accessible waterproof card which outlines the possible nature of the injury and titled with the following text:

   "IMPORTANT MEDICAL INFORMATION!"

   This card is found in the inside pocket of this binder. If the card is missing contact NLB at 1–800–227–7652 for a replacement.

3. **Immediate first aid** – Where medical examination is not immediately possible in remote situations, first aid measures should be confined to dressing the wound and observing the patient closely until medical examination has been arranged.

4. **Reporting** – If any person or equipment is accidentally struck by the water jet, this fact must be immediately reported to a responsible party.

N. Responsibility

1. **Purpose** – These recommended practices are provided to assist persons unfamiliar with the operator of high pressure water jetting equipment.

   The responsibility of correct operation and use of the equipment is the sole responsibility of the operator. The operator should be familiarize himself with the identification of high pressure water jetting metal fittings, hoses, lance/guns, and accessories. Modification of high pressure water jetting equipment or accessories is not recommended without prior written approval by NLB.

   Serious harm or injury may result from the misuse of high pressure water jetting equipment, the use of improper fittings, hoses or improper attachments.

DO.....	DO NOT.....
Contact site engineer, obtain necessary permits and note special precautions.	**DO NOT** commence work on site without necessary permission.
Erect barriers, rope off the clear area. Erect warning signs.	**DO NOT** commence any jetting operation until warning signs are on show and area is roped off.
Ensure adequate water supply.	**DO NOT** operate without adequate personal protection for eyes, head, ears, hands, feet, and body.
Check fluid levels on engine, gearbox and pump (lubrication oil, fuel and water).	**DO NOT** run any equipment with leakage whatsoever, without rectifying.
Lay out equipment and visually inspect for damage (hoses, connections, etc.).	**DO NOT** attempt to tighten any pressure joint while equipment is under pressure.
Assemble equipment, checking all joints.	**DO NOT** by-pass safety cut-outs. *DO* check reasons for malfunctions (low water, blocked filters, low oil level, etc.).
Ensure that filters are clean.	**DO NOT** operate with guns and control valves not functioning correctly (leaking or failing to shut off).
Fully prime equipment and bleed where necessary.	**DO NOT** operate guns or control valves with the operating lever tied back, wedged or locked in the "ON" position.
Fit gun or lances and/or control valves. Visually check that correct size and type of nozzle is fitted for the application.	**DO NOT** operate with badly worn or undersize nozzles.
Increase pressure slowly until operating conditions are reached.	**DO NOT** continue to operate if any unauthorized personnel enter the operating area.
Re-check hose couplings and joints for leaks.	**DO NOT** operate equipment at power levels which can produce a reaction force greater than the lance/gun operator can comfortably absorb.
Rectify all leaks, ensuring that the unit is shut down and line pressure is released before making adjustments.	**DO NOT** leave high pressure water jetting unit running unattended.
Ensure all operators are wearing suitable protective clothing and are correctly positioned.	
Regularly check operating conditions (oil and water pressure, condition of filters, pipe work and hoses).	

DO. . . . . .

Ensure that all pressure in lines is released on any shut down.

Upon completion, strip down equipment and store in clean condition.

Clear the site of barriers, warning signs and debris, to customer's satisfaction.

Upon completion, ensure that customer has signed the necessary paperwork (satisfaction notes, work sheets, etc.).

DO NOT. . . . . .

DO NOT leave equipment unattended on site.

DO NOT store unserviceable equipment (notify supervisor).

DO NOT leave the site in a dangerous or untidy condition.

DO NOT leave site without notifying all parties (engineers, site agents, occupiers, etc.).

SECTION 3

OPERATIONS

SECTION 3

OPERATING

INDEX

CAUTION :

HIGH-PRESSURE WATER - HIGH SOUND LEVEL: AS WITH ANY HIGH-PRESSURE WATER JETTING EQUIPMENT, SPECIAL PRECAUTIONS ARE NECESSARY TO PREVENT PERSONAL INJURY. THIS UNIT PRODUCES VERY HIGH PRESSURE WATER. ANY LEAK THAT OCCURS ANYWHERE ON THE PUMP, OR IN THE DISCHARGE SYSTEM, CAN PRODUCE A DANGEROUS WATER JET. IT IS THEREFORE NECESSARY THAT WATER-JETTING PROTECTIVE CLOTHING, INCLUDING EAR PROTECTORS, BE WORN BY OPERATING PERSONNEL AT ALL TIMES THIS UNIT IS IN OPERATION. OPERATING PERSONNEL MUST BE FULLY TRAINED IN THE PROPER OPERATION OF THIS UNIT.

SOME OF THE WAYS THIS UNIT CAN HURT YOU

1. ANY LEAK FROM THE PUMP OR DISCHARGE SYSTEM CAN PRODUCE A HIGH-VELOCITY CUTTING JET. THE JET CAN CUT SKIN, FLESH, MUSCLE, AND BONE. KEEP AWAY FROM THE UNIT UNLESS ABSOLUTELY NECESSARY FOR BRIEF MONITORING. WEAR PROTECTIVE CLOTHING WHEN NEAR AN OPERATING SYSTEM.

2. WHEN THE PUMP IS RUNNING, A PLUNGER OR STUB CAN SHEAR OFF A FINGER. KEEP HANDS AWAY FROM THE PLUNGER WELL AREA.

3. THE NOISE FROM THE UNIT CAN DAMAGE YOUR HEARING. WEAR EAR PROTECTION.

WAYS TO WRECK YOUR PUMP

1. RUN WATER TANK LOW ON WATER.
2. RUN PUMP ON "WHITE" WATER.
3. RUN PUMP WITH LESS THAN 30 PSI (2.1 BAR) OF SUCTION PRESSURE.
4. RUN PUMP AT A PRESSURE HIGHER THAN RATED FOR PLUNGER DIAMETER.
5. RUN THE POWER END OR OPTIONAL GEAR-PAC LOW ON OIL.

TURTLESKIN® WATERARMOR™

TurtleSkin® and WaterArmor™ are trademarks of Warwick Mills.

Item	Part Number	Description
1	**TWA**	TurtleSkin® WaterArmor™
2	**TWA-vest**	Vest
3	**TWA-chaps**	Chaps
4	**TWAG**	Gaiters
5	**MB-951-size (07 through 13)**	Boots, with steel metatarsal guard, sizes 7-13 available
6	**HC-69**	Hard Hat
7	**7**	Face Shield Holder
8	**10**	Face Shield
9	**1100**	Goggles

Item	Part Number	Description
10	**6780**	Rubber Gloves
11	**MX-01**	Wet Suit, Small
	MX-02	Wet Suit, Medium
	MX-03	Wet Suit, Large
	MX-04	Wet Suit, X-Large
	MX-05	Wet Suit, XX-Large

Jackets and pants are also available separately. To order a jacket, simply add "01" to the part number of the suit size you need. To order pants, add "02".

EXAMPLES: Large suit: MX-03
Large jacket: MX-03-01
Large pants: MX-03-02

3.1 PRE-OPERATING PROCEDURE

CAREFULLY READ SECTION 2 IN THIS BINDER REGARDING SAFETY BEFORE ATTEMPTING TO OPERATE THIS EQUIPMENT.

A. PERFORM ALL APPLICABLE CHECKS LISTED IN PRE-OPERATING CHECKLIST ON PAGE 3 OF THE SAFETY SECTION.

B. LEVEL THE UNIT WITHIN 5°.

C. CHECK OIL LEVEL IN ENGINE CRANKCASE, AS SHOWN IN *FIGURE A*. ADD OIL IF NEEDED.

D. CHECK OIL LEVEL IN HIGH PRESSURE PUMP POWER END, REFER TO *FIGURE B.* ADD OIL IF NEEDED.

E. CHECK OIL LEVEL IN GEAR-PAC (IF EQUIPPED). ADD OIL IF NEEDED.

F. FILL THE OIL PLUNGER LUBRICATOR WITH OIL (IF EQUIPPED), SEE *FIGURE C.*

G. CHECK COOLANT LEVEL IN ENGINE RADIATOR, ADD COOLANT IF NEEDED.

H. CHECK FUEL GAGE ON THE TANK, ADD FUEL IF NEEDED, AS SHOWN IN TO *FIGURE D.*

I. CONFIRM THAT THE INLET WATER FIRST FILTER CONTAINS A TEN (10) MICRON ELEMENT AND THE SECOND FILTER CONTAINS A FIVE (5) MICRON ELEMENT.

J. INSPECT THE WATER TANK. REMOVE ALL DIRT, SAND, GRIT, AND DUST. MAKE SURE THAT IT IS CLEAN. CONNECT THE WATER HOSE TO THE FILTER. FILL THE TANK WITH WATER.

K. DRAIN THE STUFFING BOX DRAIN SUMP LOCATED AT THE REAR OF THE UNIT, SEE *FIGURE E.* THE DRAIN SUMP COLLECTS WATER AND OIL FROM THE PACKING CARTRIDGES.

L. GREASE THE FITTINGS ON THE ENGINE POWER TAKE-OFF. (LOCATION OF FITTINGS MAY VARY WITH ENGINE MODEL.)

M. LAY OUT ALL HIGH PRESSURE HOSES.

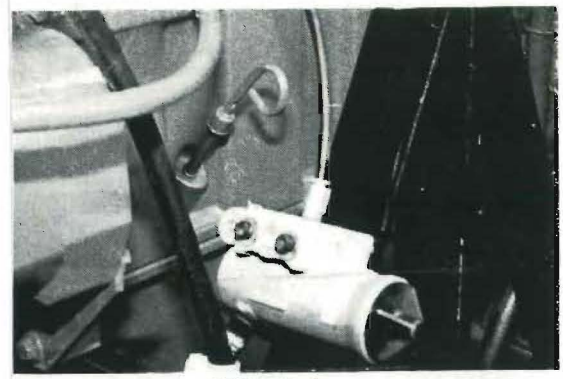


FIGURE A

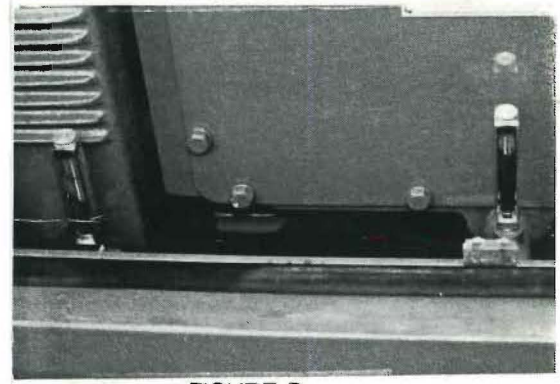


FIGURE B

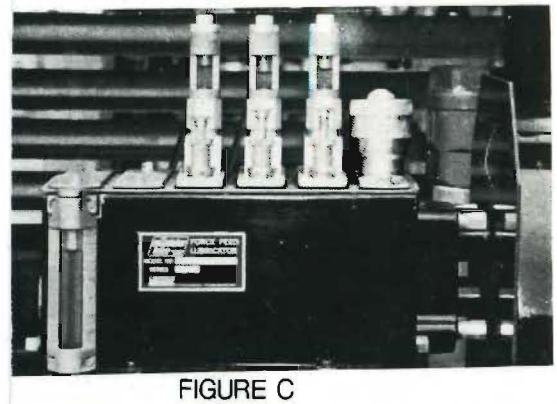


FIGURE C

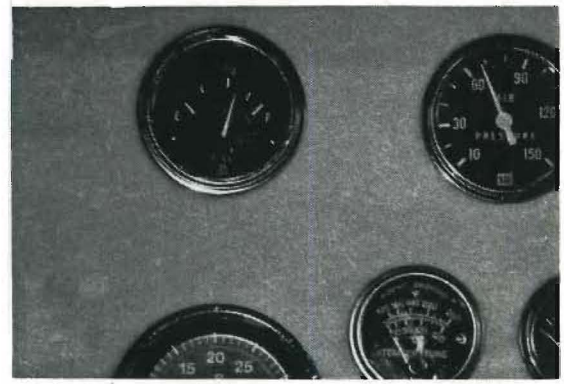


FIGURE D

FIGURE E

N. LOOK AT THE WATER IN THE TANK. IF IT'S DIRTY, DRAIN IT, AND REFILL. IF IT CONTAINS AIR (IF IT LOOKS "MILKY"), DON'T RUN THE PUMP. WAIT (10) TEN MINUTES OR UNTIL ALL AIR IS GONE, BEFORE RUNNING PUMP. (RUNNING A PUMP ON "WHITE" WATER CAN CRACK A PRESSURE SLEEVE, VALVE SEAT, SEAL CARTRIDGE, OR MANIFOLD.)

O. SAFETY - AFTER ALL PRE-OPERATING CHECKS HAVE BEEN COMPLETED, THE SAFETY CHECKS LISTED ON PAGE 4 OF THE SAFETY SECTION SHOULD BE PERFORMED. (MAKE COPIES OF THE MASTER SAFETY CHECK LIST SO THAT A NEW LIST CAN BE USED FOR EACH JOB.)

3.2 ENGINE SPEED ADJUSTMENT - (UNITS EQUIPPED WITH LOR/MURPHY)

THIS UNIT IS EQUIPPED WITH AN AUTOMATIC THROTTLE CONTROL. THE THROTTLE CONTROL USES SYSTEM PRESSURE TO CONTROL ENGINE SPEED. WHEN SYSTEM PRESSURE IS LOW, THE CONTROL KEEPS THE ENGINE AT IDLE SPEED. WHEN SYSTEM PRESSURE IS HIGH, ENGINE SPEED IS HELD AT THE PRESET (LOADED) VALUE.

THE THROTTLE CONTROL MAY BE ADJUSTED FOR ANY DESIRED LOADED ENGINE SPEED, AND LOCKED IN THAT POSITION SO THAT EACH TIME THE LANCE IS ACTUATED, THE ENGINE SPEED WILL INCREASE TO THAT PRESET VALUE.

THE CONTROL SHOULD BE ADJUSTED TO THE IDLE POSITION AT THE START OF EACH JOB OR WHEN THE NOZZLE HAS BEEN CHANGED. AFTER THE CLUTCH IS ENGAGED, AND THE LANCE VALVE TRIGGER IS SQUEEZED, ADJUST THE THROTTLE CONTROL TO PRODUCE THE DESIRED SYSTEM PRESSURE.

ENGINE SPEED IS INCREASED BY TURNING THE THROTTLE HANDLE COUNTER-CLOCKWISE AND IS DECREASED BY TURNING IT CLOCKWISE.

3.3 STARTING & OPERATING PROCEDURE - (UNITS EQUIPPED WITH WITH LOR/MURPHY)

A. COMPLETE ALL PRE-OPERATING AND SAFETY CHECKS.

B. FOLLOW THE OPERATING INSTRUCTIONS FOR THE BY-PASS VALVE AND ALL OTHER SYSTEM COMPONENTS. PREPARE ALL COMPONENTS FOR OPERATION.

C. PUMP THE LUBRICATOR BY HAND UNTIL OIL CAN BE SEEN ON THE TOP OF EACH PLUNGER.

D. DISCONNECT THE HIGH-PRESSURE SYSTEM WATER HOSE FROM THE ACCESSORIES MANIFOLD.

E. LOOSEN THE ADJUSTING SCREW ON THE BY-PASS VALVE.

F. ADJUST THE ENGINE THROTTLE CONTROL TO AN IDLE POSITION. (TURN THE KNOB CLOCKWISE.)

G. TURN KEY TO THE "ON" POSITION.

H. DEPRESS THE TATTLETALE™ PUSH BUTTON AND RELEASE WHEN ENGINE FIRES.

I. PUSH THE STARTER CRANK PUSH BUTTON AND RELEASE WHEN ENGINE FIRES.

J. CONTINUE TO HOLD TATTLETALE™ PUSH BUTTON UNTIL OIL PRESSURE GAUGE NEEDLE MOVES OFF RESETING STOP. TATTLETALE™ PUSH BUTTON IS A FAULT RESET FOR LOW OIL PRESSURE, HIGH ENGINE TEMPERATURE AND HIGH COOLANT TEMPERATURE.

K. OPEN THE VALVE AT THE DISCHARGE OF THE CENTRIFUGAL BOOSTER PUMP.

L. ENGAGE THE CLUTCH.

M. RUN THE HIGH PRESSURE PUMP UNTIL A STEADY STREAM OF WATER IS FLOWING FROM THE ACCESSORIES MANIFOLD.

N. DISENGAGE THE CLUTCH.

O. CONNECT THE SYSTEM HOSE TO THE ACCESSORIES MANIFOLD. (DON'T CONNECT THE LANCE.)

P. ENGAGE THE CLUTCH.

Q. ALLOW WATER TO FLOW THROUGH THE HOSE FOR 1 - 2 MINUTES. (THIS WILL FLUSH LOOSE SOLIDS FROM THE HOSE.)

R. DISENGAGE THE CLUTCH.

S. CONNECT THE LANCE TO THE HOSE.

T. MAKE A CHECK OF THE AREA TO MAKE SURE THAT NO ONE IS IN THE DANGER ZONE AND CLEAR THE AREA.

U. ENGAGE THE CLUTCH.

V. SQUEEZE THE TRIGGER ON THE LANCE.

W. SLOWLY ADJUST THE BY-PASS VALVE AND THE THROTTLE CONTROL UNTIL SYSTEM PRESSURE REACHES THE DESIRED VALUE. FOR OPTIMUM OPERATION, THE BY-PASS VALVE SHOULD BE TIGHTENED JUST TIGHT ENOUGH THAT NO WATER FLOWS FROM THE VALVE. THIS WILL MINIMIZE ENGINE AND PUMP SPEED, WILL CONSERVE FUEL, AND WILL MAXIMIZE THE LIVES OF ALL SYSTEM COMPONENTS.

3.3.1 LOW WATER LEVEL PUSH BUTTON STATION- (UNITS EQUIPPED WITH LOR/MURPHY)

THE LOW WATER LEVEL PUSH BUTTON IS HOUSED IN A METAL ENCLOSURE THAT CONTAINS A PILOT LIGHT, PUSH BUTTON AND A FUEL GAUGE.

DEVICES ON THE PUSH BUTTON STATION ARE DESCRIBED FROM TOP TO BOTTOM.

"LOW WATER LEVEL"

DEVICE: PILOT LIGHT COLOR: RED
ILLUMINATES TO INDICATE A LOW WATER CONDITION.

"FAULT RESET"

DEVICE: PUSH BUTTON
DEPRESS TO RESET A LOW WATER CONDITION.

"FUEL GAUGE"

DEVICE: GAUGE
INDICATES THE AMOUNT OF FUEL AVAILABLE IN THE FUEL TANK.

3.4 SEQUENCE OF OPERATION - (UNITS EQUIPPED WITH LOR/MURPHY)

A. START THE DIESEL ENGINE ACCORDING TO THE INSTRUCTIONS IN THE DIESEL ENGINE MANUAL.

B. IF A LOW WATER FAULT CONDITION OCCURS THE ENGINE WILL GO TO IDLE AND THE RED "LOW WATER LEVEL" PILOT WILL ILLUMINATE.

C. REFILL THE WATER TANK AND RESET THE FAULT BY DEPRESSING THE "LOW WATER RESET" PUSH BUTTON.

3.5 STARTING, OPERATING PROCEDURE, & SEQUENCE OF OPERATION - (UNITS EQUIPPED WITH THE CONTROLS INCORPORATED ELECTRONIC ENGINE CONTROLLER)

REFER TO THE CONTROLS INCORPORATED ELECTRONIC ENGINE CONTROLLER MANUAL LOCATED IN THE MANUFACTURERS' LITERATURE SECTION OF THIS MANUAL FOR OPERATING INSTRUCTIONS.

3.6 ANTI-FREEZING THE HIGH PRESSURE PUMP

WHEN THE HIGH PRESSURE PUMP IS EXPOSED TO AN AMBIENT TEMPERATURE BELOW 32° F (0°C), IT MUST BE FILLED WITH A 50-50 SOLUTION OF RV NON-TOXIC ANTI-FREEZE AND WATER. FOLLOW THESE STEPS:

A. DRAIN ALL WATER FROM THE WATER TANK THROUGH THE DRAIN VALVE.

B. DISCONNECT THE HIGH PRESSURE SYSTEM HOSE FROM THE UNIT. (IF THE HOSE IS TO BE STORED AT THE LOW TEMPERATURE, CAREFULLY DRAIN ALL WATER FROM THE HOSE.)

C. CLOSE THE VALVE BETWEEN THE WATER TANK AND THE STAND-PIPE.

D. OPEN THE VALVE AT THE TOP OF THE STAND-PIPE.

E. FILL THE STAND-PIPE WITH ANTI-FREEZE SOLUTION.

F. START THE ENGINE. ENGAGE THE CLUTCH, AND SIMULTANEOUSLY POUR ANTI-FREEZE SOLUTION INTO THE STAND-PIPE.

G. CONTINUE THIS PROCEDURE UNTIL SOLUTION FLOWS FROM THE UNIT HIGH-PRESSURE DISCHARGE CONNECTION.

H. DISENGAGE THE CLUTCH.

I. SHUT THE ENGINE DOWN.

J. DISCONNECT THE HOSE FROM THE DISCHARGE CONNECTION ON THE BY-PASS VALVE. LET ALL WATER DRAIN FROM THE HOSE.

K. REMOVE BOTH INLET WATER FILTER BOWLS AND CARTRIDGES, AND EMPTY THEM OF WATER.

WARNING:

DO NOT DRAIN THE HOSES AND ASSUME THE HIGH PRESSURE PUMP IS DRAINED. WATER ALWAYS STAYS TRAPPED INSIDE THE PUMP. WATER FREEZING IN THE PUMP WILL DAMAGE THE PUMP. SUCH DAMAGE IS NOT COVERED BY THE WARRANTY.

SECTION 4

TROUBLESHOOTING

SYMPTOM	POSSIBLE PROBLEM	ACTION REQUIRED
Excessive pulsation in high pressure pump discharge	Insufficient water in tank	Fill water in tank. This condition could be caused by water shut off to the high pressure water jetting unit. Check water supply source.
	Pump not primed	Open by-pass on accessory cleaning lance. Engage clutch and throttle engine upwards for one minute or until you observe smooth discharge at by-pass.
	Valves sticking open	This condition is caused by a piece of dirt or a foreign object stuck between the valve and seat. Clean and deburr valve
	Valve springs broken	Replace. See Section 6: REPAIR.
	Valves scored	Replace. See Section 6: REPAIR.
	V-belts slipping	Adjust.
Low capacity and Pump pounds or vibrates	All pumping chambers not primed	Prime all chambers
	Suction pressure too low	Increase suction pressure
	Low water level in tank	Increase water level
	Broken or weak valve spring	Replace spring
	Valve stuck open	Clean and deburr valve
Low capacity (only)	Speed too low	Increase to rated speed
	Pump valves leaking	Relap or replace
	By-pass valve leaking	Repair or replace valve

SYMPTOM	POSSIBLE PROBLEM	ACTION REQUIRED
Pump pounds or knocks (only)	Suction pressure too low	Increase suction pressure
	Low water level in tank	Increase water level
	Broken or weak valve spring	Replace spring
	Plunger nut loose	Tighten nut
	Low oil in power end	Fill to proper level
	Gear tooth cracked or broken	Replace gear
	Excessive clearance in connecting rod bearing	Replace bearing
	Worn crosshead pin or bearing	Replace worn parts
	Excessive end play in main bearings	Reduce end play
Short packing life	Inadequate packing lubrication	Improve lubrication
	Worn packing bushings	Replace bushings
	Worn plunger	Replace plunger
	Worn cartridge bore	Replace cartridge
	Packing installed incorrectly	Install correctly
	Water not properly filtered	Provide proper filtration
Leak from valve seat area	Manifold cap screws not tight enough	Torque properly
	Some cartridge cap screws too tight	Loosen cartridge screws Torque manifold screws Torque cartridge screws
	Scratch in face of sleeve or seat	Lap parts together
	Valve seat cracked	Replace seat
	Pressure sleeve cracked	Replace sleeve

SYMPTOM	POSSIBLE PROBLEM	ACTION REQUIRED
Hot power end (over 180° F) (82°C) and/or short life of power power end parts	Contaminated oil Eliminate contaminant	Fill with clean oil
	Incorrect oil	Fill with correct oil
	Oil level too high	Lower oil level
	Oil level too low	Raise oil level
	Bearings too tight	Increase clearance or end play
	Discharge valve stuck open	Clean and deburr valve
	Inadequate air circulation	Increase air circulation
	Pump exposed to heat source	Shield pump from heat
Leak from weep hole in bottom of frame plate	Cartridge cap screws not tight	Torque properly
	Scratch in face of sleeve or cartridge	Lap parts together
	Packing cartridge cracked	Replace cartridge
Cylinder stud or bolt failure	Not adequately torqued	Torque properly
Broken crankshaft	Discharge pressure too high	Reduce discharge pressure
	Pump pounding	(See "Pump pounds")
	Discharge valve stuck open	Clean and deburr valve

SECTION 5

MAINTENANCE

SECTION 5

MAINTENANCE

INDEX

5.1 GENERAL INFORMATION

A GOOD MAINTENANCE PROGRAM IS NECESSARY TO INSURE A LONG AND USEFUL LIFE OF YOUR NEW EQUIPMENT. NO PIECE OF MACHINERY WILL OPERATE SATISFACTORILY UNLESS IT RECEIVES PROPER AND PERIODIC ATTENTION.

THIS SECTION PROVIDES GENERAL MAINTENANCE INFORMATION, AND A PREVENTIVE MAINTENANCE PROGRAM.

ABNORMAL ENVIRONMENTAL CONDITIONS

A. FREEZING CONDITIONS

TO PREVENT FREEZING OF WATER IN THE FLUID CYLINDER, AND TO PREVENT THE LUBRICATING OILS FROM BECOMING TOO VISCOUS, THIS HIGH PRESSURE WATER JETTING UNIT SHOULD BE PROTECTED FROM FREEZING TEMPERATURES. IF EXPOSURE TO TEMPERATURES BELOW 32°F (0°C) IS UNAVOIDABLE, PROVISIONS MUST BE MADE TO WARM THE POWER END, FLUID END, AND MECHANICAL LUBRICATOR. DURING SHUT-DOWN PERIODS, WATER MUST BE DRAINED FROM THE SYSTEM, AND ANTI-FREEZE PUMPED THROUGH THE SYSTEM. SEE THE ANTI-FREEZING SECTION FOR DETAILS.

B. DUSTY CONDITIONS

AIR-BORNE ABRASIVES WILL DEPOSIT THEMSELVES ON PLUNGERS AND CROSSHEAD EXTENSIONS, SHORTENING THE LIVES OF PLUNGERS, PACKING, EXTENSIONS, AND SEALS; AND MAY BE DRAWN THROUGH THE POWER END BREATHER, CONTAMINATING THE OIL AND SHORTENING BEARING LIFE. EFFORTS SHOULD BE MADE TO PROTECT THE PUMP AGAINST DUST AND GRIT.

C. CORROSIVE VAPORS

ATTEMPTS SHOULD BE MADE TO PREVENT THE EXPOSURE OF THE SYSTEM TO CORROSIVE GASES TO PREVENT CONTAMINATION OF POWER END AND PACKING LUBRICANTS.

D. HIGH HUMIDITY

PUMPS EXPOSED TO HIGH HUMIDITY, UNLESS OPERATED CONTINUOUSLY, WILL ACCUMULATE CONDENSATION IN THE POWER END AND LUBRICATOR. PERIODIC SAMPLES OF OIL SHOULD BE TAKEN FROM DRAIN CONNECTIONS, AND, WHEN WATER IS DETECTED, THE OIL SHOULD BE CHANGED.

E. PRESSURIZING POWER END

DO NOT ATTEMPT TO PRESSURIZE THE POWER END WITH DRY GAS (TO EXCLUDE CONTAMINANTS) WITHOUT A SPECIAL OIL LEVEL INDICATOR. WITH THE STANDARD INDICATOR, ALL OIL WILL BE LOST THROUGH THE VENT HOLE IN TOP OF THE INDICATOR.

GENERAL MAINTENANCE INFORMATION ON THE HIGH PRESSURE PUMP

A. LUBRICATION OF THE POWER END

BEFORE RUNNING THE PUMP, THE POWER END MUST BE FILLED TO THE INDICATED LEVEL WITH SAE 15W40 OIL, THE OIL LEVEL SHOULD BE MAINTAINED NEAR THE UPPER MARKS ON THE OIL GAGES (WHEN THE PUMP IS STOPPED). THE AMOUNT OF OIL REQUIRED TO FILL THE TRIPLEX POWER END IS 19 QUARTS (18.9 LITERS). THE OIL SHOULD BE CHANGED AFTER THE FIRST 125 HOURS OF OPERATION. THEREAFTER, THE OIL SHOULD BE CHANGED EVERY 1000 OPERATING HOURS, OR SIX MONTHS, WHICHEVER OCCURS FIRST. IF WATER GETS INTO THE OIL (THE OIL MAY APPEAR MILKY), THE OIL SHOULD BE CHANGED MORE FREQUENTLY.

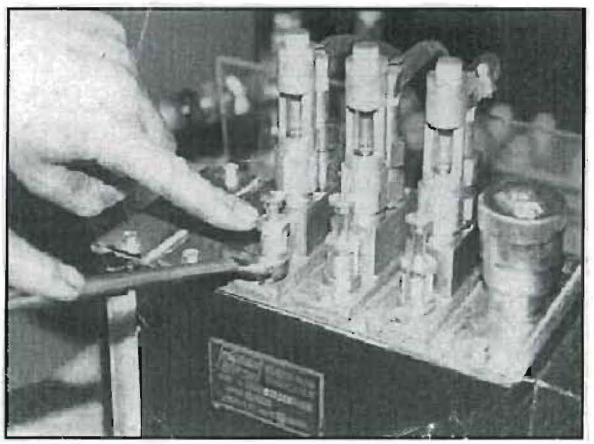
CLEAN THE POWER END DURING EACH OIL CHANGE.

B. OIL LUBRICATION OF THE PLUNGER PACKING

THE CARTRIDGE FLANGES HAVE BEEN PROVIDED WITH FITTINGS WHICH DEPOSIT OIL DIRECTLY ONTO THE PLUNGERS AS THE PUMP RUNS. PACKING AND PLUNGER LIVES ARE GREATLY EXTENDED BY THIS LUBRICATION. A MECHANICAL LUBRICATOR, DRIVEN BY A BELT FROM THE PUMP CRANKSHAFT, AUTOMATICALLY PERFORMS THE LUBRICATON. THE LUBRICATOR MAY BE ADJUSTED TO CHANGE THE LUBRICATION RATE. THE RECOMMENDED RATE IS A MINIMUM OF 10-12 DROPS PER MINUTE PER PLUNGER AT 300 RPM.

ADJUSTMENT OF THE DRIP RATE IS ACCOMPLISHED BY LOOSENING THE LOCKNUT (SHOWN BELOW) AND TURNING THE ADJUSTING SCREW CLOCKWISE (DOWN) FOR LESS OIL OR COUNTER-CLOCKWISE (UP) FOR MORE OIL.

THE LUBRICATOR OIL MAY BE THE SAME AS THAT USED IN THE PUMP POWER END.



C. WATER LUBRICATION OF THE PLUNGER PACKING

THE CARTRIDGE FLANGES HAVE BEEN PROVIDED WITH FITTINGS WHICH DEPOSIT WATER DIRECTLY ONTO THE PLUNGERS AS THE HIGH PRESSURE PUMP RUNS. PACKING AND PLUNGER LIVES ARE GREATLY EXTENDED BY THIS LUBRICATION. THE LUBRICATOR WAS FACTORY ADJUSTED FOR 1/3 GALLON *(1.2 L)* OF WATER PER PLUNGER PER MINUTE. FLOW IS CONSTANT BUT PRESSURE IS LIMITED TO INLET WATER SUPPLY PRESSURE.

D. LIFE OF THE PACKING

PACKING LIFE IS DEPENDENT UPON MANY FACTORS. CLEAN, COOL WATER WILL INCREASE THE LIFE OF THE PACKING. ANY REDUCTION IN DISCHARGE PRESSURE OR PUMP SPEED WILL ALSO INCREASE THE LIFE OF THE PACKING. DIRTY WATER, INSUFFICIENT PACKING LUBRICATION, OR DIRT ON THE PLUNGERS, WILL CAUSE VERY SHORT PACKING LIFE. WORN PLUNGERS, WORN STUFFING BOXES, OR IMPROPER PACKING INSTALLATION WILL ALSO SHORTEN THE LIFE.

WHEN ONE SET OF PACKING FAILS, IT DOESN'T MEAN THAT THE OTHERS ARE ABOUT TO FAIL. THEY MAY LAST CONSIDERABLY LONGER AND, THEREFORE, DO NOT NEED TO BE CHANGED. IF A SET OF PACKING IS LEAKING MINIMALLY, THERE IS NO NEED TO CHANGE IT.

AN OLDER SET OF PACKINGS WILL OCCASIONALLY LEAK HEAVILY UPON START-UP, THEN SEAL OFF, AND LEAK MINIMALLY.

E. LEAKAGE OF PACKING

WHEN A SET OF PACKING IS NEW, ONLY OIL WILL BE SEEN ON THE PLUNGER AND DRIPPING FROM THE FLANGE. TYPICALLY, AFTER 10-20 HOURS OF OPERATION, THE OIL WILL BEGIN TO TURN WHITE, AS WATER BEGINS TO MIX WITH THE OIL. AFTER FURTHER OPERATION, WATER DROPLETS WILL BE SEEN ON THE FLANGE.

WHEN LEAKAGE INCREASES TO ABOUT 6 DROPS/SEC. (FOR ONE PLUNGER), WATER DROPLETS MAY BE THROWN FORWARD UNDER THE LIQUID END. LEAKAGE MAY SPRAY FROM THE FLANGE, OR MAY BE SEEN AS A CONTINUOUS STREAM OF WATER BELOW THE FLANGE. A LEAKAGE RATE OF 1/2 GAL HR *(1.89 L/HR)* PER PLUNGER IS CONSIDERED THE POINT OF FAILURE. IF NOT CHANGED AT THIS TIME, INCREASED LEAKAGE MAY CAUSE A PULSE ON THE DISCHARGE SIDE OF THE PUMP AND BREAK A PLUNGER.

F. MODEL PM3801 INLET WATER BAG TYPE FILTER INSTALLATION

CONNECT INLET AND OUTLET PIPING TO FILTER. CONNECTIONS ARE 1-1/2" FEMALE NPT. (FLOW THROUGH THE FILTER MEDIA IS FROM INSIDE TO OUTSIDE).

A MINIMUM CLEARANCE OF 15" *(38.1CM)* ABOVE THE CENTERLINE OF THE FILTER INLET IS NECESSARY FOR REMOVAL OF THE FILTER INTERNALS.

PROVISION SHOULD BE MADE FOR RELIEVING ANY RESIDUAL PRESSURE THAT MAY REMAIN IN THE FILTER AFTER INLET FLOW IS SHUT OFF.

OPERATION
MAXIMUM PRESSURE/TEMPERATURE RATINGS:

300 PSI *(20.7 BAR)* AT 100 °F *(38°C)*

IF OPERATING PRESSURE CAN EXCEED 300 PSI, *(20.7 BAR)* AN AUTOMATIC PRESSURE RELIEVING OR LIMITING DEVICE MUST BE INSTALLED TO PROTECT THE FILTER.

MAXIMUM DIFFERENTIAL PRESSURE ACROSS FILTER MEDIA: 50 PSI *(3.4 BAR)*

WHEN FILTER OUTLET PRESSURE OR FLOW FALLS BELOW AN ACCEPTABLE LEVEL:

1. SHUT OFF FLOW TO FILTER INLET.

2. CAUTION: PRESSURE MAY EXIST; RELIEVE ANY RESIDUAL PRESSURE IN THE FILTER. DRAIN THE FILTER IF DESIRED.

3. LOOSEN THE LID HOLD-DOWN NUTS AND REMOVE THE LID.

4. REMOVE THE FILTER MEDIA. CLEAN OR REPLACE AS NECESSARY AND REINSTALL IN THE FILTER. IF IT IWAS NECESSARY TO REMOVE THE PERFORATED SUPPORT BASKET, BE SURE TO REINSTALL THE FLAT GASKET. CONTAMINATED BYPASS MAY RESULT IF THE FLAT GASKET IS NOT IN PLACE. MAKE SURE ALL FLAT GASKET AND O-RING SEALING SURFACES ARE CLEAN.

5. REINSTALL THE LID HOLD DOWN NUTS.

6. TURN ON FLOW TO FILTER INLET.

MAINTENANCE
THE FLAT GASKET (PM9144) AND LID O-RING (PM9143) SHOULD BE PERIODICALLY CHECKED FOR WEAR.

G. V-BELT ENGINE DRIVE ADJUSTMENT

OPEN V-BELT INSPECTION DOOR ON THE V-BELT GUARD AND CHECK THE BELT FOR SLIPPAGE, AS EVIDENCED BY EXCESSIVE LOOSENESS. TIGHTEN OR REPLACE AS NECESSARY. CORRECT TENSION IS REALIZED WHEN BELTS CAN BE DEPRESSED NO MORE THAN 5/8" *(15.8 MM)* COLD OR 1-1/4" *(31.7 MM)* HOT.

ADJUSTING SCREWS ARE LOCATED IN PUMP MOUNTING BASE.

5.2 DAILY OR APPROXIMATELY EVERY EIGHT (8) HOURS OF OPERATION

CHECK:

A. OPERATION IS SMOOTH.

B. OPERATING TEMPERATURES ARE NORMAL AND STABLE, IN BOTH THE POWER END AND LIQUID END (AFTER APPROXIMATELY ONE HOUR OF OPERATION).

C. OIL LEVELS IN THE HIGH PRESSURE PUMP AND DIESEL ENGINE CRANKCASES ARE PROPER.

D. THERE IS NO LEAKAGE FROM THE HIGH PRESSURE PUMP'S LIQUID END (OTHER THAN FROM PACKING).

E. THE PACKING LUBRICATOR IS FILLED WITH OIL.

F. EACH PLUNGER HAS A COATING OF OIL AS IT SLIDES INTO AND OUT OF THE PACKING.

G. GREASE IDLER PULLEY ON THE AIR COMPRESSOR.

H. THERE IS NO EXCESSIVE FLUID ACCUMULATION IN THE PLUNGER WELL. IF WATER IS PRESENT A PACKING(S) MAY BE BLOWN. CHECK THE PLUNGERS FOR EXCESSIVE DRIPPAGE FOR UNITS WITH THE FOLLOWING LUBRICATORS:

L55i OIL PLUNGER LUBRICATOR

REPLACE PACKING WHEN YOU SEE SIX (6) DROPS PER SECOND, COMING FROM A PLUNGER, REFER TO SECTION 6; REPAIR FOR PROCEDURE.

CAUTION: IT IS IMPORTANT TO REPLACE THE PACKING BEFORE IT BECOMES BLOWN. FAILURE TO REPLACE A BLOWN PACKING COULD POSSIBLY CAUSE THE PLUNGER TO CRACK.

5.3 WEEKLY OR APPROXIMATELY EVERY 40 HOURS OF OPERATION

CHECK:

A. THE OIL IN THE POWER END FOR WATER OR OTHER CONTAMINATES.

B. THAT THE PLUNGER NUTS ARE ALL STILL TIGHT ON THE CROSSHEAD STUBS.

5.4 MONTHLY OR APPROXIMATELY EVERY 160 HOURS OF OPERATION

CHECK:

A. ALL BOLTING, ESPECIALLY THOSE ON THE LIQUID END OF THE PUMP. TIGHTEN IF NECESSARY. (THE CYLINDER TIE STUDS (OR BOLTS) ARE MOST IMPORTANT!)

B. THE CRANKCASE BREATHER, CLEAN THE BREATHER IF NECESSARY. NOTE: IF THE ATMOSPHERE IS DUSTY, CLEAN MORE FREQUENTLY.

5.5 EVERY SIX (6) MONTHS OR APPROXIMATELY 1,000 HOURS OF OPERATION

A. IF NECESSARY, LAP THE SEALING SURFACES OF THE VALVES AND SEATS.

B. REPLACE ANY COMPRESSED OR BROKEN VALVE SPRINGS.

C. REPLACE THE CROSSHEAD STUB SEALS

D. CHANGE THE OIL IN THE POWER END (IF APPLICABLE). DURING THE OIL CHANGE, REMOVE THE COVER AND WIPE THE INTERIORS CLEAN WITH CLEAN LINT FREE RAGS. CHECK FOR WORN PARTS AND OTHER ABNORMAL CONDITIONS. CHECK THE TORQUE ON THE CONNNECTING RODS BOLTS.

NOTE: USE THE HOUR METER ON THE ENGINE CONTROL PANEL TO DETERMINE WHEN MAINTENANCE IS REQUIRED. USE THE RECORD SHEET ON THE FOLLOWING PAGE TO RECORD THE MAINTENANCE PERFORMED.

MAINTENANCE RECORD

EQUIPMENT SERIAL NO.	DATE OF INSPECTION	HOURS	RESULT OF INSPECTION	PARTS REPLACED OR REPAIRED	COMMENTS	TECHNICIAN'S INITIALS

SECTION 6

REPAIR

SECTION 6

REPAIR

INDEX

PUMP

DUE TO THE PRECISE MACHINING AND STRINGENT METALLURGICAL SPECIFICATIONS REQUIRED FOR SAFE AND PROPER OPERATION, ONLY NLB PARTS SHOULD BE USED WHEN REPAIRING THIS PUMP.

MAINTENANCE TO THE PUMP WILL BE REQUIRED IF THE LEAKAGE FROM ANY PACKING EXCEEDS 6 DROPS/SEC., IF ANY OTHER PART ALLOWS ANY WATER TO LEAK, OR IF THE PUMP IS NOT PERFORMING PROPERLY.

THE FOLLOWING PROCEDURE PROVIDES FOR DISASSEMBLY AND REPAIR OF THE COMPLETE LIQUID END. REPAIR OF ONLY ONE PART OF THE LIQUID END WILL NOT REQUIRE COMPLETE DISASSEMBLY.

REFER TO SECTION 8 FOR PARTS AND BREAKDOWN.

DISASSEMBLY

REMOVAL OF PACKING SUBASSEMBLIES:

A. DISENGAGE THE CLUTCH.

B. SHUT THE ENGINE DOWN.

C. REMOVE THE KEY FROM THE IGNITION.

D. REMOVE THE COUPLING GUARD.

E. REMOVE THE PLASTIC COVER FROM THE PLUNGER WELL. LIFT THE COVER AND SLIDE THE THREE LUBRICATOR HOSES OFF THE COPPER TUBES. LAY THE HOSES BACK ACROSS THE LUBRICATOR.

F. LOOSEN THE PLUNGER COUPLING NUT, AS SHOWN IN FIGURE 6-1, AND SLIDE THE PLUNGER TOWARD THE LIQUID END.

G. ROTATE THE CRANKSHAFT COUPLING BY HAND UNTIL THE STUB PULLS BACK INTO THE POWER END TO ITS BOTTOM-DEAD-CENTER POSITION.

H. REMOVE THE FOUR CARTRIDGE CAP SCREWS, AS SHOWN IN FIGURE 6-2.

I. SLIDE THE PACKING CARTRIDGE ASSEMBLY (WITH THE PLUNGER) OUT OF THE FRAME PLATE, AS SHOWN IN FIGURE 6-3.

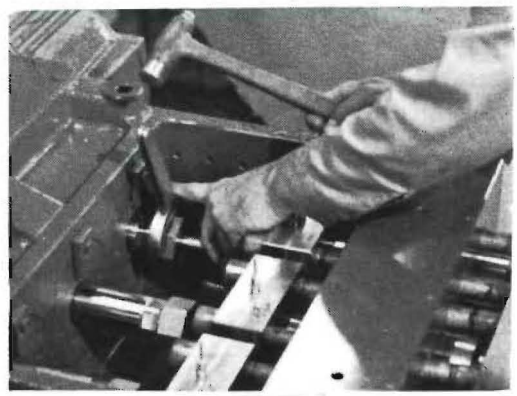


FIGURE 6-1

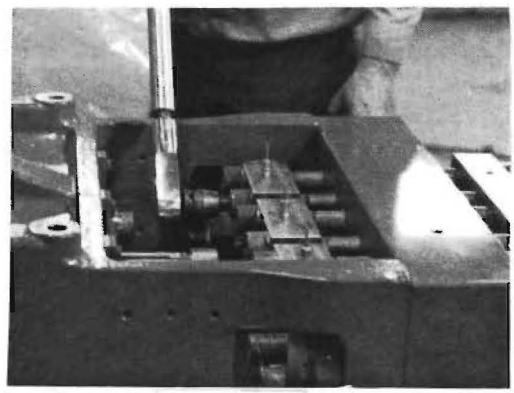


FIGURE 6-2

REMOVAL OF MANIFOLD AND VALVES:

A. DISCONNECT THE SUCTION AND DISCHARGE HOSES.

B. REMOVE THE TWO UPPER-CORNER CAP SCREWS FROM THE PUMP MANIFOLD.

C. SCREW IN THE SPECIAL STUDS AT THESE TWO LOCATIONS. (THESE WILL SUPPORT THE MANIFOLD WHEN THE OTHER SCREWS ARE REMOVED.)

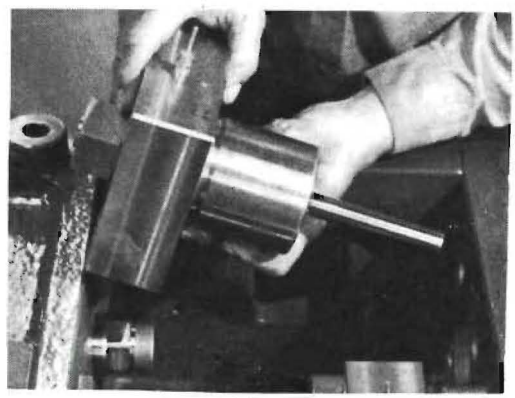


FIGURE 6-3

D. REMOVE THE REMAINING CAP SCREWS, AND SLIDE THE MANIFOLD FROM THE LIQUID END, AS SHOWN IN FIGURE 6-4. (NOTE THAT THE MANIFOLD IS DRILLED AND TAPPED 1/2"-13 FOR TWO LIFTING EYES WHICH CAN BE USED FOR LIFTING AND TRANSPORTING THE MANIFOLD.)

E. CAREFULLY SLIDE EACH VALVE SUBASSEMBLY FROM THE PRESSURE SLEEVE, AS SHOWN IN FIGURE 6-5. (THIS INCLUDES THE ALIGNING RING, SEAT, SUCTION VALVE, DISCHARGE VALVE, AND DISCHARGE SPRING.) PLACE A HAND UNDER THE SEAT TO CATCH THE SUCTION VALVE WHICH MAY SLIDE DOWN THE BACK OF THE SEAT.

F. REMOVE THE SUCTION VALVE SPRING AND STOP FROM THE PRESSURE SLEEVE.

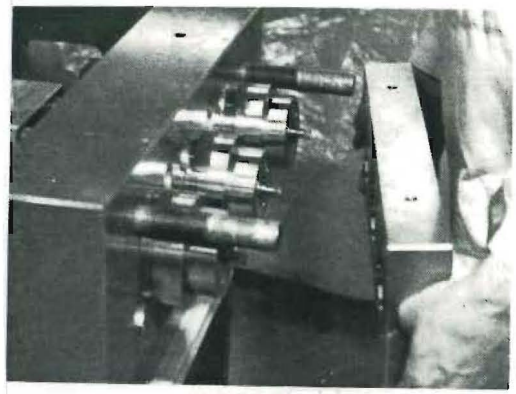


FIGURE 6-4

FIGURE 6-5

REMOVAL OF THE PRESSURE SLEEVES AND FRAME PLATE:

CAUTION:

THERE IS A POSSIBILITY THAT, DURING DISASSEMBLY, THE INNER SLEEVE WILL JUMP FORWARD. IF YOUR HAND IS IN FRONT OF THE SLEEVE, IT COULD CRUSH A FINGER! KEEP YOUR HANDS AWAY FROM THE FRONT OF THE INNER SLEEVE UNTIL IT IS LOOSE IN THE OUTER SLEEVE.

(TO REMOVE A PRESSURE SLEEVE SUBASSEMBLY, THE OUTER SLEEVE IS HELD IN PLACE WHILE THE INNER SLEEVE IS PRESSED OUT.)

A. BOLT THE SPECIAL TOOL #BT3617 (REFER TO SECTION 7) AGAINST THE FACE OF THE OUTER SLEEVE WITH THE TWO SHORT CAP SCREWS, AS SHOWN IN FIGURE 6-6.

B. INSERT THE SPECIAL ROD INTO THE BACK OF THE INNER SLEEVE, SLIDE A CARTRIDGE FLANGE ONTO THE ROD, INSERT TWO OF THE CAP SCREWS INTO OPPOSITE HOLES IN THE FLANGE, AND THREAD THEM INTO THE FRAME PLATE, AS SHOWN IN FIGURE 6-7.

C. TIGHTEN THE TWO CAP SCREWS UNIFORMLY. (THE INNER SLEEVE WILL BE LOOSE FROM THE OUTER SLEEVE AFTER IT SLIDES LESS THAN 1/4" (6.4MM).

D. REMOVE THE CLAMP FROM THE OUTER SLEEVE, AND REMOVE THE INNER SLEEVE.

E. REMOVE THE FLANGE AND SPECIAL ROD.

F. SLIDE THE OUTER SLEEVE FROM THE FRAME PLATE. (IF IT CANNOT BE PUSHED OUT BY HAND, ADD THE SPECIAL PLATE TO THE REMOVAL ROD, AS SHOWN IN FIGURE 6-8, AND PRESS THE OUTER SLEEVE OUT THE SAME AS THE INNER SLEEVE WAS PRESSED OUT.)

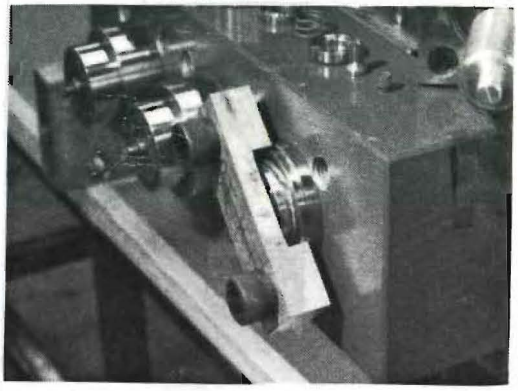


FIGURE 6-6

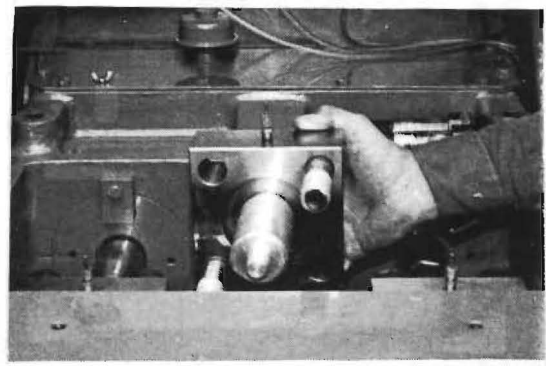


FIGURE 6-7

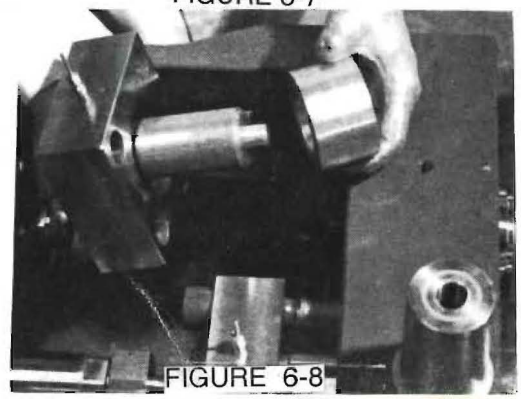


FIGURE 6-8

G. REMOVE THE TWO NUTS HOLDING THE FRAME PLATE TO THE POWER FRAME, AND SLIDE THE PLATE FROM THE FRAME. (NOTE THAT THE PLATE IS DRILLED AND TAPPED 1/2"-13 FOR TWO LIFTING EYES WHICH CAN BE USED FOR LIFTING AND TRANSPORTING THE PLATE.)

PACKING REMOVAL:

A. PULL THE PLUNGER FROM THE CARTRIDGE, ON A WORKBENCH.

B. PUSH THE PACKING AND BUSHINGS FROM THE CARTRIDGE.

FIGURE 6-11

REPAIR

PACKING REPLACEMENT:

A. EACH TIME THE SQUARE-RING PACKING IS REPLACED, REPLACE ANY ADAPTERS OR BUSHINGS WHICH ARE WORN, DEFORMED, OR CRACKED.

B. IF THE PLUNGER SURFACE CONTAINS DEPOSITS, IT MUST BE POLISHED WITH FINE EMERY CLOTH OR A DIAMOND DUST PAD. IF IT HAS A SUPERFICIAL SCRATCH, IT MUST BE POLISHED WITH A DIAMOND COMPOUND. IF IT BECOMES ROUGH OR SCORED, REPLACE IT.

C. IF THE BORE OF THE CARTRIDGE IS GROOVED OR WASHED, REPLACE THE CARTRIDGE. IF THE CARTRIDGE IS CRACKED, REPLACE IT.

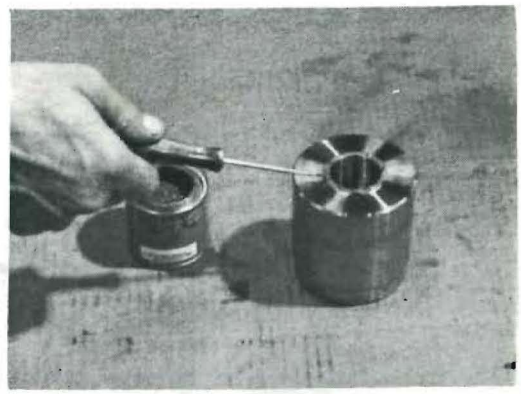
FIGURE 6-12

LAPPING METAL FACES:

IF A LEAK HAS OCCURRED AT EITHER OF THE METAL-TO-METAL SEALS, INSPECT THE FACES. IF A SEALING FACE IS SCRATCHED, IT MUST BE LAPPED WITH 600 GRIT LAPPING COMPOUND. LAP CAREFULLY UNTIL PARTS MATCH 100%. WHEN FINISHED, REMOVE ALL TRACES OF LAPPING COMPOUND.

A. IF THE LEAK IS BETWEEN THE VALVE SEAT (4) AND PRESSURE SLEEVE (3), THESE PARTS MUST BE LAPPED TOGETHER. COAT THE SEALING FACE WITH 600 GRIT LAPPING COMPOUND. USING THE ALIGNING RING AS A GUIDE, OSCILLATE THE SEAT AGAINST THE SLEEVE, BY HAND, UNTIL THE SCRATCH IS GONE. (SEE FIGURES 6-11 AND 6-12.) (THIS CAN BE DONE WITHOUT REMOVING THE SLEEVE FROM THE FRAME PLATE.)

B. IF THE LEAK IS BETWEEN THE PACKING CARTRIDGE (6) AND PRESSURE SLEEVE (3), THESE PARTS MUST BE LAPPED TOGETHER. COAT THE SEALING FACE WITH 600 GRIT LAPPING COMPOUND (FIGURE 6-13), AND OSCILLATE THE CARTRIDGE AGAINST THE SLEEVE, BY HAND, UNTIL THE SCRATCH IS GONE. (THIS IS EASIEST TO DO WITH THE SLEEVE INSTALLED IN THE FRAME PLATE. THE PLATE WILL GUIDE THE CARTRIDGE AS IT IS OSCILLATED, AS SHOWN IN FIGURE 6-14.)



FIGURE

LAPPING THE VALVES:

A. IF THE DISCHARGE VALVE (11), OR SEAT (4), HAS A SCRATCH ACROSS THE SEATING SURFACE, THE TWO PARTS MUST BE LAPPED TOGETHER. COAT THE SEATING FACE WITH 600 GRIT LAPPING COMPOUND (FIGURE 6-15), THEN OSCILLATE THE VALVE IN THE SEAT. (USE THE SLOT IN THE VALVE STEM TO OSCILLATE THE VALVE, AS SHOWN IN FIGURE 6-16).

B. IF THE SUCTION VALVE (13), OR VALVE SEAT (4), HAS A SCRATCH ACROSS A SEATING SURFACE, THE TWO PARTS MUST BE LAPPED SEPERATELY ON A LAPPING PLATE. USE 600 GRIT LAPPING COMPOUND.

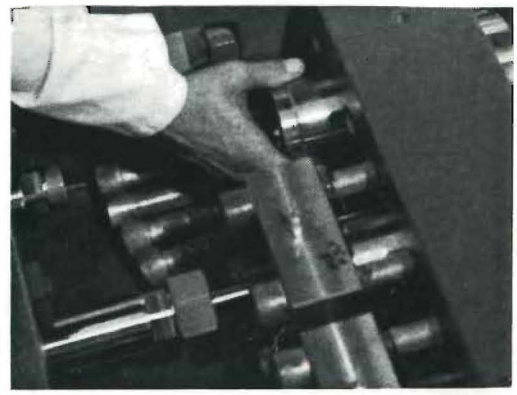


FIGURE 6-14

REASSEMBLY

CAREFULLY WASH AND DRY ALL PARTS, INCLUDING THE FACE OF THE POWER FRAME (IF THE PLATE HAS BEEN REMOVED).

REASSEMBLY OF FRAME PLATE (1), SLEEVES (3), VALVES, AND MANIFOLD (2):

A. SLIDE THE FRAME PLATE (1) ONTO THE DOWEL PINS IN THE POWER FRAME.

B. COAT THE THREADS ON THE TWO TIE STUDS (25) WITH MEDIUM-STRENGTH LOCTITE® OR EQUAL.

C. THREAD THE NUTS (26) ONTO THE TWO STUDS, AND UNIFORMLY TIGHTEN THEM TO PULL THE PLATE FLAT AGAINST THE FRAME. ALTERNATE BETWEEN THE NUTS, TIGHTENING THEM, IN STEPS OF ABOUT 100 lb. Ft.(136N-m), TO A UNIFORM TORQUE AS SPECIFIED IN THE TORQUE VALVE TABLE.

FIGURE 6-15

FIGURE 6-16

D. COAT THE OUTSIDE DIAMETER OF EACH OUTER SLEEVE WITH ANTI-SEIZE COMPOUND AND SLIDE THEM INTO THE FRAME PLATE.

E. COVER THE TAPERED OUTSIDE DIAMETER OF EACH INNER SLEEVE, AND THE TAPERED INSIDE DIAMETER OF EACH OUTER SLEEVE, WITH ANTI-SEIZE COMPOUND, AND SLIDE THE INNER SLEEVE INTO THE OUTER SLEEVE. (THESE SLEEVES ARE MACHINED IN MATCHED SETS, AND SERIALIZED. THEY MUST NOT BE INTERCHANGED. KEEP THEM IN MATCHED SETS.)

F. IF THEY'VE BEEN REMOVED, THREAD THE TWO GUIDE STUDS INTO THE OUTER, TOP CORNERS OF THE FRAME PLATE.

G. SLIDE THE SUCTION VALVE STOPS AND SUCTION VALVE SPRINGS INTO EACH SLEEVE.

H. PLACE THE SUCTION VALVE AGAINST THE STOP WITH THE GROOVE FACING THE SEAT.

I. INSTALL THE O-RINGS INTO THE GROOVES IN THE VALVE SEAT.

J. SLIDE THE ALIGNING RING ONTO THE O.D. OF THE PRESSURE SLEEVE.

K. SLIDE THE VALVE SEAT AND VALVE INTO POSITION AGAINST THE PRESSURE SLEEVE. A SMALL PIECE OF TAPE CAN BE USED TO HELP KEEP PARTS IN POSITION AS SHOWN IN FIGURE 6-19.

L. SLIDE THE DISCHARGE VALVE INTO THE VALVE SEAT.

M. SLIDE THE DISCHARGE VALVE SPRING ONTO THE VALVE STEM (FIGURE 6-20).

N. SLIDE THE MANIFOLD OVER THE GUIDE STUDS AND AGAINST THE VALVE SEATS (FIGURE 6-21).

O. COAT THE THREADS AND SHOULDERS ON THE CAP SCREWS WITH ANTI-SEIZE.

P. THREAD THE CAP SCREWS THROUGH THE MANIFOLD AND INTO THE FRAME PLATE, AND TIGHTEN BY HAND.

Q. REMOVE THE TWO GUIDE STUDS.

R. THREAD THE REMAINING TWO CAP SCREWS INTO THE PLATE AND TIGHTEN THEM BY HAND.

S. TIGHTEN EACH CAP SCREW, IN A CROSSING PATTERN, TO 200 LB-FT (272N-m) (FIGURE 6-22). THIS PROCEDURE MUST BE REPEATED THREE OR FOUR TIMES UNTIL ALL INNER SLEEVES ARE FULLY SEATED INTO THE OUTER SLEEVES.

T. TIGHTEN EACH CAP SCREW, IN A CROSSING PATTERN, TO 50 LB-FT (68N-m), THEN IN STEPS OF 50 LB-FT (68N-m) TO A UNIFORM TORQUE AS SPECIFIED IN THE TORQUE VALUE TABLE. REVERSE THE TIGHTENING SEQUENCE AT EACH STEP.

FIGURE 6-19

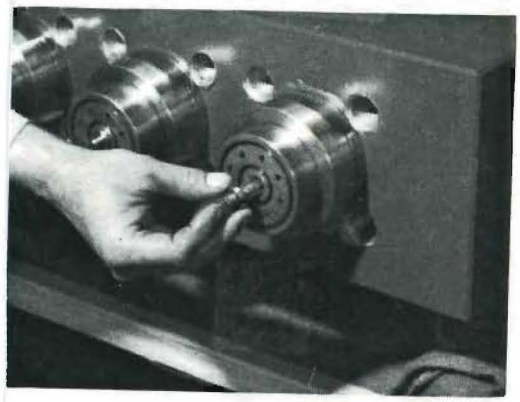


FIGURE 6-20

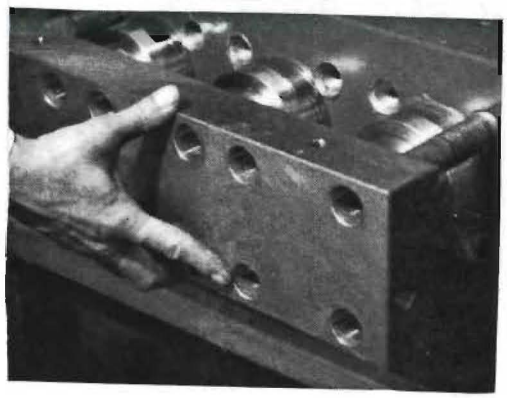


FIGURE 6-21

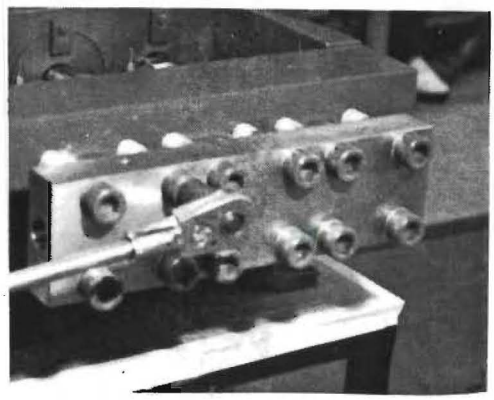


FIGURE 6-22

REASSEMBLY OF A PACKING SUBASSEMBLY:

A. DIP EACH ADAPTER AND SQUARE-RING PACKING INTO CLEAN OIL, THEN PUSH EACH RING INTO EACH CAVITY IN THE ORDER SHOWN IN FIGURE 6-23. (STAGGER SPLITS YELLOW/ BLACK/WHITE.)

B. SLIDE THE CARTRIDGE INTO THE COUNTER-BORE IN THE FLANGE.

C. SNAP THE RING INTO THE GROOVE ON THE PLUNGER. (A PLUNGER NUT CAN BE USED TO PUSH THE RING OVER THE END OF THE PLUNGER.)

D. SLIDE THE NUT ONTO THE PLUNGER. (SEE FIGURE 6-24.)

E. PUSH THE PLUNGER THROUGH THE PACKING UNTIL IT PROTRUDES ABOUT 3 INCHES (76.2MM).

F. SLIDE THE PACKING CARTRIDGE SUBASSEMBLY (INCLUDING THE PLUNGER AND FLANGE) INTO THE FRAME PLATE. SEE FIGURE 6-25.

G. COAT THE THREADS ON THE FOUR CAP SCREWS WITH ANTI-SIEZE.

H. THREAD THE FOUR CAP SCREWS THROUGH THE FLANGE AND INTO THE PLATE. TIGHTEN THEM UNIFORMLY BY HAND. MAKE SURE THAT THE FLANGE IS NOT COCKED - IT MUST BE SQUARE.

I. IN A CROSSING PATTERN, TIGHTEN EACH CAP SCREW TO 50 LB-FT (68N-m), THEN IN STEPS OF 50 LB-FT (68N-m) TO A UNIFORM TORQUE AS SPECIFIED IN THE TORQUE VALUE TABLE. REVERSE THE TIGHTENING SEQUENCES AT EACH STEP.

J. PUT ANTI-SEIZE ON THE THREADS OF THE CROSSHEAD STUB. COUPLE THE PLUNGER TO THE STUB, AND TIGHTEN THE NUT TO ABOUT 20 LB-FT (27.2N-m).

K. FEED THE LUBRICATOR LINES THROUGH THE PLASTIC COVER, AND CONNECT TO THE COPPER TUBES.

L. INSTALL THE PLASTIC COVER OVER THE PLUNGER WELL.

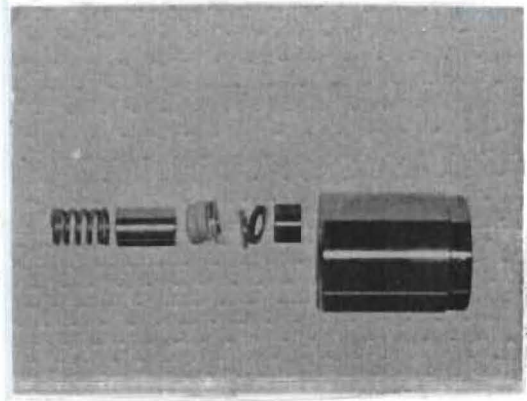


FIGURE 6-23

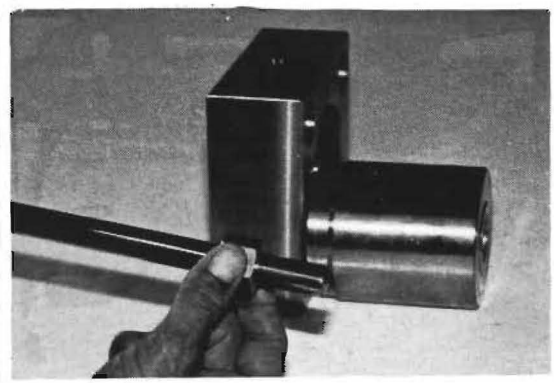


FIGURE 24

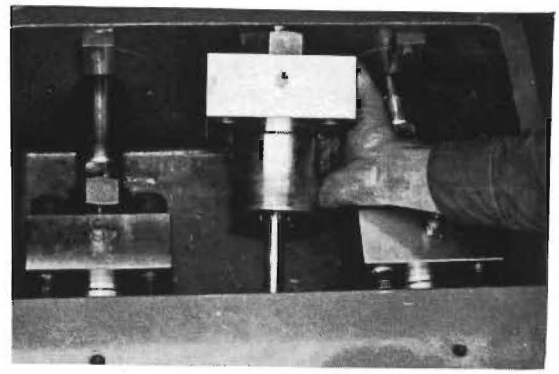


FIGURE 6-25

REPAIR OF HIGH PRESSURE PUMP POWER END

IN ORDER TO COMPLETELY DISMANTLE POWER END, THE COUPLING OR SHEAVE MUST BE REMOVED FROM THE CRANKSHAFT. IF THE PUMP IS EQUIPPED WITH THE OPTIONAL GEAR-PAC, THE MAIN GEAR MUST BE REMOVED.

A. DRAIN OIL FROM CRANKCASE.

B. DISCONNECT EACH PLUNGER FROM CROSSHEAD STUB AND PUSH PLUNGER INTO FLUID END. REFER TO PAGE 6-1, ITEM F.

C. REMOVE CROSSHEAD STUB DEFLECTORS.

D. REMOVE STUB SEAL CAPS BY PULLING FROM FRAME BORE, AFTER REMOVING CAP SCREW AND RETAINING CLAMP LOCATED DIRECTLY ABOVE EACH CAP. IF NECESSARY, TWO 3/8" (9.5MM) EYE BOLTS CAN BE SCREWED INTO THE TAPPED HOLES IN THE CAP TO FACILITATE REMOVAL.

E. REMOVE EACH CROSSHEAD STUB BY UNSCREWING FROM CROSSHEAD. A MODERATE AMOUNT OF RESISTANCE WILL BE EXPERIENCED WHEN UNSCREWING STUB BECAUSE A MEDIUM STRENGTH ANAEROBIC ADHESIVE (I.E.,LOCKTITE®) IS USED ON THE THREADS DURING ASSEMBLY TO MINIMIZE THE CHANCE OF THIS JOINT LOOSENING DURING OPERATION.

F. REMOVE CRANKCASE COVER.

G. DISCONNECT CONNECTING RODS FROM CRANKSHAFT BY REMOVING CONNECTING ROD BOLTS, CAPS, AND ROD BEARINGS. THEN, PUSH ROD AND CROSSHEAD ASSEMBLY AS FAR AS POSSIBLE TOWARDS FLUID END. KEEP BEARING TOGETHER WITH CAP SO THEY CAN BE REASSEMBLED IN THE SAME POSITION, (IF THEY ARE RE-USED). WHEN RE- ASSEMBLING, MATCH THE SET NUMBERS (1,2,3, ETC.) STAMPED ON RODS AND CAPS.

H. REMOVE CRANKSHAFT FRAME CAPS, KEEPING SHIMS WITH CAPS FOR REASSEMBLY THE CRANKSHAFT MAY NOW BE REMOVED FROM EITHER SIDE BY TAPPING GENTLY WITH A WOODEN BLOCK. TWO 1" (25.4 MM) RODS, EACH THREADED ON ONE END (8 THREADS/INCH), MAY BE SCREWED INTO BOTH ENDS OF THE CRANKSHAFT TO FACILITATE REMOVAL AS SHOWN IN FIGURES 6-26 AND 6-27.

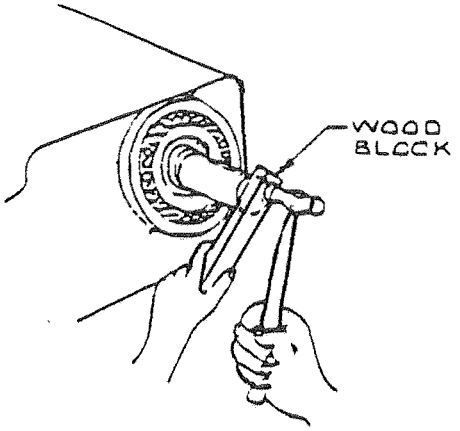


FIGURE 6-26 CRANKSHAFT REMOVAL

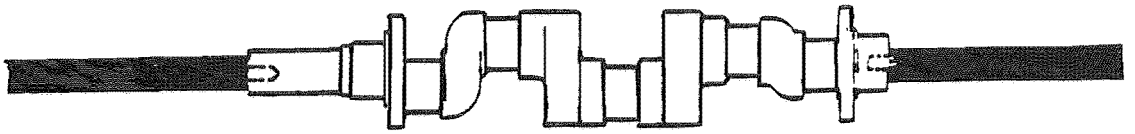


FIGURE 6-27 1" RODS SCREWED INTO BOTH ENDS OF SHAFT

I. THE CONNECTING ROD AND CROSSHEAD ASSEMBLIES MAY NOW BE REMOVED IF CROSSHEAD ASSEMBLY IS TO BE REUSED, IT MUST BE REASSEMBLED IN THE SAME LOCATION.

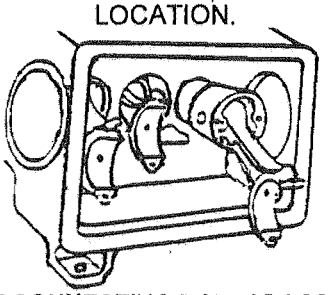


FIGURE 6-28 REMOVAL OF CONNECTING ROD, CROSSHEAD ASSEMBLIES

J. THE CROSSHEAD PIN IS HELD IN CROSSHEAD WITH A SET SCREW. REMOVE SET SCREW AND PUSH OUT.

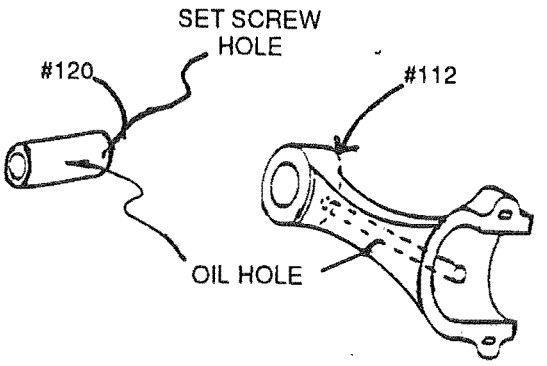


FIGURE 6-29 CROSSHEAD PIN AND CONNECTING ROD

MAIN BEARINGS - REMOVAL AND REPLACEMENT

THE TWO MAIN BEARINGS ARE TAPERED ROLLER BEARING TYPE. THE OUTER RACE (CUP), OF THE TAPERED ROLLER BEARING, IS A SLIP FIT IN THE POWER FRAME AND MAY BE REMOVED BY GENTLY TAPPING WITH A BLOCK OF WOOD OR A SOFT HAMMER.

THE INNER RACE (CONE) AND ROLLER ASSEMBLY IS INSTALLED WITH AN INTERFERENCE FIT ON THE CRANKSHAFT AND MUST BE REMOVED WITH A PULLER, PRESS, OR TORCH. IF A TORCH IS USED, CARE MUST BE EXERCISED NOT TO DAMAGE OR OVERHEAT THE CRANKSHAFT.

A NEW BEARING SHOULD BE INSTALLED AS A UNIT. A NEW BEARING SHOULD NOT BE RUN IN AN OLD RACE, OR VICE VERSA.

TO INSTALL A NEW BEARING ON THE CRANKSHAFT, IT IS RECOMMENDED THAT THE INNER RACE/BEARING ASSEMBLY BE HEATED TO 300°F (150°C) (NO HOTTER) AND SLIPPED ONTO SHAFT.

CONNECTING ROD BEARINGS

THE CONNECTING ROD BEARING (FIGURE 6-30) IS MADE IN TWO HALVES AND IS CLAMPED IN POSITION BETWEEN THE CONNECTING ROD AND CAP.

THE BEARING IS STEEL, WITH A LAYER OF BABBIT ON THE WEARING SURFACE.

WHEN THE ROD ASSEMBLY IS COMPLETED, THE BOLTS, WITH THREADS AND HEAD LUBRICATED, SHOULD BE TORQUED TO 55 LB-FT (74.6 N-M).

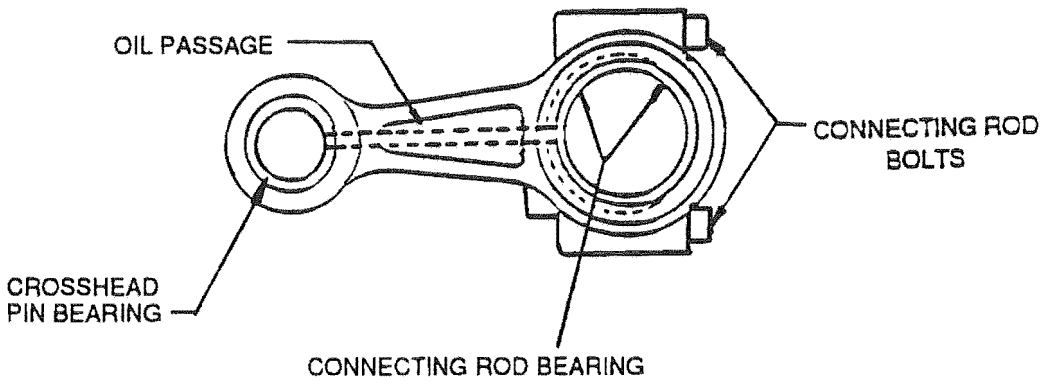


FIG. 6-30 CONNECTING ROD SUB-ASSEMBLY

CROSSHEAD PIN BEARINGS - REMOVAL AND REPLACEMENT

THE CROSSHEAD PIN BEARING IS MADE OF OIL-IMPREGNATED BRONZE. A HOLE IN THE BEARING ALLOWS OIL TO FLOW FROM THE CROSSHEAD PIN INTO THE HOLE IN THE CONNECTING ROD, AND ON TO THE CONNECTING ROD BEARING. THE BEARING IS PRESSED INTO THE CONNECTING ROD, AND EXTENDS 1/8" (3.2 MM) BEYOND THE SIDES OF THE ROD.

THE BEARING IS REMOVED BY PRESSING FROM THE ROD WITH A SUITABLE ARBOR. THE BEARING IS INSTALLED IN THE ROD BY PRESSING INTO POSITION, BEING CAREFUL TO ALIGN THE OIL HOLE AND LEAVE 1/8" (3.22 MM) PROTRUDING FROM EACH SIDE.

AFTER PRESSING INTO POSITION, THE BUSHING MUST BE REAMED TO 2.3765/2.3770 INCH (60.363/60.376MM).

REASSEMBLY OF POWER END

A. REASSEMBLE POWER END IN REVERSE ORDER. IT IS GOOD PRACTICE TO INSTALL NEW OIL SEALS AND NEW GASKETS.

B. **CRANKSHAFT END PLAY:**
WHEN THE PUMP IS BUILT, THE CRANKSHAFT END PLAY IS SET AT 0.001" (0.03MM) TO 0.005" (0.13MM). ONLY WHEN REPLACING A CRANKSHAFT OR A MAIN BEARING DOES THIS END PLAY NEED TO BE RESET TO THESE LIMITS.

A GOOD METHOD OF MEASURING END PLAY IS BY MOUNTING A DIAL INDICATOR ON POWER FRAME AND PLACING INDICATOR BUTTON ON ANY VERTICAL SURFACE OF CRANKSHAFT. THE CRANKSHAFT IS THEN PRIED TO ONE SIDE, AND THEN THE OTHER, NOTING TOTAL TRAVEL OF THE DIAL INDICATOR. TO ESTABLISH PROPER END PLAY, ADD OR REMOVE SHIMS AT CRANKSHAFT FRAME CAPS.

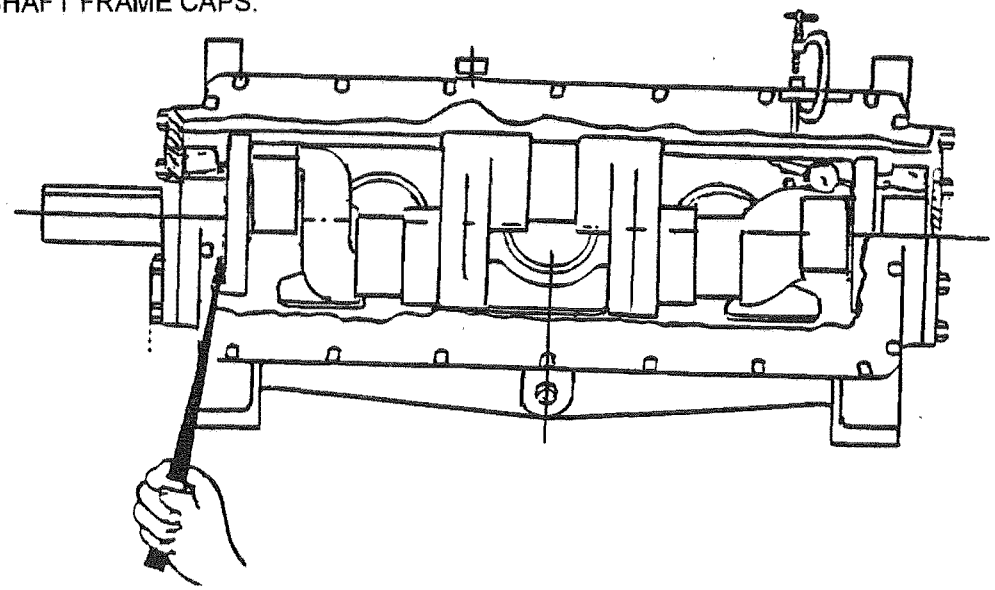


FIGURE 6-31 CRANKSHAFT END PLAY ADJUSTMENT

WHEN SHIMMING IS COMPLETE, CONNECTING RODS AND PIN BEARINGS SHOULD BE POSITIONED NEAR CENTER OF CROSSHEAD OPENING, (SEE FIGURE 6-32). IF ANY PIN BEARING RUBS ON INSIDE OF ANY CROSSHEAD, TRANSFER SHIMS FROM ONE SIDE OF PUMP TO THE OTHER TO SHIFT CRANKSHAFT.

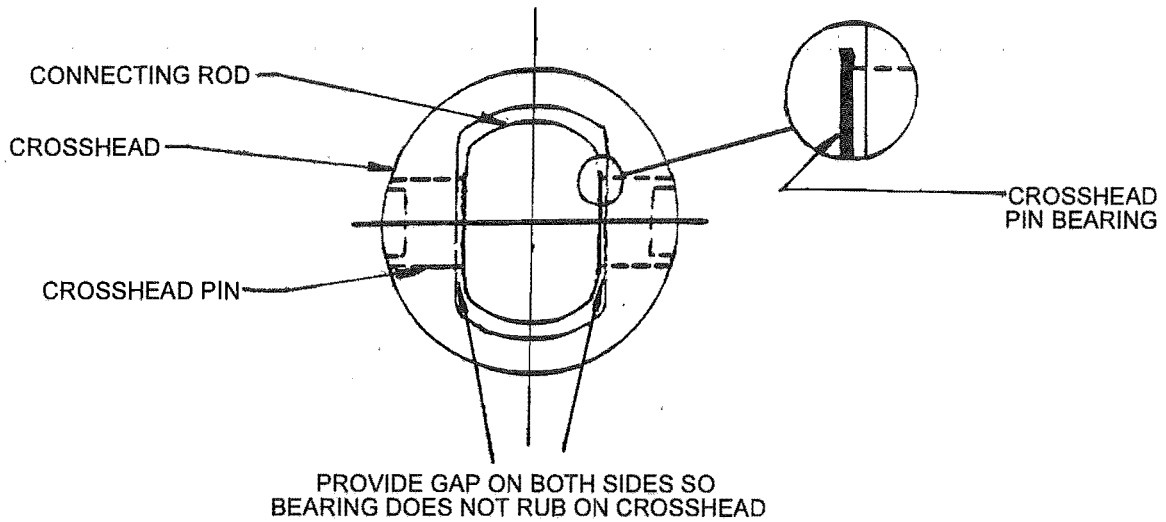


FIGURE 6-32 CENTERING CONNECTING ROD IN CROSSHEAD

TORQUE VALUES

36201/40201 FLUID END

BOLTS / NUTS		RECOMMENDED TORQUE	
		LB - FT	N - M
FRAME PLATE TIE STUD NUT OR SCREW CAP	PLAIN	600	810
	CADMIUM	450	610
MANIFOLD CAP SCREWS	PLAIN	450	610
	CADMIUM	350	470
PACKING CARTRIDE CAP SCREWS	PLAIN	400	540
	CADMIUM	300	410
PLUNGER TO COUPLING NUT	PLAIN	20	30
	CADMIUM	15	25

36201/40201 POWER FRAME

BOLTS / NUTS	RECOMMENDED TORQUE	
	LB - FT	N - M
ROD CAPS	55	75
FRAME CAPS	120	165
CRANKCASE COVER	35	45

NOTE: ALL TORQUE VALUES ARE GIVEN FOR LUBRICATED PLAIN AND CADMIUM PLATED SCREWS FOR THE FLUID END. TORQUE VALUES FOR THE POWER END ARE FOR PLAIN SCREWS ONLY.

OPTIONAL GEAR PAC

DISASSEMBLY

REMOVAL OF INTERNALS

A. DRAIN OIL FROM GEAR-PAC HOUSING.

B. REMOVE GEAR-PAC HOUSING COVER. THERE ARE (14) 7/16 UNC CAPS SCREWS WHICH HOLD THE COVER ON. ALSO, THERE ARE JACKBOLT HOLES NEAR EACH COVER LOCATING DOWEL PIN. BE CAREFUL NOT TO DAMAGE COVER GASKET OR PINION SHAFT OIL SEAL.

C. INSERT GEAR LIFTING HOOK INTO ONE (1) OF THE HOLES IN THE MAIN GEAR, CONNECT IT TO A HOIST OR CHAIN ALL AND REMOVE SLACK FROM CHAIN.

D. REMOVE (4) 1/2"-13 UNC CAP SCREWS FROM MAIN GEAR BUSHING, INSERT THEM IN JACKING HOLES ON MAIN GEAR BUSHING, AND JACK MAIN GEAR BUSHING, AND JACK MAIN GEAR FROM BUSHING.

E. SCREW A 3/8" NPT PIPE PLUG INTO PIPE TAP PROVIDED IN THE SPLIT OF THE MAIN GEAR BUSHING, THEN PULL MAIN GEAR BUSHING FROM CRANKSHAFT.

F. TAKE ALL THE WEIGHT OFF THE MAIN GEAR ON THE HOOK AND CAREFULLY SWING MAIN GEAR OUT OF HOUSING. BE CAREFUL NOT TO DAMAGE GEAR TEETH. DAMAGED TEETH WILL CAUSE ROUGH AND NOISY OPERATION AND SHORTENED GEAR LIFE.

G. THE PINION SHAFT, SHIMS AND BEARINGS, CAN NOW BE PULLED FROM GEAR HOUSING. THE 1/2-13 TAPPED HOLE IN THE END OF THE PINION SHAFT MAY BE USED FOR REMOVING PINION. THE INNER RACE (CONE) AND ROLLER ASSEMBLY IS INSTALLED WITH AN INTERFERENCE FIT ON THE PINION SHAFT AND MAY BE REMOVED WITH A PULLER, PRESS OR TORCH. IF A TORCH IS USED, CARE MUST BE EXERCISED NOT TO DAMAGE OR OVERHEAT THE PINION.

H. THE PINION INBOARD BEARING OUTER RACE MAY BE REMOVED FROM THE HOUSING WITH AN INSIDE BEARING PULLER. THE OUTER RACE IS A SLIP FIT IN THE HOUSING.

REMOVAL OF GEAR-PAC HOUSING

A. SCREW AN EYE BOLT (SPECIALLY THREADED FOR 1/2 NPT) INTO TAPPED HOLE IN TOP OF GEAR-PAC HOUSING, CONNECT IT TO A HOIST OR CHAIN FALL AND REMOVE SLACK IN CHAIN.

B. REMOVE BOLTS ON THE INSIDE OF HOUSING AND PULL HOUSING AWAY FROM POWER FRAME. (THE TOP BOLT IS A SOCKET-HEAD SHOULDER BOLT WHICH ESTABLISHES ANGULAR ALIGNMENT OF HOUSING WITH POWER FRAME.

REASSEMBLY OF GEAR -PAC

A. A NEW PINION BEARING SHOULD BE INSTALLED AS A UNIT. (A NEW BEARING SHOULD NOT BE INSTALLED IN AN OLD RACE OR VICE VERSA.) A NEW BEARING MAY BE PRESSED ON OR HEATED TO 300°F (150°C, NO HOTTER) AND SLIPPED ONTO SHAFT.

B. IT WILL USUALLY BE MORE CONVENIENT TO INSTALL THE PINION PRIOR TO INSTALLING THE MAIN GEAR. WHEN INSTALLING NEW PINION BEARINGS, BE SURE THAT THE OUTER RACE (CUP) OF THE INBOARD BEARING IS SEATED PRIOR TO INSTALLING PINION.

C. THE MAIN GEAR, SUPPORTED BY THE LIFTING HOOK IS SWUNG INTO THE HOUSING AND SUSPENDED OVER THE SHAFT. THE KEY IS THEN INSTALLED IN THE KEYWAY. THE TAPERED BUSHING IS SPREAD BY SCREWING A 3/8" PIPE PLUG INTO OPENING AT THE SLOT OR BY A WEDGE, THEN SLIPPED ONTO THE SHAFT AND INTO THE GEAR. THE BUSHING MUST BE PUSHED AGAINST THE SHOULDER, ON THE SHAFT. WHEN SHOULDERED THE PLUG OR WEDGE IS REMOVED. THE FOUR (4) CAP SCREWS ARE THEN INSTALLED THROUGH THE BUSHING AND SCREWED INTO THE GEAR. BY TIGHTENING THE BOLTS UNIFORMLY, THE GEAR IS PULLED UP ONTO THE BUSHING, WEDGING THE BUSHING TIGHTLY ONTO THE SHAFT. AFTER INSTALLATION, THE GEAR MUST RUN TRUE. THE T.I.R. RUNOUT ON THE GEAR FACE MUST NOT EXCEED 0.0017 INCH (0.043 MM).

D. IT IS RECOMMENDED THAT A NEW GASKET AND PINION OIL SEAL BE INSTALLED.

E. WHEN SLIDING THE COVER INTO POSITION OVER THE PINION SHAFT, CARE MUST BE EXERCISED TO PREVENT THE LIP OF THE OIL SEAL FROM BEING DAMAGED BY THE KEYWAY.

F. AFTER THE COVER BOLTS ARE TIGHTENED, THE END PLAY OF THE PINION SHOULD BE CHECKED TO SEE THAT IT FALLS BETWEEN 0.004 INCH (0.100 MM) AND 0.006 INCH (0.150 MM) (COLD). IF THE ENDPLAY IS OUTSIDE THESE LIMITS, SHIMS SHOULD BE ADDED OR SUBRACTED ADJACENT TO THE OUTBOARD BEARING OUTER RACE. ADDING SHIMS DECREASES THE ENDPLAY.

G. IF THE GEAR-PAC HOUSING HAS BEEN REMOVED FROM THE POWER FRAME, ALIGNMENT OF THE PINION AND DRIVER SHAFTS SHOULD BE CHECKED AND IF NECESSARY, RESET AT A MAXIMUM TOTAL-INDICATOR-RUNOUT OF 0.008 INCH (0.200 MM) BEFORE OPERATING UNIT.

H. BE SURE THAT THE GEAR-PAC IS FILLED TO THE PROPER LEVEL WITH SAE15W40 OIL BEFORE OPERATING. THE GEAR-PAC REQUIRES 10 QUARTS (9.5L).

TORQUE REQUIREMENTS FOR GEAR-PAC HOUSING

BOLT LOCATION	BOLT SIZE	TORQUE REQUIREMENT (LUBRICATED)	
		POUND - FOOT	NEWTON - METER
GEAR-PAC HOUSING TO POWER FRAME	5/8-11 UNC	70	95
MAIN GEAR TO MAIN GEAR BUSHING	1/2-13 UNC	55	75
GEAR-PAC HOUSING COVER	7/16-14 UNC	35	45

BV36-115 & BV40-010 BY-PASS VALVE REPAIR

REFER TO SECTION 8 FOR THE BY-PASS VALVE PARTS AND PARTS BREAKDOWN

DISASSEMBLY

A. CLAMP THE SEAT FRAME (ITEM 4) IN A VISE.

B. LOOSEN LOCKNUT (ITEM 10).

C. LOOSEN ADJUSTING SCREW (ITEM 9) UNTIL THERE IS NO SPRING FORCE ON THE SCREW.

D. REMOVE THE BODY (ITEM 1) AS SHOWN IN FIGURE 1.

E. TIGHTEN THE ADJUSTING SCREW (ITEM 9) TO PUSH THE VALVE SEAT (ITEM 3) FROM THE BODY.

F. CAREFULLY GRASP THE NOSE OF THE PIN (ITEM 2) WITH PLIERS, AND PULL THE PIN FROM THE BODY AS SHOWN IN FIGURE 2. (OIL WILL DRAIN FROM TWO (2) OF THE CAVITIES IN THE BODY.)

G. LOOSEN THE ADJUSTING SCREW (ITEM 9) UNTIL THERE IS NO SPRING FORCE ON THE SCREW.

H. REMOVE THE CAP NUT (ITEM 8) FROM THE BODY AS SHOWN IN FIGURE 3.

I. INVERT THE BODY AND DUMP ALL INTERNAL PARTS INTO A PAN. (OIL WILL DRAIN FROM THE UPPER PORTION OF THE BODY.)

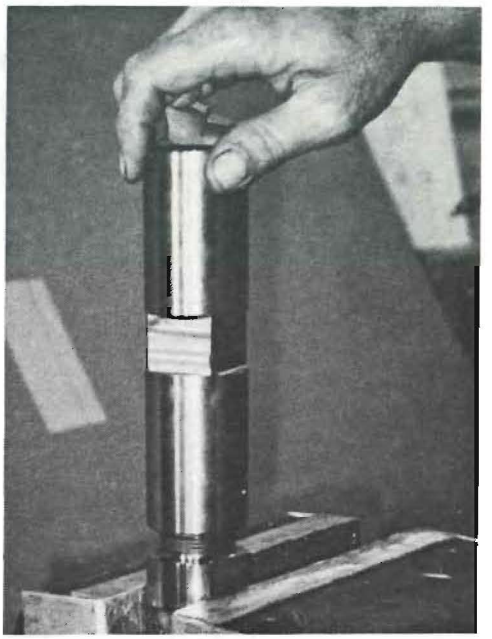


FIGURE 1

REASSEMBLY

A. CAREFULLY WASH AND DRY ALL PARTS.

B. REPLACE ANY PARTS WORN BEYOND THEIR USEFUL LIFE. REPLACE THE TWO (2) O-RINGS (ITEMS 12 & 13).

C. IF THE BORE IN THE BODY IS ROUGH, SMOOTH IT WITH EMERY CLOTH.

D. IF THE PIN (ITEM 2) AND SEAT (ITEM 3) ARE WORN, EITHER LAP THE TWO (2) PARTS TOGETHER, OR REPLACE THEM.

E. INSTALL A NEW O-RING (ITEM 12), ON THE PIN (ITEM 2), AND COAT IT WITH OIL OR GREASE AS SHOWN IN FIGURE 4.

F. SLIDE THE PIN INTO THE BODY UNTIL IT BOTTOMS OUT.

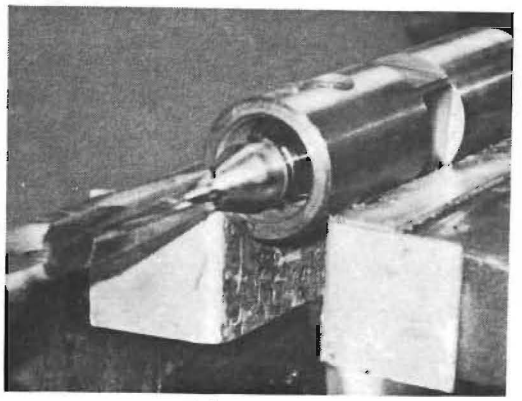


FIGURE 2

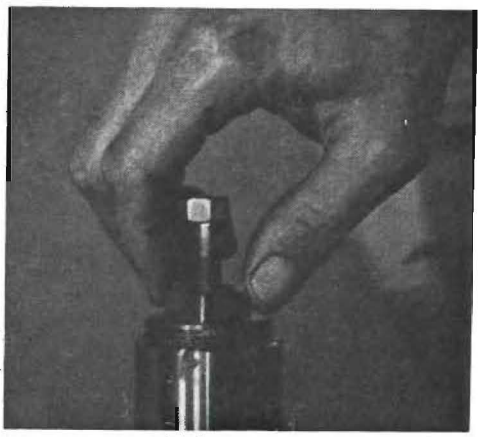


FIGURE 3

G. WITH THE SEAT FRAME CLAMPED IN A VISE INSTALL A NEW O-RING (ITEM 13).

H. COAT THE O-RING, THE FACE OF THE SEAT FRAME, AND THE THREADS WITH ANTI-SEIZE COMPOUND.

I. SET THE SEAT (ITEM 3) ON TOP OF THE SEAT FRAME AS SHOWN IN FIGURE 6.

J. THREAD THE BODY ONTO INTO THE SEAT FRAME. TIGHTEN JUST FINGER-TIGHT.

K. WITH THE ADJUSTING SCREW END UP POUR ABOUT ONE (1) OUNCE OF DEXTRON® OR EQUAL AUTOMATIC TRANSMISSION FLUID (ATF) INTO THE BODY AS SHOWN IN FIGURE 7.

L. REACHING THROUGH THE TOP OF THE VALVE WITH A LONG, CLEAN ROD, PUSH THE PIN (2) ONTO THE SEAT (ITEM 3), THEN RAISE THE PIN OFF THE SEAT 1/4 INCH (6.3 MM) WITH PLIERS, AS SHOWN IN FIGURE 8. REPEAT THIS SEVERAL TIMES.(THIS EXPELS AIR FROM THE CAVITY ABOVE THE PIN, WHICH IS NECESSARY IN ORDER TO KEEP THE VALVE FROM SQUEALING.)

M. SLIDE THE SPRING GUIDE ITEM (5) INTO THE BODY.

N. POUR ATF INTO THE BODY UNTIL THE CAVITY IS ABOUT HALF FULL.

O. PLACE THE FIRST DISC SPRING (ITEM 11), FACE UP, ONTO THE SPRING GUIDE AS SHOWN IN FIGURE 9.

P. PLACE THE SECOND SPRING, FACE DOWN, ONTO THE GUIDE.

Q. CONTINUE TO STACK THE SPRINGS, FACE UP, FACE DOWN, ENDING WITH THE TOP SPRING FACE UP AS SHOWN IN FIGURE 10. IF NECESSARY ADD ATF TO BRING THE LEVEL TO ABOVE THE TOP OF THE SPRING GUIDE.

R. SLIDE THE GUIDE BUSHING (ITEM 6) ONTO THE TOP OF THE SPRINGS.

S. SLIDE THE DISC (ITEM 7) ONTO THE TOP OF THE GUIDE BUSHING.

T. COAT THE CAP NUT (ITEM 8) WITH ANTI-SEIZE COMPOUND AND THREAD IT INTO THE BODY (ITEM 1) AND TIGHTEN.

FIGURE 4

FIGURE 5

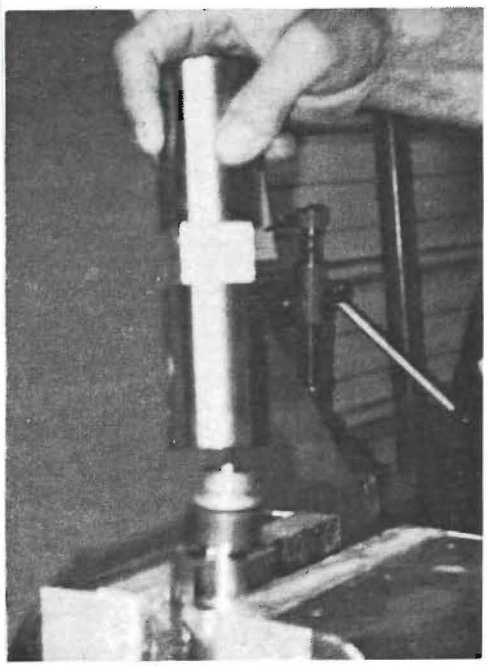


FIGURE 6

U. TIGHTEN THE ADJUSTER SCREW (ITEM 9) UNTIL IT TOUCHES THE DISC, THEN TIGHTEN IT ABOUT THREE MORE TURNS AS SHOWN IN FIGURE 11. (THIS PUSHES THE PIN INTO THE SEAT, AND CENTERS THE SEAT).

V. TIGHTEN THE SEAT FRAME (ITEM 4) TO ABOUT 200 LB-FT OF TORQUE AS SHOWN IN FIGURE 12.

W. LOOSEN THE ADJUSTING SCREW (ITEM 9).

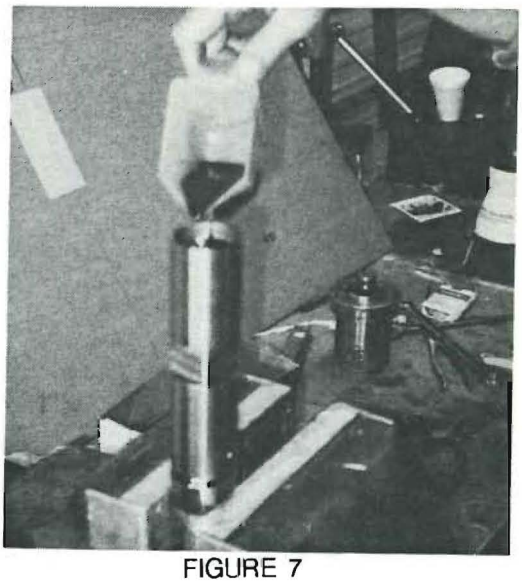


FIGURE 7

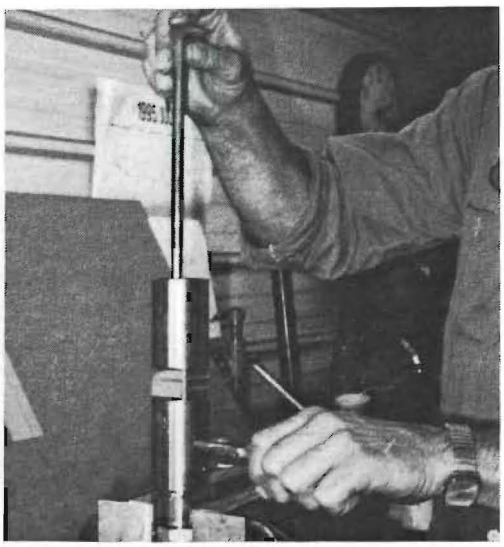


FIGURE 8

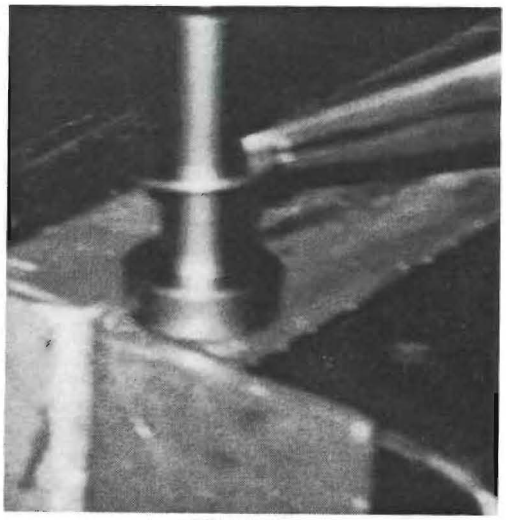


FIGURE 9

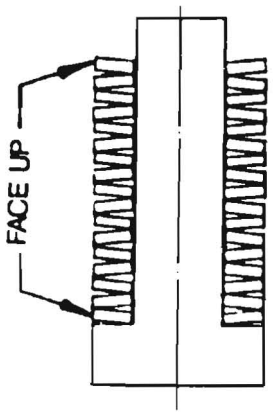


FIGURE 10

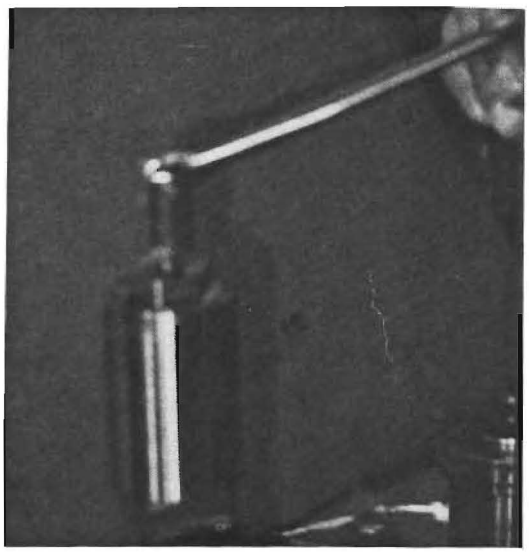


FIGURE 11

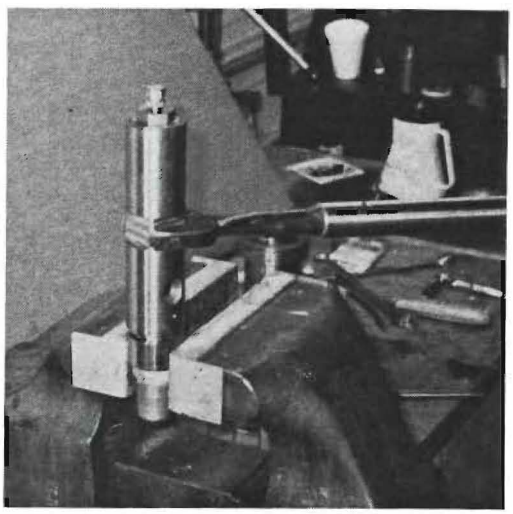
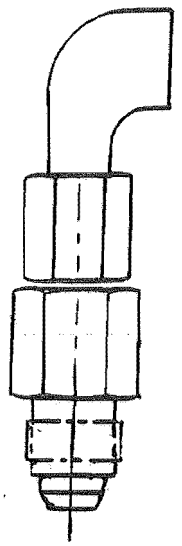


FIGURE 12

REPLACEMENT OF RUPTURE DISC



(THE PURPOSE OF THE ELBOW AT THE END OF THE POP-OFF VALVE IS TO DIRECT THE FLOW OF WATER IF THE RUPTURE DISC BURSTS.)

A. TO REPLACE THE RUPTURE DISC, PLACE AN OPEN END WRENCH ON THE VALVE BODY TO KEEP IT FROM TURNING. THEN, PLACE A 13/16" WRENCH ON THE CAP AND REMOVE IT FROM THE VALVE BODY. THE WASHER AND RUPTURE DISC SHOULD FALL OUT. IF THEY DON'T, USE A SCREW DRIVER TO "FISH" THEM OUT.

B. UNSCREW AND REMOVE THE VALVE BODY AND SEAT.

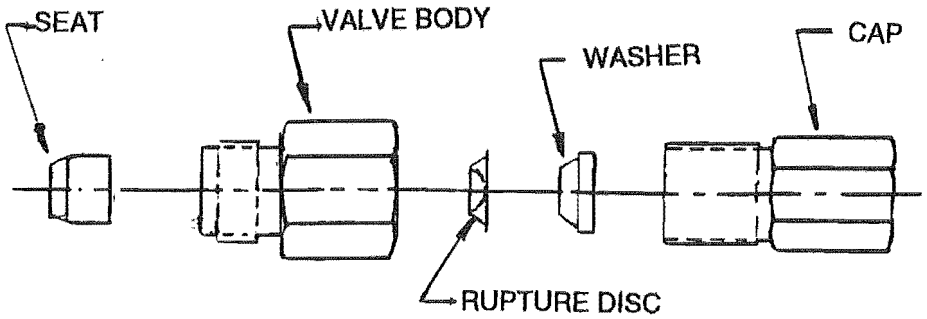
C. THE PARTS OF THE VALVE GO BACK TOGETHER IN THE ORDER SHOWN BELOW. PLACE A NEW DISC AND THE WASHER BACK INTO THE VALVE BODY AS ILLUSTRATED. THEY MUST BE SEATED PROPERLY.

D. AFTER THE DISC AND WASHER HAVE BEEN PROPERLY POSITIONED INTO THE VALVE BODY, SCREW THE CAP INTO THE VALVE BODY AND TIGHTEN SECURELY.

E SCREW THE VALVE BODY BACK INTO THE DISCHARGE BLOCK SO THAT THE TAPER ON THE SEAT POINTS IN THE PROPER DIRECTION. REFER TO FIGURE. THE VALVE BODY AND CAP MUST BE TIGHTENED SECURELY.

WARNING: ALWAYS REPLACE THE ELBOW INTO THE END OF THE RUPTURE DISC VALVE AND TIGHTEN SECURELY. IT **MUST** BE POINTING **AWAY** FROM THE OPERATOR. THE ELBOW ACTS AS A DEFLECTOR WHICH SAFELY DIRECTS THE WATER AWAY FROM THE OPERATOR IF THE RUPTURE DISC BURSTS.

FAILURE TO REPLACE THE ELBOW MAY RESULT IN INJURY.



LINCOLN MODEL 55i
SERIES "B" LUBRICATING PUMP

PUMP DESCRIPTION

The Model 55i Lubricator Pump is an improved version of the previous Lincoln Model 55 Lubricator Pump. Pump performance and serviceability have been improved with the Model 55i. The pump has been simplified by reducing the part count. The number of seals have been reduced by creating a unit pump body and sight glass, thus reducing the number of service parts and possible leak problems.

PUMP OPERATION

The pump is operated by a rotating cam against the pump rocker arm, causing the pump's plunger to reciprocate within its bore in the pump body.

The pump output is set by the adjusting sleeve on the top of the pump body. The sleeve limits the stroke length of the pump plunger thus limiting the pump output. Full pump output may be obtained when the adjusting sleeve is fully extended out of the top of the plunger stroke.

Maximum recommended oil viscosity is 8000 SUS.

SUCTION STROKE

As the plunger moves downward, oil is drawn through the suction check and into the plunger bore from the small reservoir in the sight glass. Reducing the volume of oil in the sight glass creates a vacuum which draws oil from the lubricator reservoir, through the suction tube and into the outside passage in the sight glass. The oil will then enter the dropper and drip into the sight glass reservoir, replacing the oil removed by the suction stroke. The quantity of oil delivered may be determined by counting the drops of oil falling out of the dropper.

DISCHARGE STROKE

As the plunger moves upward, oil is forced from the plunger bore through the outlet checks and into the lubrication point feedline. The suction check prevents any backflow of oil into the sight glass assembly and allows any oil that may bypass the plunger to be returned to the sight glass, area through a return passage.

STARTING INSTRUCTION

1. Remove the dropper from the sight glass and fill approximately 1/3 full of oil.
2. Manually operate the pump with the priming stem until oil, without air bubbles, flows from pump outlet.
3. Connect the feedline to the pump outlet union and manually operate the pump with the priming stem until the feedline is filled.
4. Connect the feedline to the lubrication point. A feedline check valve at the lubrication point is recommended and is available as an accessory item.
5. Refill the sight glass to the 1/3 full level with SAE 15W40 oil.
6. Refill the lubricator reservoir and adjust the pump output.

SETTING PUMP OUTPUT

Count the number of drops falling through the sight glass in one minute. Set the adjusting sleeve to obtain the desired quantity and secure the setting with the locknut.

***Conversion Factors**

1 drop =	,002 cu. In.
500 drops =	1 cu. In.
1 pint =	12,608 drops

* Conversion Factors are based on SAE 15W40 oil at room temperature.

SIGHT GLASS:

The sight glass gives a visual indication of the condition of the oil flowing through the lubrication pump.

An increasing oil level indicates absorption of air in the sight glass by the oil passing through. Over fill eliminates visual metering of drops in the sight glass, but has no effect on pump operation.

A decreasing oil level indicates the vacuum in the sight glass is withdrawing entrained air from the oil passing through the sight glass, or a vacuum leak in the pump's inlet circuit. If the decreasing oil level is allowed to continue, an airlock can result.

Under normal conditions, the oil level will raise or fall until an equilibrium is reached, but may change from time to time as the condition of the oil changes. Regardless of the oil level, a continuing passage of the correct oil volume indicates that the pump is operating properly.

AIRLOCK:

Airlocking occurs when air, instead of oil, enters the plunger bore and cannot be compressed to a high enough pressure to be forced out of the pump against the feed line back pressure.

Airlocking is caused either by entrained air being separated from oil by the vacuum in the sight glass, or by air entering the pump when the oil level in the lubricator reservoir is lower than the suction tube inlet. Severely agitated oils, such as oil supplied from crankcase, will usually contain entrained air. An airlock can be easily detected since, when it occurs, no oil will be visible in the sight glass. If entrained air is found to be a problem, either a pressurized pump supply or a settling tank should be utilized.

An airlock can be eliminated by refilling the lubricator reservoir, and sight glass, loosening the outlet union at the pump outlet, and manually operating the pump with the priming stem until no air bubbles appear at the pump outlet. The airlock may reoccur if the cause is not found and eliminated.

OVER FILL:

Over filling is caused by the oil absorbing the air in the sight glass as it passes through the pump.

This condition does not affect the operation of the pump except that the oil cannot be observed coming out of the dropper due to the sight glass being filled with oil.

Normal sight glass operation can be restored by momentarily loosing the dropper at the top of the sight glass to break the vacuum within the sight glass. Do not leave the sight glass dropper open for very long as this will allow all the oil in the sight glass to drain out possibly causing an airlock condition.

Pulsation Dampener Assembly

Caution:

Replacement parts must be genuine NLB parts. The use of any other parts could create a hazardous situation. Also, the use of other parts will void all warranties on this equipment.

Note:

Refer to Section 8; PARTS for breakdown and parts lists of the following procedures:

A. It is important to only disassemble **one** end of the dampener at a time.

B. The segmented ring, (item #3), is a match set and **must** be reassembled in exactly the same way.

C. Mark the "top" of each piece with a marker **before** removal. Be certain that all marks are pointing "up" upon reassembly.

Caution:

Care should be taken so that segments from the top and bottom are never mixed up. They are not interchangeable and at no time should rings be reinstalled "upside down" from the way they were removed.

4071-40 Throttle Control

Seal & Piston Replacement

Caution:

Replacement parts must be genuine NLB parts. The use of any other parts could create a hazardous situation. Also, the use of other parts will void all warranties on this equipment.

Service people required: 1
Recommended tools: Adjustable wrench
Parts (subject to inspection): Seal, (Item #1) & Piston, (Item #2)
Supplies: Tube of light grease and a jar of anti-seize compound

Note:

Refer to Section 8; PARTS for breakdowns and parts lists for the following procedures:

a. The Seal, (Item #1) is installed onto the Piston, (Item #2) as shown in *Figure 1.* The seal is a five-piece design and is packaged with a replacement retaining clip and assembly schematic for quick reference. It is important to orient the seal as shown, otherwise leakage may occur. After the Seal, (Item #1) is installed into the Piston, (Item #2), a light coating of grease should be applied to the seal and piston assembly to assist with installation into the adapter bore.

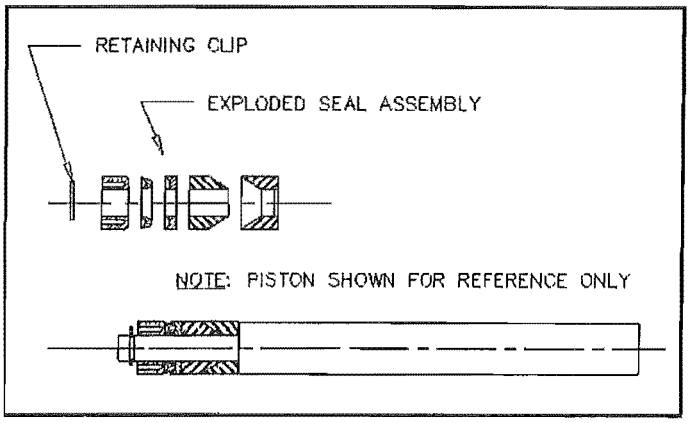


Figure 1

b. The seal and piston assembly *(Figure 1)* should be installed into the Adapter, (Item #12) by carefully inserting the seal and piston assembly into adapter and pushing it flush with the adapter end, refer to *Figure 2.*

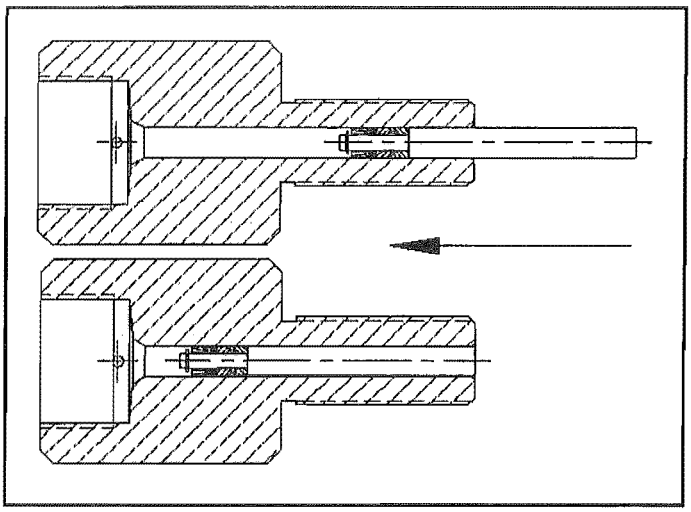
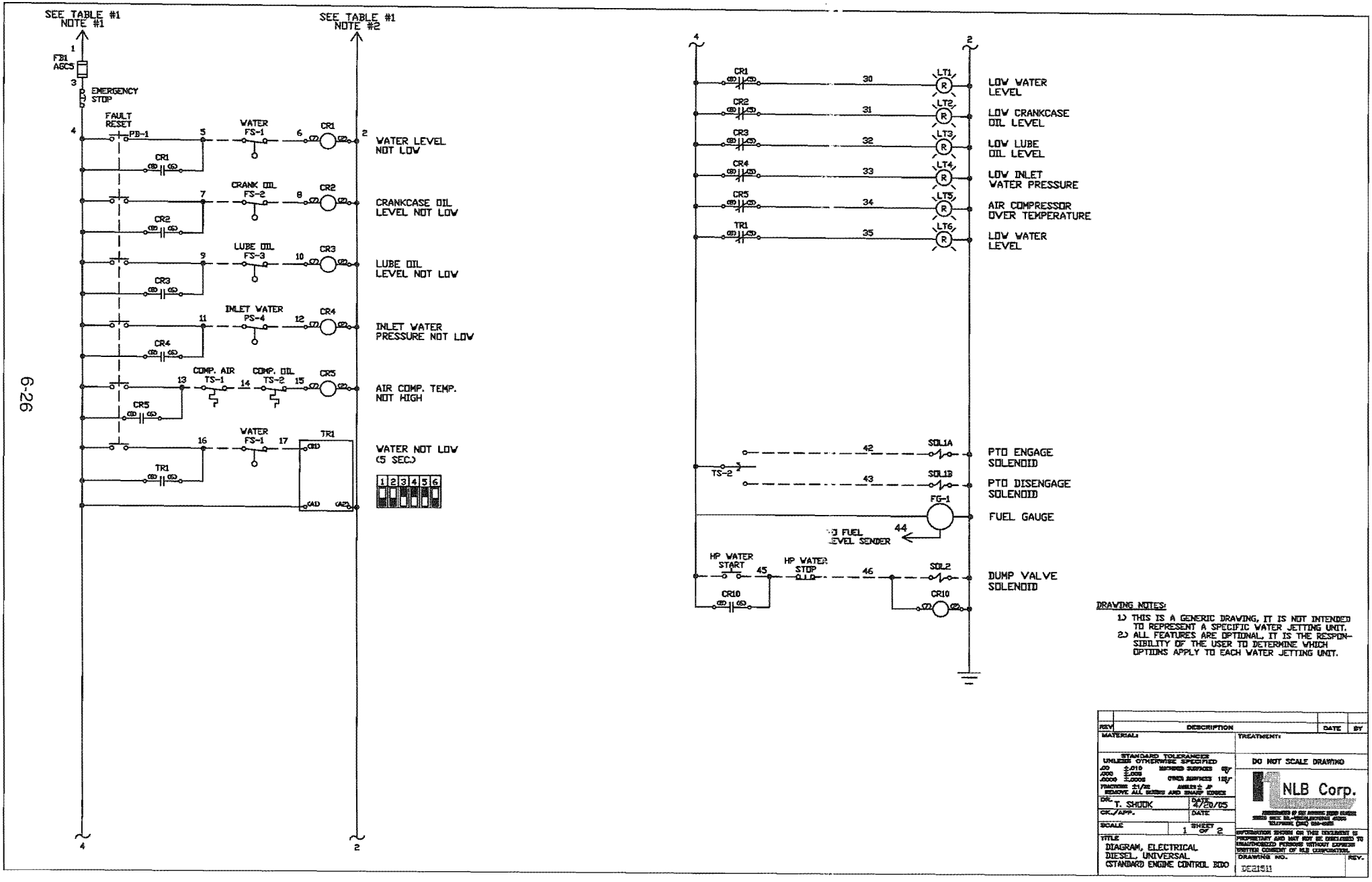


Figure 2

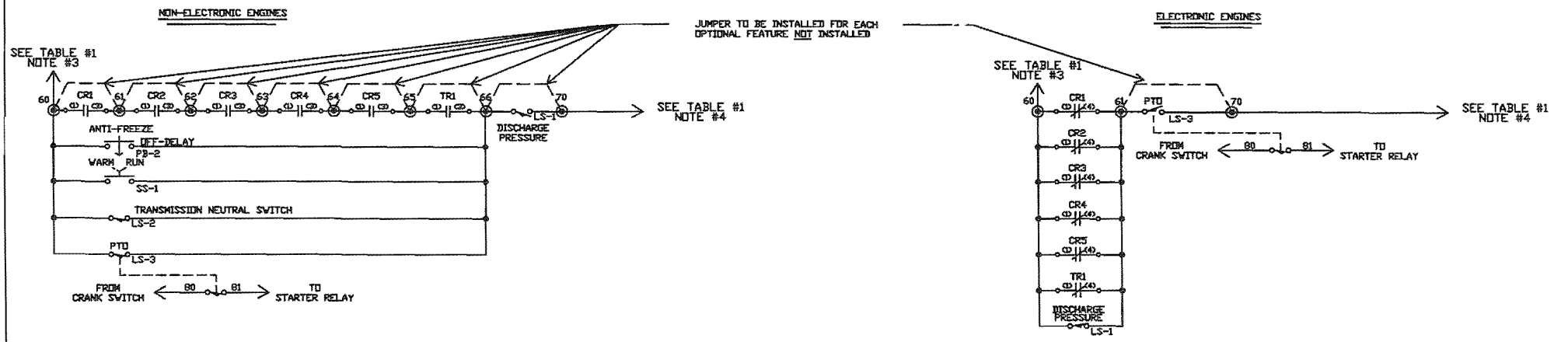
c. The Adjustable Stop, (Item #3) should be lightly coated with anti-seize compound prior to assembly. The stop is made out of gall-resistant bronze and does not require lubrication; however the use of lubrication should provide additional wear resistance under heavy-duty, continuous cycling.



DRAWING NOTES:

1) THIS IS A GENERIC DRAWING, IT IS NOT INTENDED TO REPRESENT A SPECIFIC WATER JETTING UNIT.
2) ALL FEATURES ARE OPTIONAL, IT IS THE RESPONSIBILITY OF THE USER TO DETERMINE WHICH OPTIONS APPLY TO EACH WATER JETTING UNIT.

REV	DESCRIPTION	DATE	BY
MATERIAL:		TREATMENT:	
STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED .00 ±.010 .000 ±.005 .0000 ±.0005 FRACTIONS ±1/32 REMOVE ALL BURRS AND SHARP EDGES		DO NOT SCALE DRAWING	
DR. T. SHOOK	DATE 4/20/05	NLB Corp.	
CK./APP.	DATE		
SCALE 1	SHEET 2 OF 2		
TITLE: DIAGRAM, ELECTRICAL DIESEL, UNIVERSAL (STANDARD ENGINE CONTROL BOX)		DRAWING NO. DE21511	REV.



ENGINE INTERFACE TABLE

(TABLE #1)

	NOTE #1	NOTE #2	NOTE #3	NOTE #4	
	POSITIVE VOLTAGE SOURCE	NEGATIVE VOLTAGE SOURCE	FAULT CONNECTION #1	FAULT CONNECTION #2	ELECTRONIC/NON-ELECTRONIC
ENGINE MODEL	WIRE #4 CONNECTED TO ...	WIRE #2 CONNECTED TO ...	WIRE #60 CONNECTED TO ...	WIRE #70 CONNECTED TO ...	
CUMMINS #M11	N.C. CONTACT (MURPHY SWITCH)	ENGINE CHASSIS GROUND	NLB WIRE #4	ENGINE FUEL SOLENOID	NON-ELECTRONIC
CUMMINS #N14	CUMMINS INST. PANEL, TERM #5	CUMMINS INST. PANEL, TERM #12	CUMMINS 15 PIN PLUG, PIN #1	ENGINE FUEL SHUT-OFF SOLENOID	NON-ELECTRONIC
CUMMINS #QSK	ENGINE 24VDC SWITCHED POWER SOURCE - KEY SWITCH (ACC)	ENGINE CHASSIS GROUND	ENGINE ECM GROUND	CUMMINS OEM INTERFACE "B" CONNECTOR PIN #35, WIRE #037	ELECTRONIC
CUMMINS #QSX15	ENGINE 24VDC SWITCHED POWER SOURCE - KEY SWITCH (IGN)	ENGINE CHASSIS GROUND	ENGINE ECM GROUND	CUMMINS OEM "B" CONNECTOR PIN #23	ELECTRONIC
CUMMINS #B3.9	N.C. CONTACT (MURPHY SWITCH)	ENGINE CHASSIS GROUND	NLB WIRE #4	NLB AIR THROTTLE SOLENOID	NON-ELECTRONIC
CUMMINS #B5.9	N.C. CONTACT (MURPHY SWITCH)	ENGINE CHASSIS GROUND	NLB WIRE #4	NLB AIR THROTTLE SOLENOID	NON-ELECTRONIC
CUMMINS #C8.3	KEY SWITCH, IGN. POSITION	ENGINE CHASSIS GROUND	ENGINE ECM GROUND	CUMMINS "ISC" INPUT ECM"B" CONNECTOR PIN #28	ELECTRONIC
CUMMINS #QSC8.3	KEY SWITCH, IGN. POSITION	ENGINE CHASSIS GROUND	ENGINE ECM GROUND	CUMMINS "ISC" INPUT ECM"B" CONNECTOR PIN #28	ELECTRONIC
CAT #3306	ENGINE TERM. #14	ENGINE CHASSIS GROUND	ENGINE TERM. #24	TERM. #6 ON CAT. TD1	NON-ELECTRONIC
CAT #C9	KEY SWITCH (RELAY TERM.)	INST. PANEL GROUND LUG	INST. PANEL GROUND LUG	INST. PANEL CONNECTOR PIN #9 (GEEN WIRE)	ELECTRONIC
CAT #C12	KEY SWITCH (RELAY TERM.)	INST. PANEL GROUND LUG	INST. PANEL GROUND LUG	INST. PANEL CONNECTOR PIN #9 (GEEN WIRE)	ELECTRONIC
CAT #C16	KEY SWITCH (RELAY TERM.)	INST. PANEL GROUND LUG	INST. PANEL GROUND LUG	INST. PANEL CONNECTOR PIN #9 (GEEN WIRE)	ELECTRONIC
CAT #3126B	KEY SWITCH (RELAY TERM.)	INST. PANEL GROUND LUG	INST. PANEL GROUND LUG	INST. PANEL CONNECTOR PIN #9 (GEEN WIRE)	ELECTRONIC

DRAWING NOTES:

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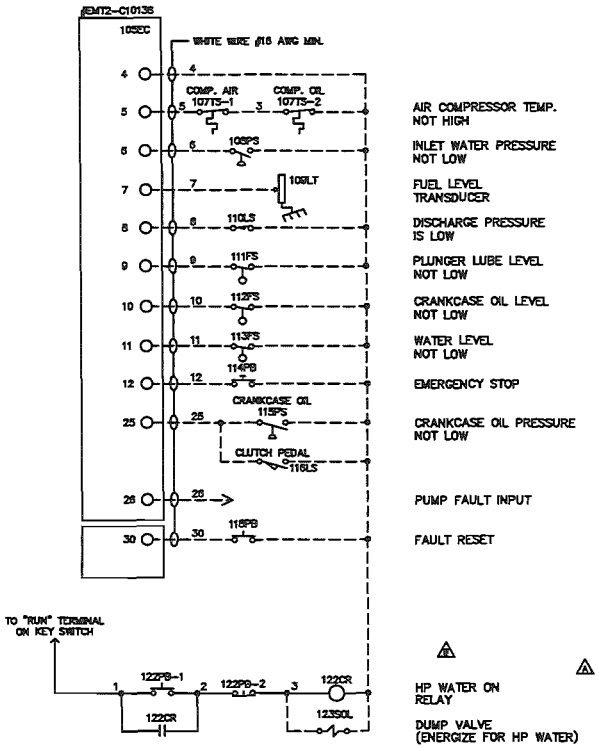
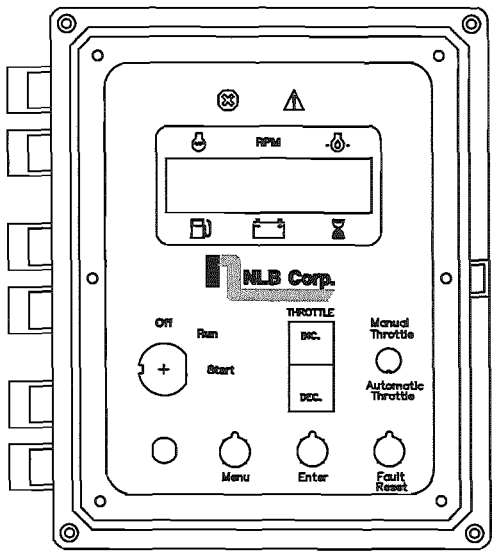
REV	DESCRIPTION	DATE	BY
MATERIAL:		TREATMENT:	
STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED .00 ±.010 .000 ±.005 .0000 ±.0005 FRACTIONS ±1/32 REMOVE ALL BURRS AND SHARP EDGES		DO NOT SCALE DRAWING	
DR. T. SHOOK	DATE 4/20/05	NLB Corp.	
CK./APP.	DATE		
SCALE	SHEET 2 OF 2		
TITLE: DIAGRAM, ELECTRICAL DIESEL, UNIVERSAL (STANDARD ENGINE CONTROL BOX)		DRAWING NO. DE21511	REV.





ENGINE CONTROLLER DOOR LAYOUT

DRAWING NOTES:

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2.) ALL FEATURES ARE OPTIONAL, IT IS THE RESPONSIBILITY OF THE USER TO DETERMINE WHICH OPTIONS APPLY TO EACH WATER JETTING UNIT.

REV	DESCRIPTION	DATE	BY
C	ADDED 115PS & 115LS	3/15/05	TS
B	REMOVED 121CR "ENGINE/PUMP FAULT" RELAY	2/15/05	TS
A	ADDED DUMP VALVE CONTROLS	2/15/05	TS

MATERIAL: TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED

DO NOT SCALE DRAWING

DR. T.SHOOK DATE 4/18/05

CHK./APP. DATE

SCALE NONE SHEET 1 OF 1

TITLE: DIAGRAM, ELECTRICAL, ELECTRONIC ENGINES W/ CONTROLS INC. PANELS

NLB CORP.

DRAWING NO. DE21611 REV. C

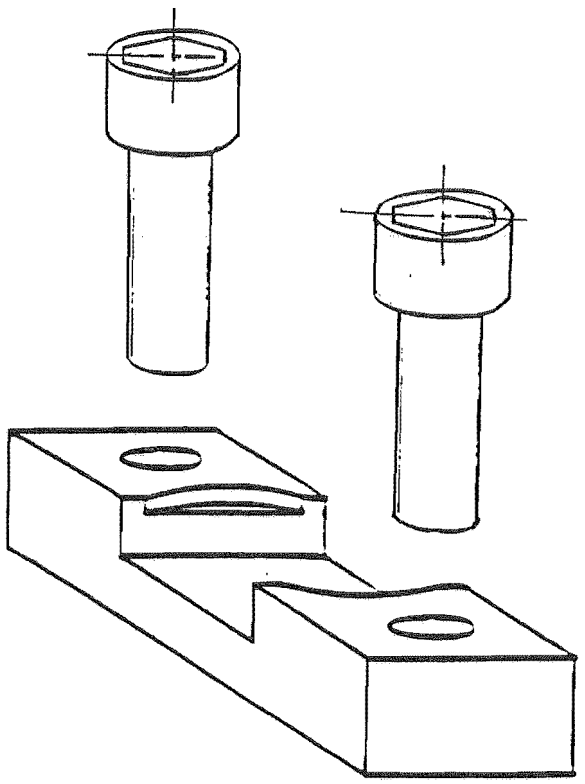
SECTION 7

SPECIAL TOOLS

SECTION 7

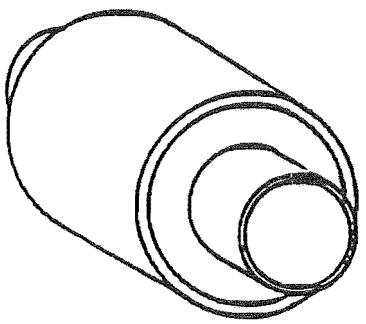
SPECIAL TOOLS

INDEX



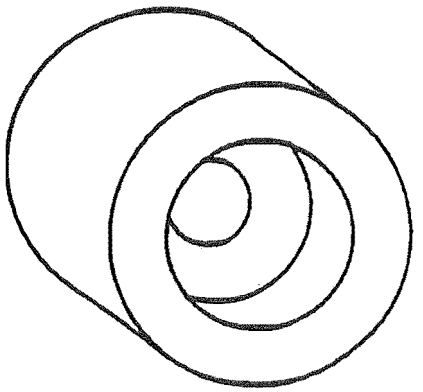
BT3617

OUTER SLEEVE RETAINING TOOL



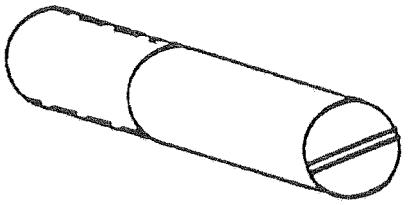
BT8128

INNER SLEEVE REMOVAL TOOL

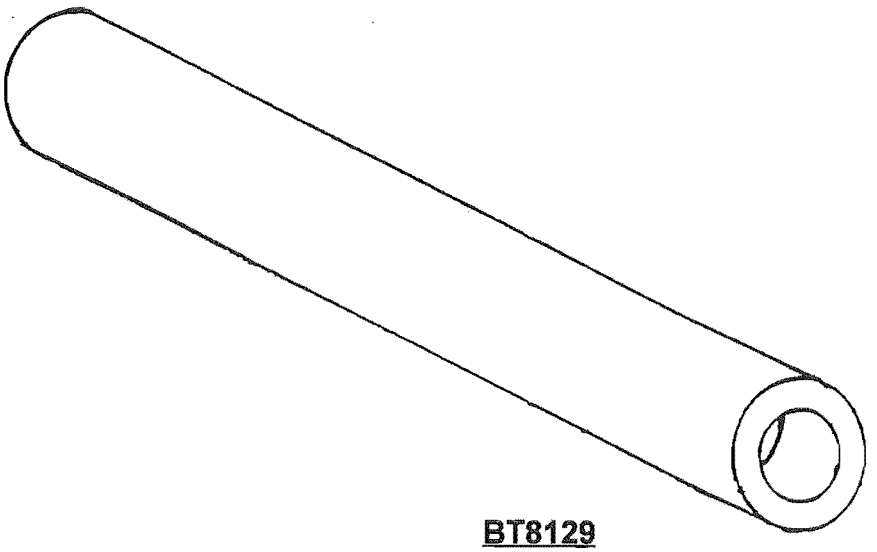


BT3604

OUTER SLEEVE REMOVAL TOOL



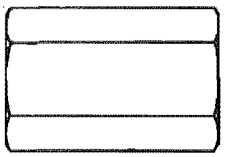
BT3619
MANIFOLD INSTALLATION TOOL SET



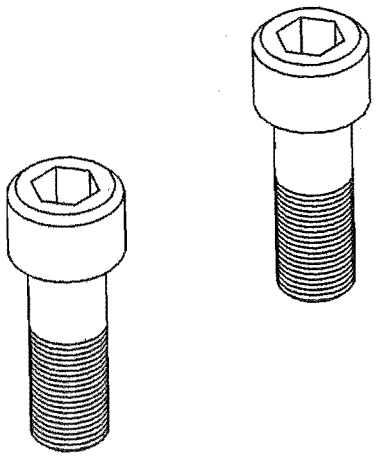
BT8129

PACKING DRIFT

ST1-3/4 SOCKET ADAPTER FOR USE ON SUCTION MANI-FOLD AND STUFFING BOX BOLTS.



ST1-7/8 SOCKET ADAPTER FOR USE ON DISCHARGE MANI-FOLD BOLTS



1-1/8-7X3-1/4SH SOCKET HEAD CAP TOOL
FOR USE ON MANIFOLD

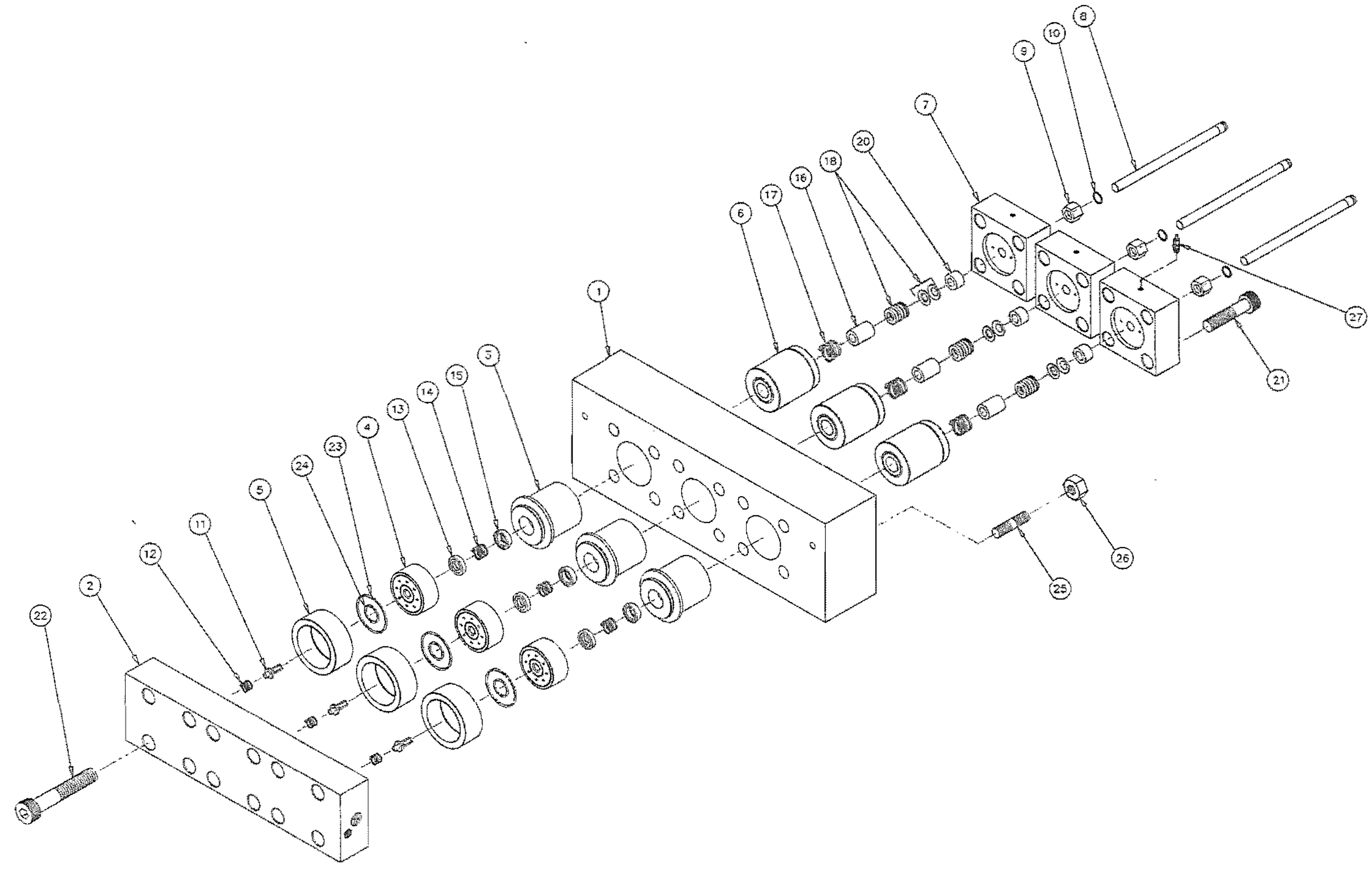
SECTION 8

PARTS

SECTION 8

PARTS

INDEX



	REFER TO SHEET -1-		
REV	DESCRIPTION	DATE	BY

MATERIAL: REFER TO BOM# U-300-05

TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED
.00 ±.010 MACHINED SURFACES 63
.000 ±.002
.0000 ±.0005 OTHER SURFACES 125
FRACTIONS ±1/32 ANGLES ± .5°
REMOVE ALL BURRS AND SHARP EDGES

DO NOT SCALE DRAWING

NLB Corp.

DR. HORTON DATE 8/17/98

CK./APP. DATE

SCALE 1/4"=1" 2 SHEET 2 OF 2

INFORMATION SHOWN ON THIS DOCUMENT IS PROPRIETARY AND MAY NOT BE DISCLOSED TO UNAUTHORIZED PERSONS WITHOUT EXPRESS WRITTEN CONSENT OF NLB CORPORATION.

TITLE
CYLINDER, FLUID
COMPLETE
35200 PUMP

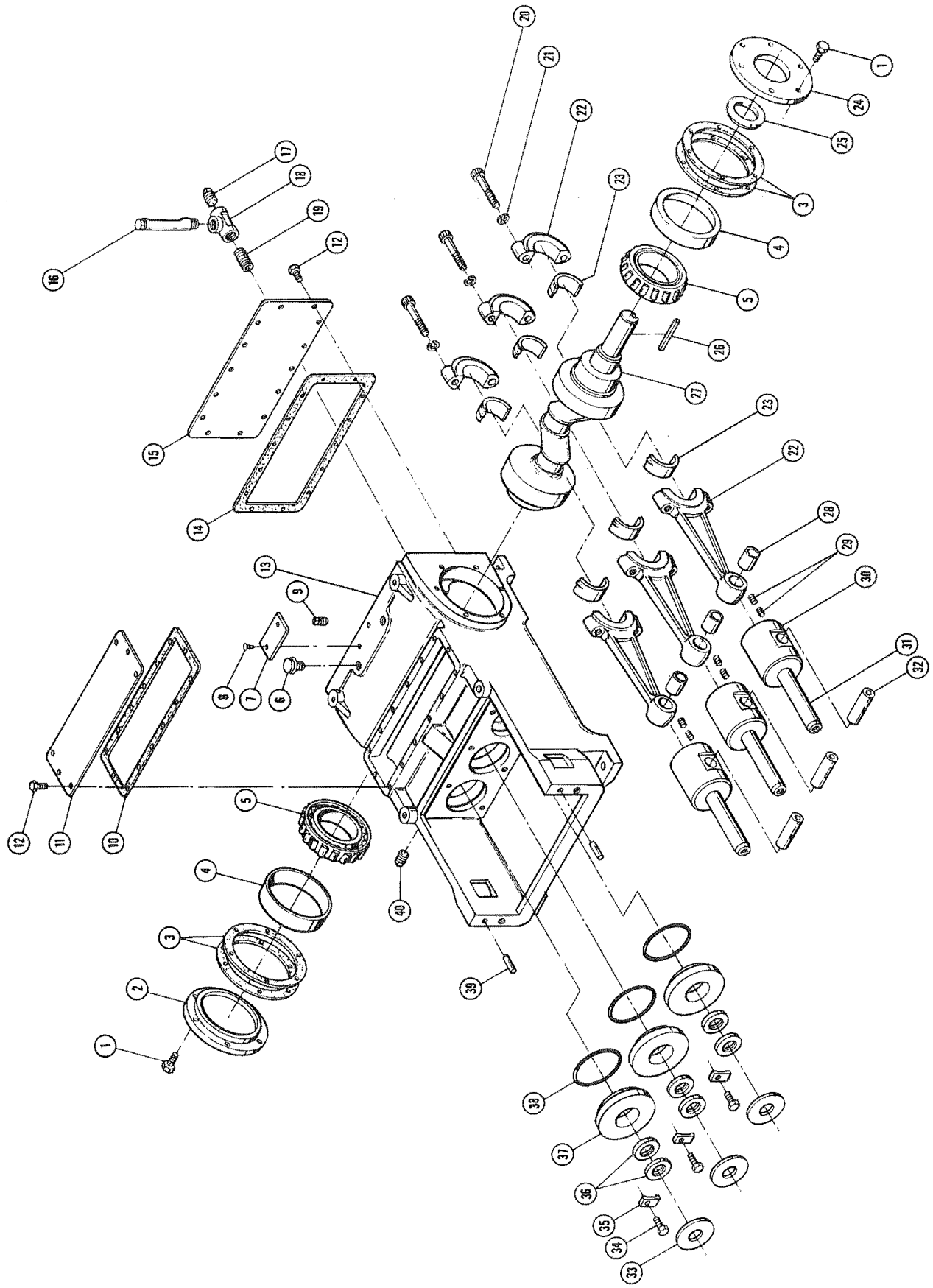
DRAWING NO. DP7812 REV. E

36201/40201 FLUID END
PARTS LIST

	ITEM #	PART #	DESCRIPTION	QTY.
	1	U-303	PLATE, FRAME	1 EA
	2	DP12264	MANIFOLD	1 EA
	3	U-304	SLEEVE, PRESSURE	3 EA
* **	4	U-384	SEAT, VALVE	3 EA
	5	U-385	RING, ALIGNING	3 EA
	6	U-337S	CARTRIDGE, SEAL SINGLE TYPE	3 EA
	7	U-366	FLANGE, PACKING, CARTRIDGE	3 EA
* **	8	U-353-05C	PLUNGER, .660 DIA., CARBIDE	3 EA
	9	U-125	NUT, PLUNGER COUPLING	3 EA
	10	D-124	RING, PLUNGER NUT RETAINER	3 EA
* **	11	F-321	VALVE, DISCHARGE	3 EA
* **	12	F-335	SPRING, DISCHARGE	3 EA
* **	13	U-320	VALVE, SUCTION	3 EA
* **	14	U-334	SPRING, SUCTION VALVE	3 EA
	15	U-370	STOP, SUCTION VALVE	3 EA
	16	BP11524	BUSHING, THROAT	3 EA
* **	17	PM10857	SPRING, SEAL	3 EA
* **	18	1732	PACKING	3 EA
* **	20	BP10858	BACK-UP, CARBIDE	3 EA
	21	F-643-2	SCREW, SOCKET HEAD CAP	12 EA
	22	F-643-3	SCREW, SOCKET HEAD CAP	12 EA
* **	23	AA-4029	O-RING	3 EA
* **	24	AA-4030	O-RING	3 EA
	25	F-301	STUD, CYLINDER TIE	2 EA
	26	L-302	NUT, TIE STUD, FLUID CYLINDER	2 EA
	27	PM12330	FITTINGS, ASSEMBLY, FLUID CYL. LUB.	3 EA
	SHADED:	RECOMMENDED FOR SPARE PARTS		

* ITEMS INCLUDED IN 36K (36201) SPARE PARTS KIT #BP2179-05

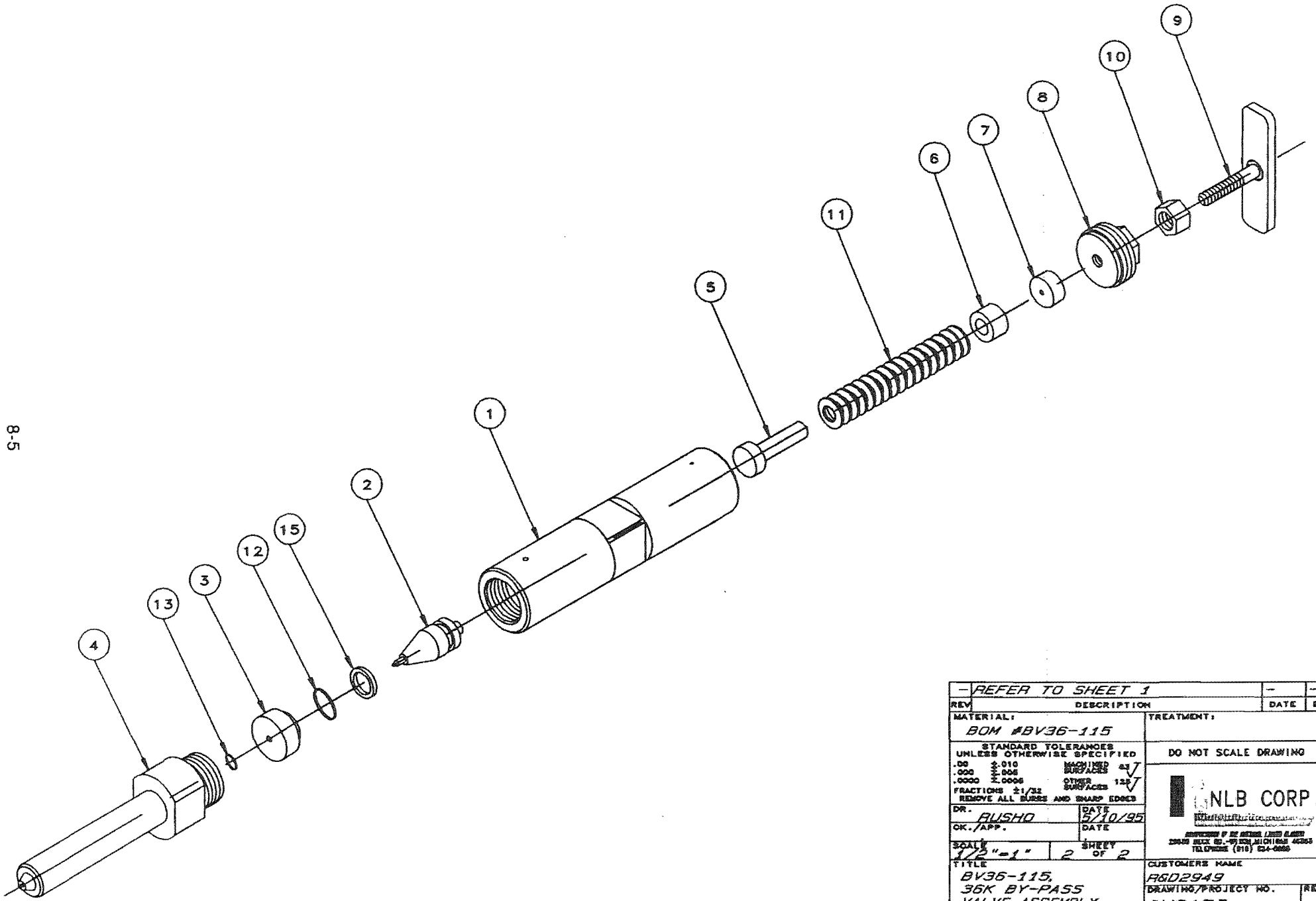
** ITEMS INCLUDED IN 40K (40201) SPARE PARTS KIT #BP13901-05



POWER END

NLB MODEL 36201/40201 POWER END

ITEM #	PART #	DESCRIPTION	QTY.
1	L-643-6	BOLT, CRANKSHAFT BEARING RETAINER	12 EA
2	L-132	RETAINER, BEARING (BLIND END)	1 EA
3	L-134	SHIM, CRANKSHAFT ROLLER BEARING	2 SET
4	L-107	BEARING, CRANKSHAFT W/RACE	2 EA
5	L-107	BEARING, CRANKSHAFT W/RACE	2 EA
6	L-634	BREATHER, CRANKCASE	1 EA
7	L-179	TAG, OIL	1 EA
8	L-192	RIVET, DRIVE	2 EA
9	L-921-1	PLUG, OIL FILL	1 EA
10	L-621	GASKET, CROSSHEAD INSPECTION PLATE	1 EA
11	L-153	PLATE, CROSSHEAD INSPECTION	1 EA
12	L-643-5	BOLT, CRANKSHAFT INSPECTION PLATE	12 EA
13	L-100	FRAME, BARE POWER	1 EA
14	L-620	GASKET, CRANKCASE COVER	1 EA
15	L-154	COVER, CRANKCASE	1 EA
16	N-175	GAUGE, SIGHT, OIL LEVEL	1 EA
17	L-921-2	PLUG, OIL LEVEL SIGHT GAUGE	1 EA
18	L-920-1	TEE, OIL LEVEL SIGHT GAUGE	1 EA
19	L-920-2	BOLT, CONNECTING ROD	1 EA
20	L-113	WASHER, CONNECTING ROD CAP BOLT LOCK	6 EA
21	L-911-1	ROD, CONNECTING	6 EA
22	L-112	BEARING, CONNECTING	3 EA
23	L-116B	BEARING, CONNECTING ROD	3 SET
24	L-133	RETAINER, BEARING, (OPEN END)	1 EA
25	AA-9910	SEAL, CRANKSHAFT OIL	1 EA
26	L-811	KEY, CRANKSHAFT	1 EA
27	L-103	CRANKSHAFT	1 EA
28	L-120	BEARING, CROSSHEAD PIN	3 EA
29	L-913	SCREW, SET	6 EA
30	L-117	CROSSHEAD (LESS STUB)	3 EA
31	U-122	STUB, CROSSHEAD	3 EA
32	L-119	PIN, CROSSHEAD	3 EA
33	D-123	DEFLECTOR, SPLASH	3 EA
34	L-901-1	BOLT, CROSSHEAD STUB SEAL FLANGE	3 EA
35	L-648	CLAMP, CROSSHEAD STUB	3 EA
36	AA-9920	SEAL, CROSSHEAD STUB	6 EA
37	L-141	FLANGE, CROSSHEAD STUB SEAL	3 EA
38	AA-8850	O-RING	3 EA
39	L-650	PIN, ALIGNMENT, FLUID CYLINDER	2 EA
40	L-921-3	PLUG, DRAIN	1 EA
SHADED:	RECOMMENDED FOR SPARE PARTS.		



REV	DESCRIPTION	DATE	BY
–	REFER TO SHEET 1	–	–

MATERIAL: BOM #BV36-115

TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED
.00 ±.010
.000 ±.005
.0000 ±.0005
FRACTIONS ±1/32
REMOVE ALL BURRS AND SHARP EDGES
MACHINED SURFACES 63
OTHER SURFACES 125

DO NOT SCALE DRAWING

DR. RUSHO — DATE 5/10/95
CK./APP. — DATE
SCALE 1/2"=1" — SHEET 2 OF 2

NLB CORP.

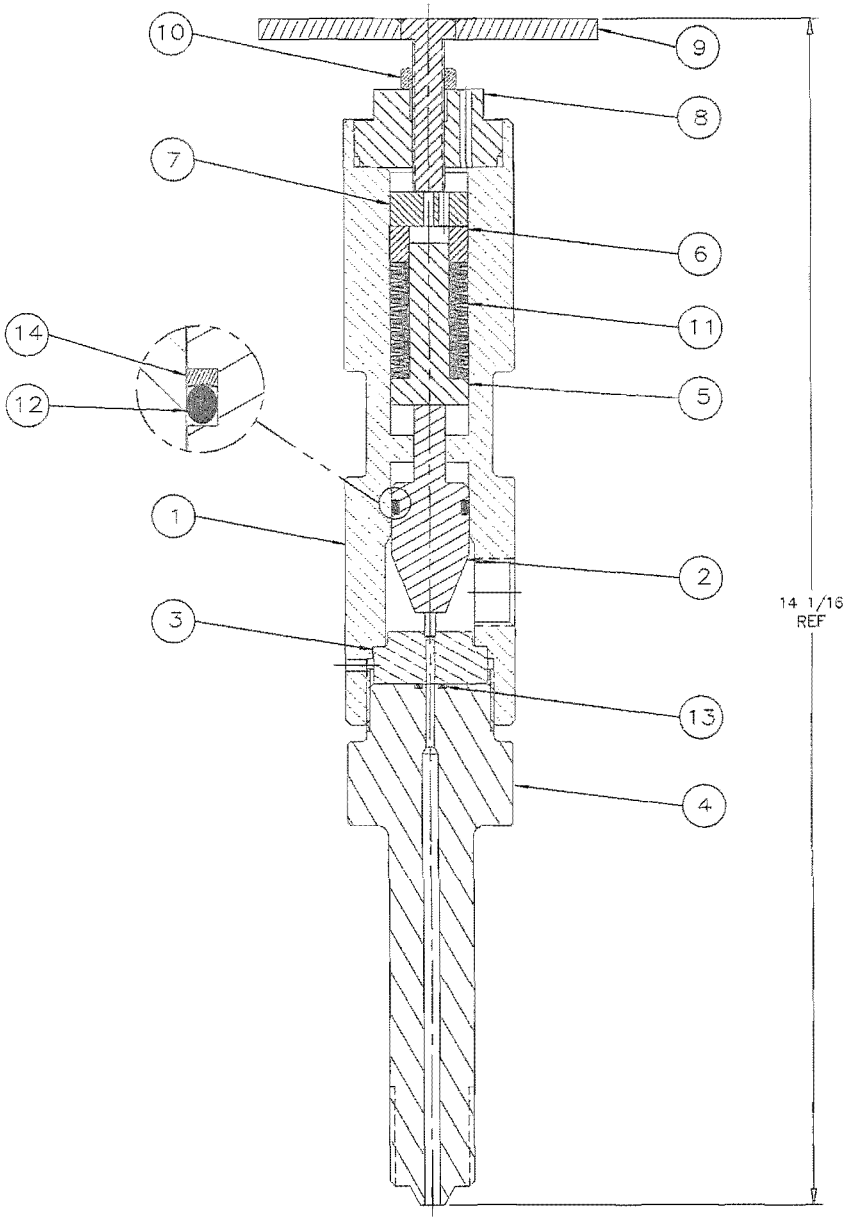
TITLE: BV36-115, 36K BY-PASS VALVE ASSEMBLY

CUSTOMERS NAME: R&D2949

DRAWING/PROJECT NO.: CV8173 — REV.

36K BY-PASS VALVE ASSEMBLY
BV36-115

ITEM #	PART #	DESCRIPTION	QTY.
1	DV8166	BODY	1 EA
2	BV8167	PIN	1 EA
3	BV8168	SEAT	1 EA
4	CV8088	FRAME, SEAT	1 EA
5	BV8169	GUIDE, SPRING	1 EA
6	BV8170	BUSHING, GUIDE	1 EA
7	BV8196	DISC	1 EA
8	BM6957	NUT, CAP	1 EA
9	BV10943	ADJUSTER, SUB-ASSEMBLY	1 EA
10	3/8-24 JN	NUT, JAM	1 EA
11	BM8583	SPRING, DISC	17 EA
12	AA-1660	O-RING	1 EA
13	AA-8450	O-RING	1 EA
15	AA-1790	O-RING, BACK-UP	1 EA
SHADED:	**RECOMMENDED FOR SPARE PARTS.**		



REV	DESCRIPTION	DATE	BY
C	ITEM #12 WAS AA-4039	3/18/98	TH
C	ITEM #4 WAS CV9876,ITEM #11 WAS BM8583, QTY 17		
B	MODIFIED ITEMS #1,2,7 & 8	7/7/97	NR
A	ITEMS #9 AND #14 NOW WELDED SUB-ASSEMBLY	10/8/96	NR

MATERIAL: REFER TO B/M #BV40-010

TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED
.00 ±.010 MACHINED SURFACES 63√
.000 ±.005
.0000 ±.0005 OTHER SURFACES 125√
FRACTIONS ±1/32 ANGLES ± .5°
REMOVE ALL BURRS AND SHARP EDGES

DO NOT SCALE DRAWING

DR. T. W. R. DATE 12/15/95

CK./APP. DATE

SCALE FULL SHEET OF

TITLE
VALVE, BY-PASS
40K, ASSEMBLY
BV40-010

NLB Corp.
MANUFACTURERS OF THE NATIONAL LIQUID BLASTER
21830 BECK RD.-WIXOM,MICHIGAN 48393
TELEPHONE (248) 624-5555

DRAWING NO. CV9874 REV. C

40K BY-PASS VALVE ASSEMBLY

BV40-010

CV9874

ITEM #	PART #	DESCRIPTION	QTY.
1	DV8166	BODY	1 EA
2	BV8167	PIN	1 EA
3	BV8168	SEAT	1 EA
4	CV8088	FRAME	1 EA
5	BV8169	GUIDE, SPRING	1 EA
6	BV8170	BUSHING, GUIDE	1 EA
7	BV8196	DISC	1 EA
8	BM6957	NUT, CAP, MULTI-GUN VALVE	1 EA
9	BV10943	ADJUSTER, SUB-ASSEMBLY	1 EA
10	3/8-24JN	NUT, JAM, PLATED	1EA
11	BM12423	SPRING, DISC	19 EA
12	AA-1660	O-RING	1 EA
13	AA-8450	O-RING	1 EA
14	AA-1790	BACK-UP, O-RING	1 EA
SHADED:	RECOMMENDED FOR SPARE PARTS.		

RUPTURE DISC ASSEMBLY

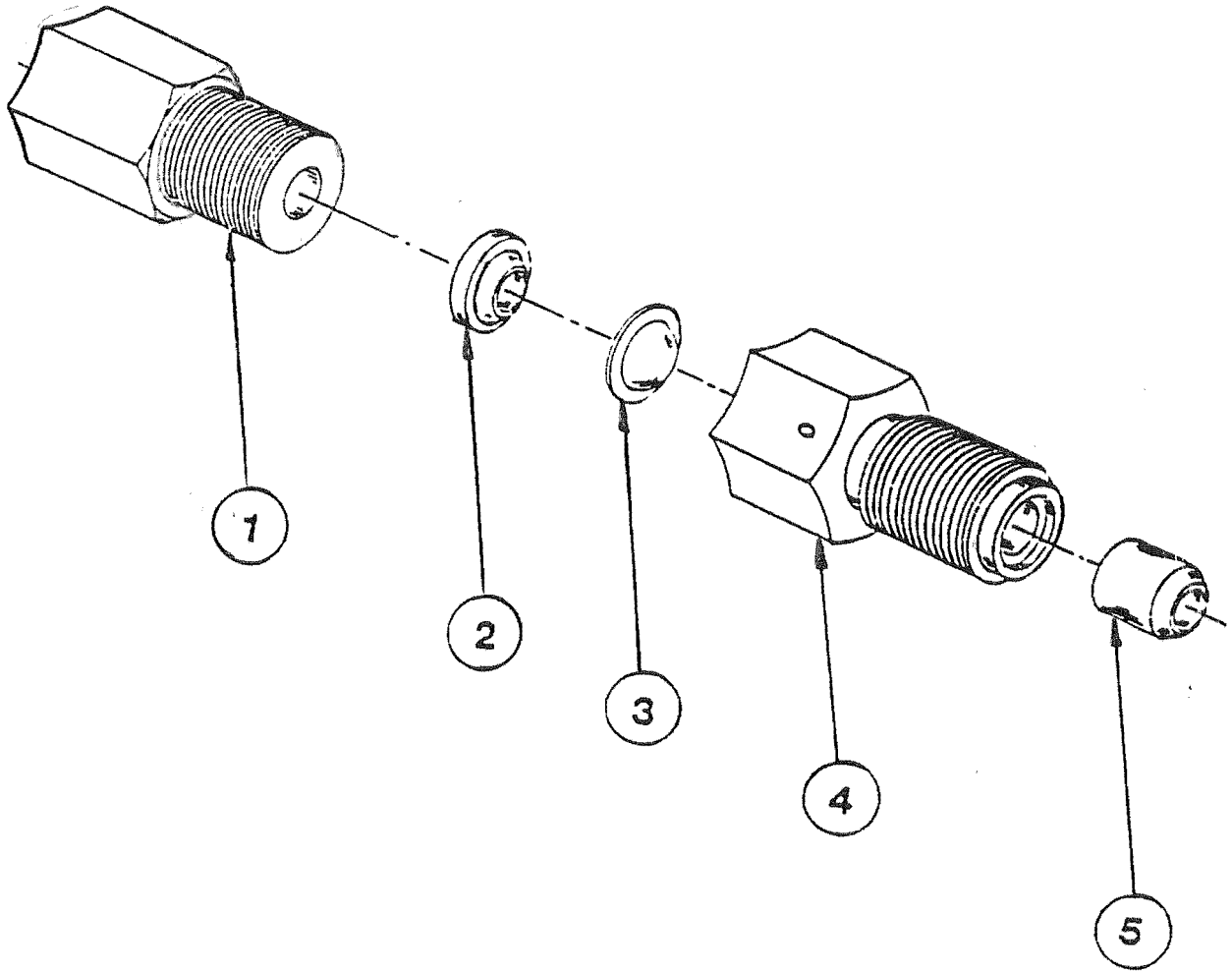
NSP 4000

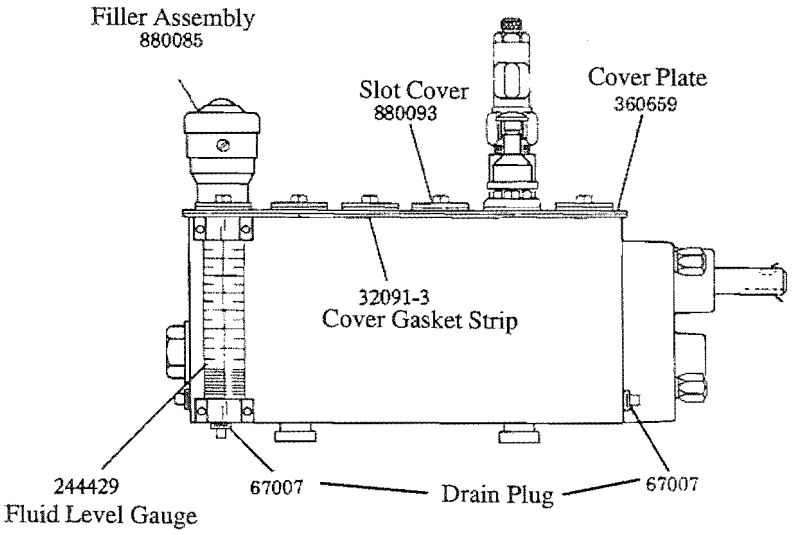
	ITEM #	PART #	DESCRIPTION	QUANTITY
	1	NSP-3001-04	CAP	1
	2	NSP-3001-03	WASHER	1
*	3	NSP-4002-34	DISC, RUPTURE, 34K LIGHT BLUE	1
*	3	NSP-4002-36	DISC, RUPTURE, 36K, TAN	1
*	3	NSP-4002-42	DISC, RUPTURE, 42K, NAVY BLUE	1
**	3	NSP-4002-42	DISC, RUPTURE, 40K, LIME GREEN	1
**	3	NSP-4002-40	DISC, RUPTURE, 42K, NAVY BLUE	1
	4	NSP-4001-01	BODY	1
	5	NSP-4001-02	SEAT, BODY	1

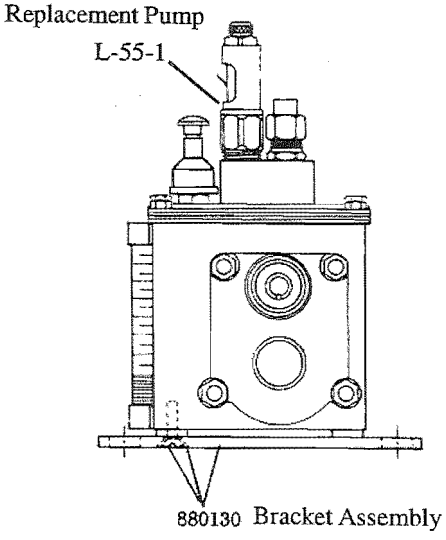
SHADED: RECOMMENDED FOR SPARE PARTS KIT

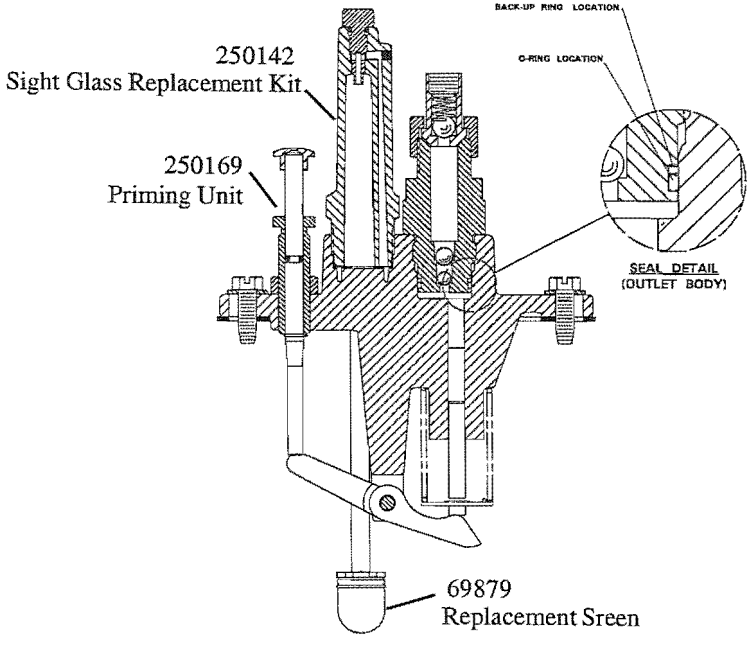
* ITEMS INCLUDED IN TRIPLEX (36201) 36K FLUID END SPARE PARTS KIT #BP2179-05

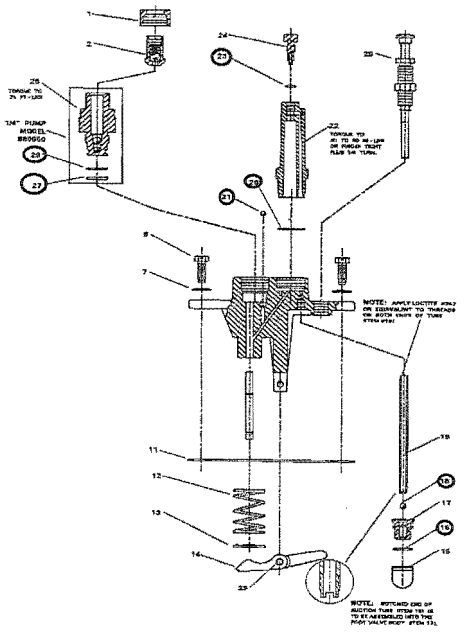
** ITEMS INCLUDED IN TRIPLEX (40201) 40K FLUID END SPARE PARTS KIT #BP13901-05











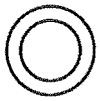
250172
Pump Seal Kit

Includes:

16 O-Ring
18 Ball(Suction Tube)
20 Sight Glass Seal
21 Ball (Inlet Check)
23 O-Ring
26 Backup Ring
27 O-Ring

L-55i/L60i Oil Plunger Lubricator Parts

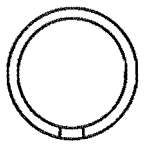
ITEM 23
O-RING (BROWN)



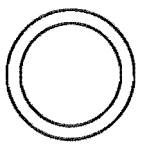
ITEM 16
O-RING (BLACK)

ITEM 7
BELLEVILLE WASHER

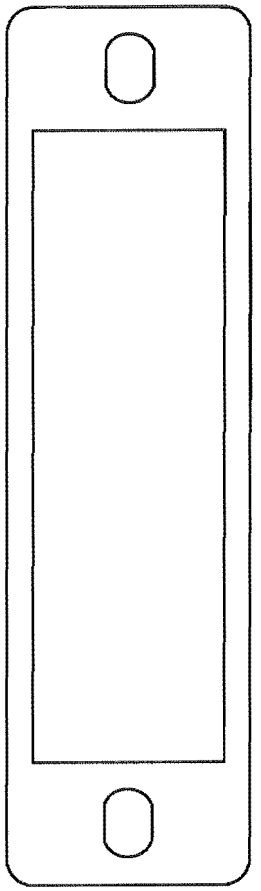
ITEM 9
PIVOT PIN



ITEM 4
BACKUP RING (WHITE)



ITEM 5
O-RING (BLACK)



ITEM 11
PUMP MOUNTING
GASKET

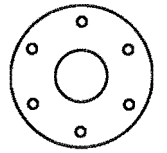
ITEM 6
MOUNTING SCREW

ITEM 21
STEEL BALL

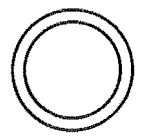
ITEM 18
STEEL BALL

ITEM 8
COTTER PIN

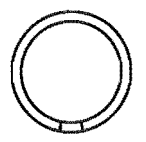
ITEM 29
GROOVED PIN



ITEM 20
SEAL (BLACK)



ITEM 27
O-RING (BLACK)



ITEM 26
BACKUP RING (WHITE)

L-55i & L-60i Oil Plunger Lubricators

ITEM#	DESCRIPTION	QUANTITY
69879	*Replacement Screen Assembly*	
15	Screen Assembly	1 Ea.
250136	*Suction Tube*	
19	Suction tube	1 Ea.
250142	*Sight Glass Replacement Kit*	
20	Sight glass seal	1 Ea.
22	Sight glass	1 Ea.
23	O-ring	1 Ea.
24	Dropper	1 Ea.
250143	*Pump Mounting Kit*	
6	Mounting Screw	2 Ea.
7	Belleville Washer	2 Ea.
11	Pump Mounting Gasket	1 Ea.
250144	*Pump Seal Kit for Model 880560 (3/8" Pump)*	
4	Backup Ring (Outlet Body)	1 Ea.
5	O-ring (Outlet Body)	1 Ea.
16	O-ring (Suction Tube)	1 Ea.
18	Ball (Suction Tube)	1 Ea.
20	Sight Glass Seal	1 Ea.
21	Ball (Inlet Check)	1 Ea.
23	O-ring (Dropper)	1 Ea.
250148	*Outlet Union Assembly*	
1	Union Nut (Outlet)	1 Ea.
2	Sleeve Assembly (Outlet)	1 Ea.
250166	*Outlet Check Kit for Model 880560 (3/8" Pump)*	
3	Adapter Assembly (with Check Balls)	1 Ea.
4	Backup Ring	1 Ea.
5	O-ring	1 Ea.
250167	*Rocker Arm for Series "A" Replacement Kit*	
8	Cotter Pin	1 Ea.
9	Pivot Pin	1 Ea.
12	Spring (Plunger Return)	1 Ea.
13	Spring Retainer	1 Ea.
14	Rocker Arm	1 Ea.

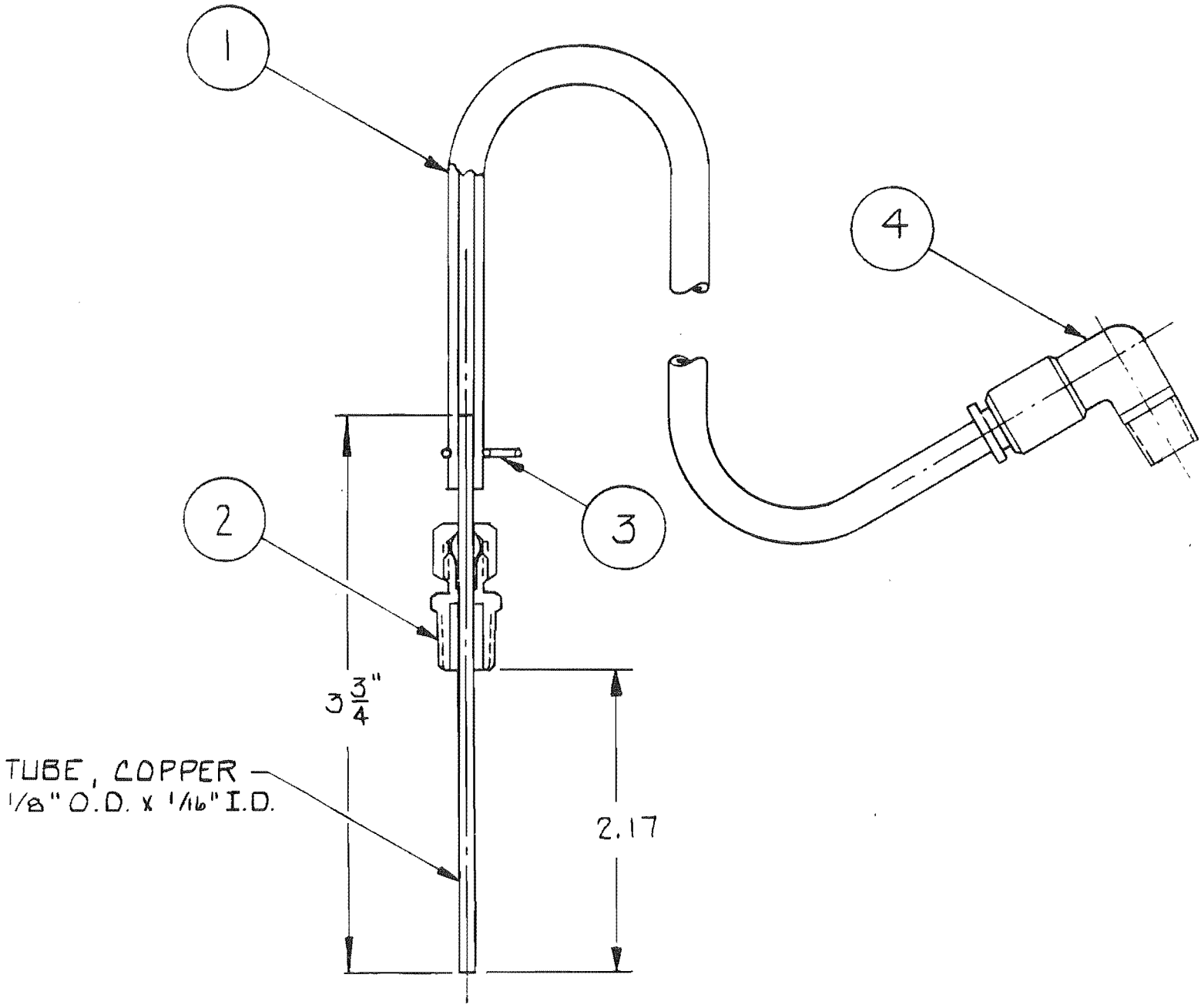
ITEM#	DESCRIPTION	QUANTITY
250169	*Priming Unit Assembly*	
25	Priming Unit Assembly	1 Ea.
250171	*Replacement Dropper Assembly*	
23	O-ring	1 Ea.
24	Dropper	1 Ea.
250172	*Pump Seal Kit for Model 880550 (1/4" Pump)*	
26	Backup Ring (Outlet Body)	1 Ea.
27	O-ring (Outlet Body)	1 Ea.
16	O-ring (Suction Tube)	1 Ea.
18	Ball (Suction Tube)	1 Ea.
20	Sight Glass Seal	1 Ea.
21	Ball (Inlet Check)	1 Ea.
23	O-ring (Dropper)	1 Ea.
250173	*Outlet Check Kit for Model 880550 (1/4"Pump)*	
26	Backup Ring	1 Ea.
27	O-ring	1 Ea.
28	Adapter Assembly (with Check Balls)	1 Ea.
250225	*Rocker Arm Kit - Series "B" or Newer*	
14	Rocker Arm	1 Ea.
29	Grooved Pin	1 Ea.
12	Screen Assembly	1 Ea.
13	Spring Retainer	1 Ea.

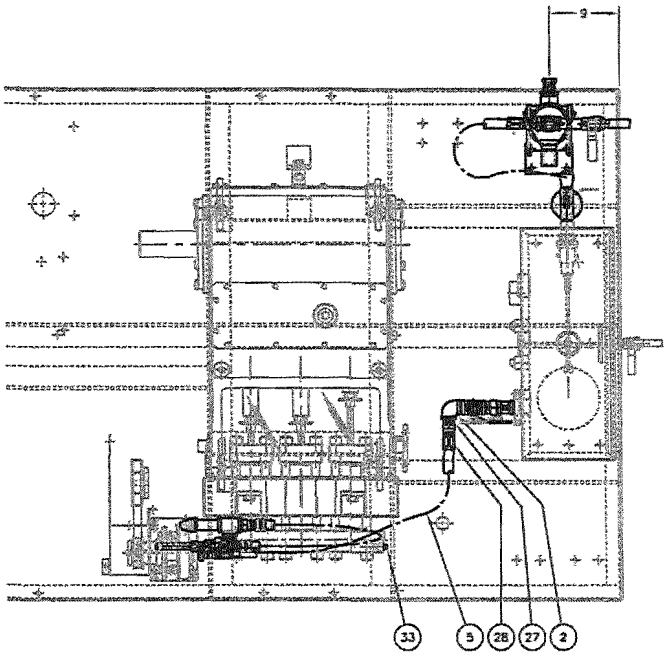
Note:

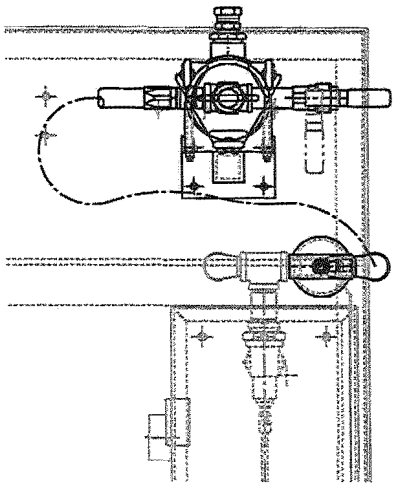
Service parts for Models 880550 and 880560 are available only in the NLB Service Kits highlighted above and are recommended for spare parts. Individual service parts and parts not listed above are not available.

PIPING, LUBRICATOR LINES

ITEM #	PART #	DESCRIPTION	QTY.
1	PM2518	TUBING, PARFLEX CLEAR PVC	9 FT
2	BM4218	CONNECTOR, MALE COMPRESSOR MODIFICATION	3 EA
3	PM2520	CLAMP, HOSE, 1/4" O.D.	3 EA
4	V-550-54	FITTING, AIR HOSE	3 EA

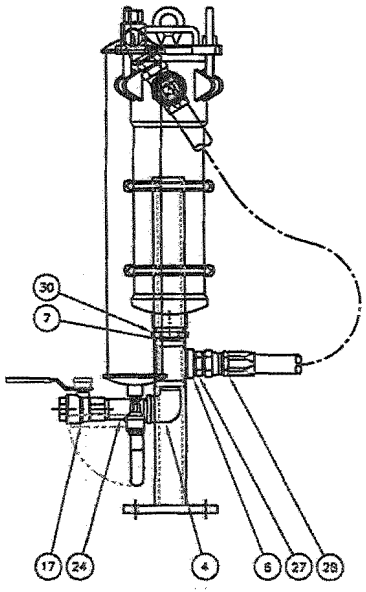






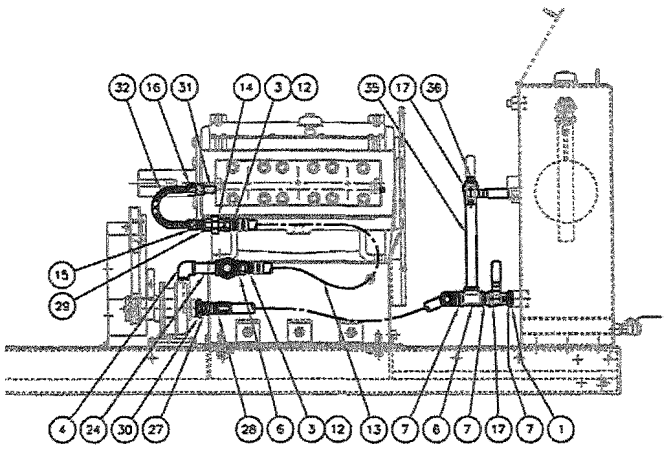
REQUIRED ORIENTATION OF CARTRIDGE FILTER FOR WATER LUBRICATION

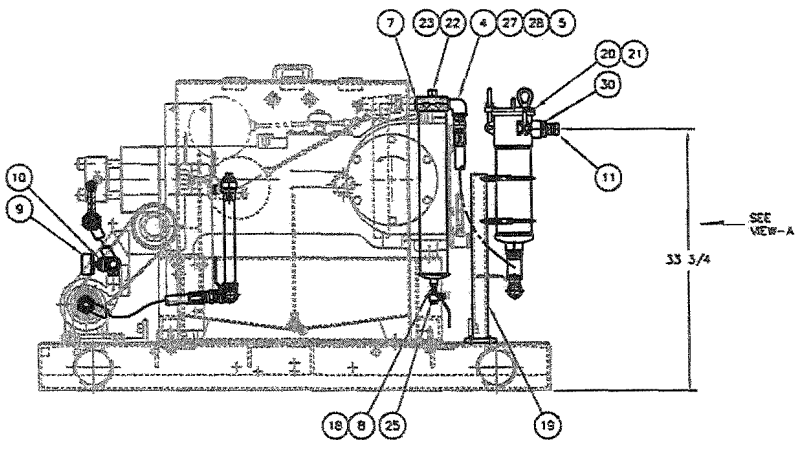
SCALE: 1/4"=1"



VIEW-A

SCALE: 1/4"=1"





REV	DESCRIPTION	DATE	BY

MATERIAL: SEE B/M DM15955

TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED

DO NOT SCALE DRAWING

DR. SPRAGUE DATE 6/5/02

CH./APP. DATE

SCALE 1/8"=1" SHEET 1 OF 1

TITLE: PIPING, INLET / SUCTION, 4020108 W/ FILTERS

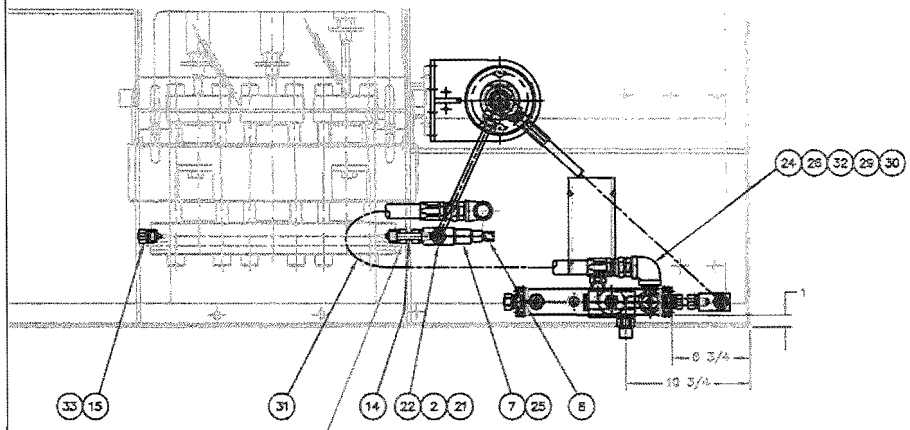
NLB Corp.

DRAWING NO. DM15955 REV.

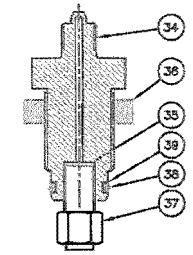
PIPING INLET / SUCTION, 40201DB W/FILTERS

DM15955

ITEM #	PART #	DESCRIPTION	QTY
1	12-10-RB-6T-S	BUSHING, REDUCER, 1-1/4" X 1" THREADED, 304 SS 150LB.	2 EA
2	10-ELB-90-40-S	ELBOW, 1", 90°, 150 LB THREADED, SS 304	1 EA
3	PM3906	BARB, HOSE, 1" STAINLESS	2 EA
4	10-ST-ELB-40-SS	ELBOW, STREET. 1", 150LB, THREADED, STAINLESS 304	2 EA
5	PM11996	HOSE, 1", BLUE, 400 WP, PER FOOT	5 FT
6	10-TEE-40-SS	TEE, 1", 150LB, THREADED, STAINLESS 304	4 EA
7	10-CL-NIP-40-SS	NIPPLE, 1" X CLOSE, SCH 40, STAINLESS 304	6 EA
8	01-CL-NIP-40-S	NIPPLE, 1/8" X CLOSE. SCH, 40 STAINLESS 304	1 EA
9	PM15127	GAUGE, 0-100 PSI, 2-1/2" DIAL 1/4" NPT LOWER MOUNT LIQUID	1 EA
10	10-02-RB-6T-S	BUSHING, REDUCER, 1" X 1/4" THREADED, STAINLESS 304	1 EA
11	2045-16-16S	COUPLING, SWIVEL, 1", MALE TO FEMALE	1 EA
12	Y0005	CLAMP, HOSE 5/8 X 2-1/4 PUN LO TUBING, CLEAR THERMOPLASTIC	4 EA
13	PM8277	TUBING, CLEAR THERMOPLASTIC, 1" I.D., 150PSI	4 FT
14	10-UN-BR-125	UNION, 1", BRASS, 125 LB	1 EA
15	PM13480	COUPLING, MALE	1 EA
16	PM13479	COUPLING, FEMALE	1 EA
17	HR-2180-10	VALVE, BALL, 1" LOW PRESSURE	3 EA
18	02-01-RB-6T-SS	BUSHING, REDUCER, 1/4" X 1/8",THREADED, STAINLESS 304	1 EA
19	CM8025	BRACKET, SINGLE BAG FILTER ASS'Y FOR PM3350/PM3328	1 EA
20	PM3350	VALVE, BALL, 1/4" LOW PRESSURE,	1 EA
21	PM3801	FILTER, BAG, HOUSING 144SQ. IN. 1-1/2" FNPT, SS	1 EA
22	PM10512	FILTER, HOUSING, 20", SS 1" MNPT, CART, USE PM10511	1 EA
23	PM10511	FILTER, ELEMENT, 20" OAL CART, 5 MICRON ABS, USE PM10512 HSG	1 EA
24	10-40-NIP-40-S	NIPPLE, 1" X 4", SCH 40, STAINLESS, 304	2 EA
25	HR-2180-02	VALVE, BALL, 1/4" LOW PRESSURE,	1 EA
27	BP1228	ADAPTER, HOSE, 1" NPT TO JIC, SS	4 EA
28	BP1229	FITTING, HOSE, 1" JIC SWIVEL SS	4 EA
29	10-04-RB-6T-S	BUSHING, REDUCER, 1" S 1/2"	1 EA
30	14-10-RB-6T-S	BUSHING, REDUCER, 1-1/2" X 1"	3 EA
31	04-24-NIP-40-SS	NIPPLE, 1/2" X 2-1/2", SCH 40, 304 STAINLESS	1 EA
32	CM13478	TUBE, SUCTION, 36201D	1 EA
33	04-PLG-6T-S	PLUG, 1/2", SQUARE HEAD	1 EA
35	10-120-NIP-40-S	NIPPLE, 1" X 12" LONG, SCH 40, SEAMLESS, 304 STAINLESS	1 EA
36	10-PLG-6T-S	PLUG, 1", SQUARE HEAD, THREADED, STAINLESS, 304	2 EA



USE SPARE COLLAR AND GLAND FROM ELBOW, ITEM #17



SNUBBER DETAIL
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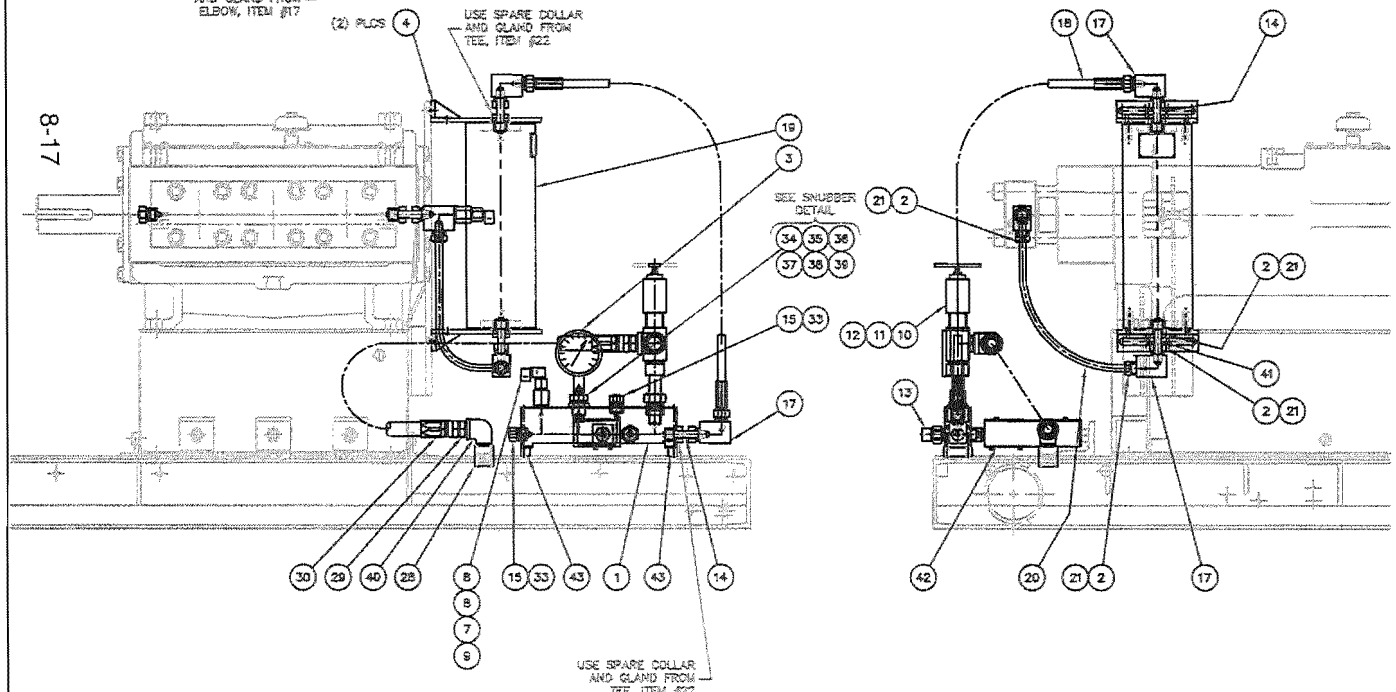


8-17

REV	DESCRIPTION	DATE	BY

MATERIAL: SEE B/M "DM23931"

TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED
.00 ±.010 MACHINED SURFACES 63
.000 ±.005
.0000 ±.0005 OTHER SURFACES 125
FRACTIONS ±1/64 ANGLES ± 0°
REMOVE ALL BURRS AND SHARP EDGES

DO NOT SCALE DRAWING

NLB Corp.

DR. DEARNLEY DATE 6/12/08
CK./APP. DATE
SCALE 3/16"=1" SHEET 1 OF 1

TITLE
PIPING, DISCHARGE.
40201DBA-TRA
CAT C6.5

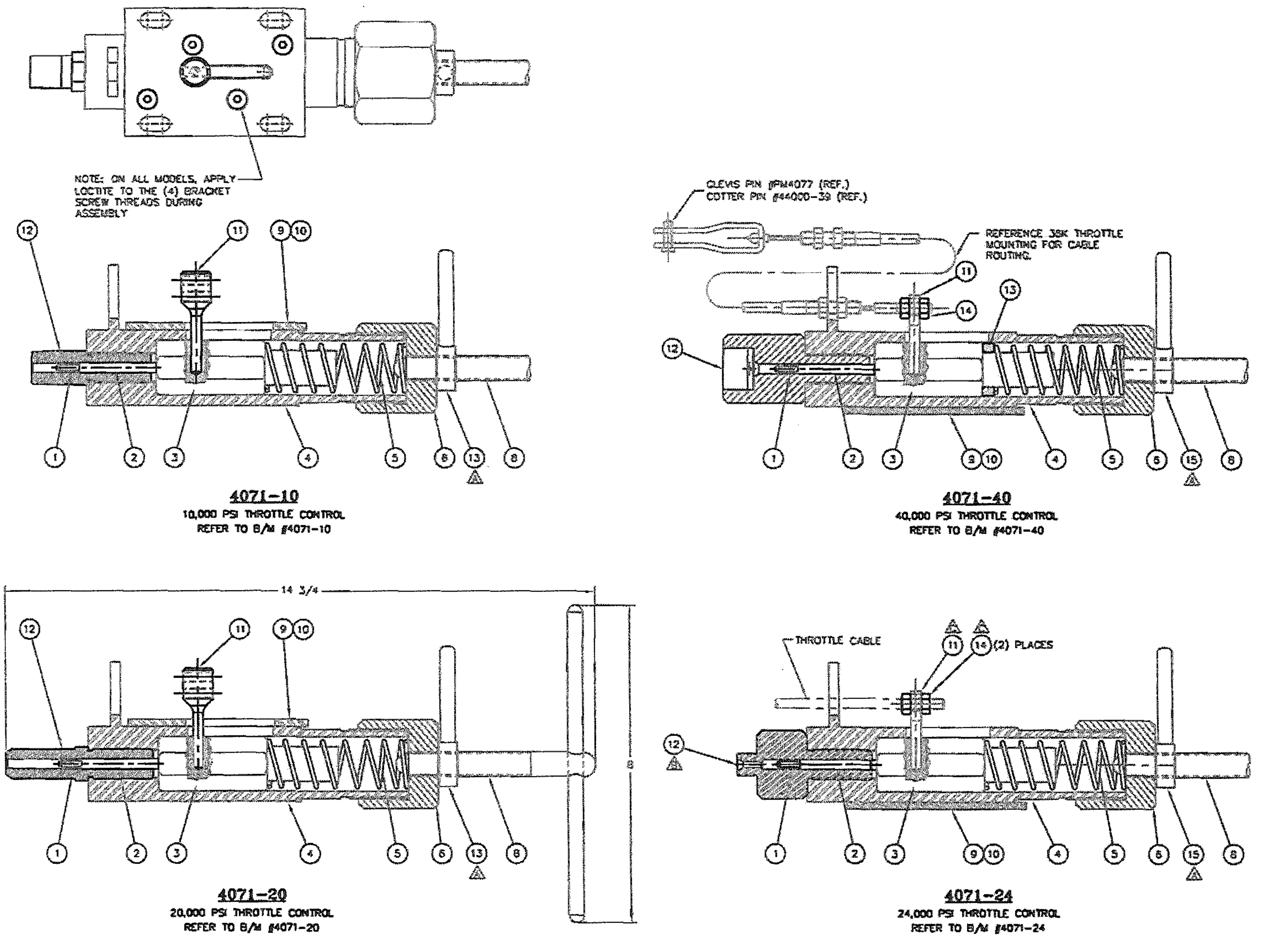
DRAWING NO. DM23931 REV.

40201DBA-TRA DISCHARGE PIPING

DM23931

ITEM #	PART #	DESCRIPTION	QTY
1	DM12378	MANIFOLD, ACCESSORY, 40K, W/SHORT SNUBBER PORT	1 EA
2	DM6023-226	GLAND, NUT, ANTI-VIBRATION HIGH PRESSURE, 60K, 9/16"	4 EA
3	5008	GAUGE, WATER PRESSURE 0-50K, GLYCERINE FILLED	1 EA
4	CM11404	BRACKET, PULSATION DAMPNER	2 EA
7	NSP-4000	VALVE, RUPTURE, 60K CONSISTING OF: (1) NSP-3001-4 CAP, RUPTURE VALVE (1) NSP-3001-3 WASHER, RETAINING (1) NSP-4001-1 BODY, RUPTURE VALVE (1) NSP-4001-2 SEAT, BODY	2 EA
8	PM12714	ADAPTER, ELBOW, STREET	3 EA
9	NSP-4002-40	DISC, RUPTURE, 40K, LIME GREEN	1 EA
10	DM6023-249	GLAND, 1" 30K, STAINLESS, 316	1 EA
11	DM6023-250	COLLAR, 1" 30K, 316 STAINLESS	1 EA
12	BV36-115	VALVE, BY-PASS, ASSEMBLY, 40K	1 EA
13	CM3680	ADAPTER, 5/16", HOSE, SWIVEL TO1-1/8"-12 PORT, 40K	1 EA
14	DM6023-238	NIPPLE, 9/16" HP X 4", 40K	3 EA
15	DM6023-211	GLAND, HIGH PRESSURE	3 EA
17	DM6023-253	ELBOW, 9/16, 40K	2 EA
18	NP40-5/16-4M	HOSE, 5/16" X 4' OAL, 40K, 9/16HP NIPPLE MALE ENDS	1 EA
19	DM7831	DAMPENER ASSY, PULSATION, 40K	1 EA
20	CP11401	TUBE, 9/16" 40K, HP PUMP TO PULSATION DAMPENER, 36200	1 EA
21	DM6023-225	COLLET, SLOTTED, ANTI-VIBRATE, HIGH PRESSURE, 60K, 9/16"	4 EA
22	DM6023-259	TEE, 9/16 40K	1 EA
24	04-CL-NIP-40-S	NIPPLE, 1/2" X CLOSE, SCH 40, SUPERSEDED BY 04-CL-NIP-40-SS	1 EA
25	NSP-4002-42	DISC, RUPTURE, 42K, NAVY BLUE	1 EA
26	10-04-RB-6T-S	BUSHING, REDUCER, 1" X 1/2" THREADED, 304 STAINLESS	1 EA
28	10-CPL-40-SS	COUPLING, 1", 150LB, THREADED, STAINLESS 304	2 EA
29	PM20733	ADAPTER, HOSE, 1" NPT TO JIC SS	2 EA
30	PM20734	FITTING, HOSE, 1" JIC SWIVEL SS	2 EA
31	PM11996	HOSE, 1", BLACK, 400WP., PER FOOT	8 FT
32	10-ELB-90-40-S	ELBOW, 1", 90°, 150LB, STAINLESS 304	1 EA
33	DM6023-217	PLUG, HIGH PRESSURE, 60K 9/16"	3 EA
34	CM12383	SNUBBER, PRESSURE GAUGE, 40K	1 EA
35	BM9186	WASHER, BRASS	1 EA
36	BM9210	NUT, JAM. 1-1/8"-12	1 EA
37	PM9001	FILTER, SNUBBER, PRESSURE GAUGE	1 EA
38	AA-1660	O-RING	1 EA
39	AA-1790	BACK-UP, O-RING	1 EA
40	10-ST-ELB-40-SS	ELBOW, STAINLESS,304	1 EA
41	DM6023-230	NIPPLE	1 EA
42	CA10800-40E	SWITCH, THROTTLE OR PRESSURE	1 EA
43	BM12516	BLOCK, SPACER, ACCESSORY MANIFOLD	2 EA

SHADED: RECOMMENDED FOR SPARE PARTS.



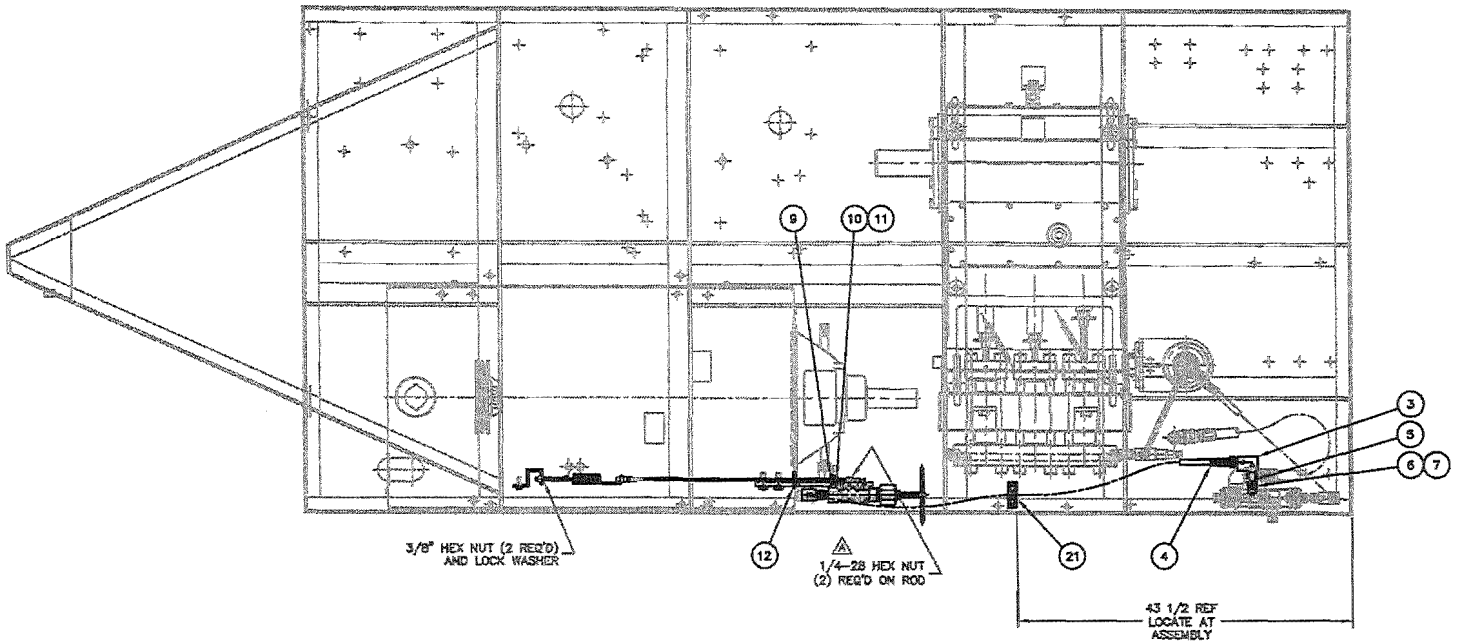
REV	DESCRIPTION	DATE	BY
C	ADDED ITEM #11, BM4074, TAB, QTY (1);	2/12/03	SS
	ITEM #14, 1/4-20HN, NUT QTY (2) WAS BM15089, TAB		
B	(4071-24) ITEM #12, CM17125, ADAPTER, QTY (1)	1/31/03	SS
	WAS BM14982, ADAPTER, QTY (1)		
A	DELETED ITEM #7, '5/8-18HNSS', NUT, HEX FROM BOMs	6/24/02	LRH
	'4071-10', '4071-20', & '4071-40'; ADDED ITEM #13,		
	'BM16267-1', HANDLE, JAM, QTY-1 TO BOMs '4071-10'		
	& '4071-20'; ADDED ITEM #15, HANDLE, JAM, QTY-1		
	TO BOM '4071-40'		

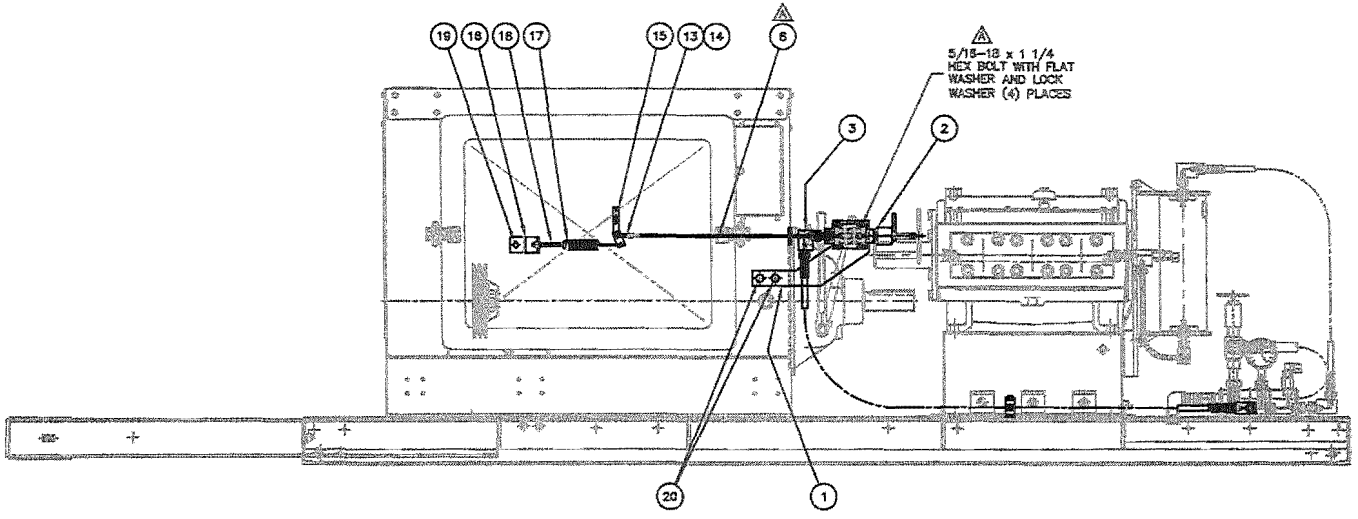
MATERIAL: (SEE BOM)	TREATMENT:
STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED	DO NOT SCALE DRAWING
DR. D. TRUNICK — DATE 03/06/01	NLB Corp.
CK./APP. — DATE	
SCALE 3/4" — SHEET 1 OF 1	
TITLE: CONTROL, THROTTLE 4071	DRAWING NO. DM15091 — REV. C

CONTROL, THROTTLE, 40K

4071-40

ITEM #	PART #	DESCRIPTION	QTY
1	PM14983	SEAL	1 EA
2	BM14981	PISTON	1 EA
3	BM15088	STOP, ADJUSTABLE	1 EA
4	CM15090	BODY, CONTROL	1 EA
5	BM15087	SPRING, COMPRESSION	1 EA
6	CM12717	NUT, THROTTLE CONTROL	1 EA
7	5/8-18HNSS	NUT, HEX, STAINLESS	1 EA
8	CM12716	HANDLE, 'T'	1 EA
9	1/4-20X1/2FHSCS	SCREW, FLAT HEAD, SOCKET, CAP	4 EA
10	BM15083	BRACKET	1 EA
11	BM4074	TAB, OPERATOR	1 EA
12	BM17337	ADAPTER	1 EA
13	BM15086	SPACER, STOP	1 EA
14	1/4-20HN	NUT, HEX, PLATED	2 EA
15	BM16267-1	HANDLE, JAM, NUT	1 EA
SHADED:	RECOMMENDED FOR SPARE PARTS		





REV	DESCRIPTION	DATE	BY
A	#8, 1171-24-48TA, ROD WAS 1174-24-8.3; 1/4-28 HEX NUT WAS 1/4-20; 5/16-18 THRD WAS 5/16-24 5/16-18 HEX BOLT WAS 5/16-24 HEX BOLT	6/7/04	SS

MATERIAL: SEE BOM DM17611

TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED

DO NOT SCALE DRAWING

NLB Corp.

DR. SPRAGUE DATE 4/24/03

CK./APP. DATE

SCALE 1/8 SHEET 1 OF 1

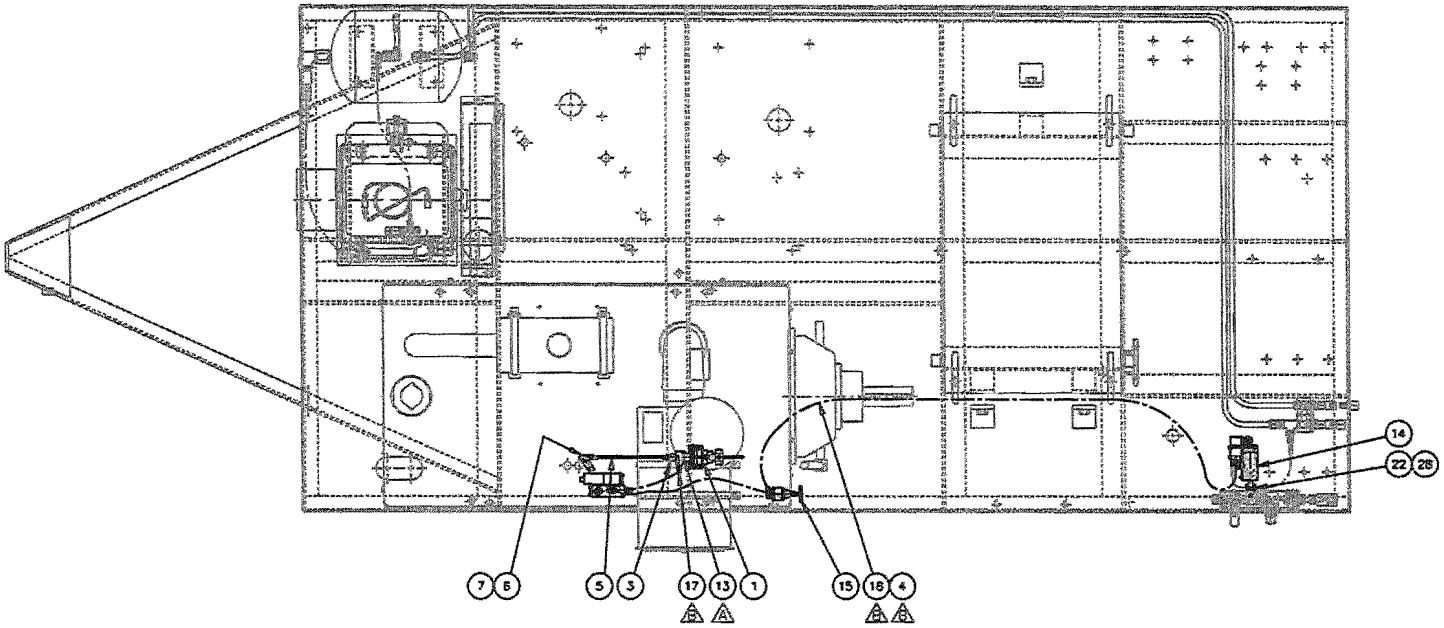
TITLE: THROTTLE, COMPONENTS, 40201DB

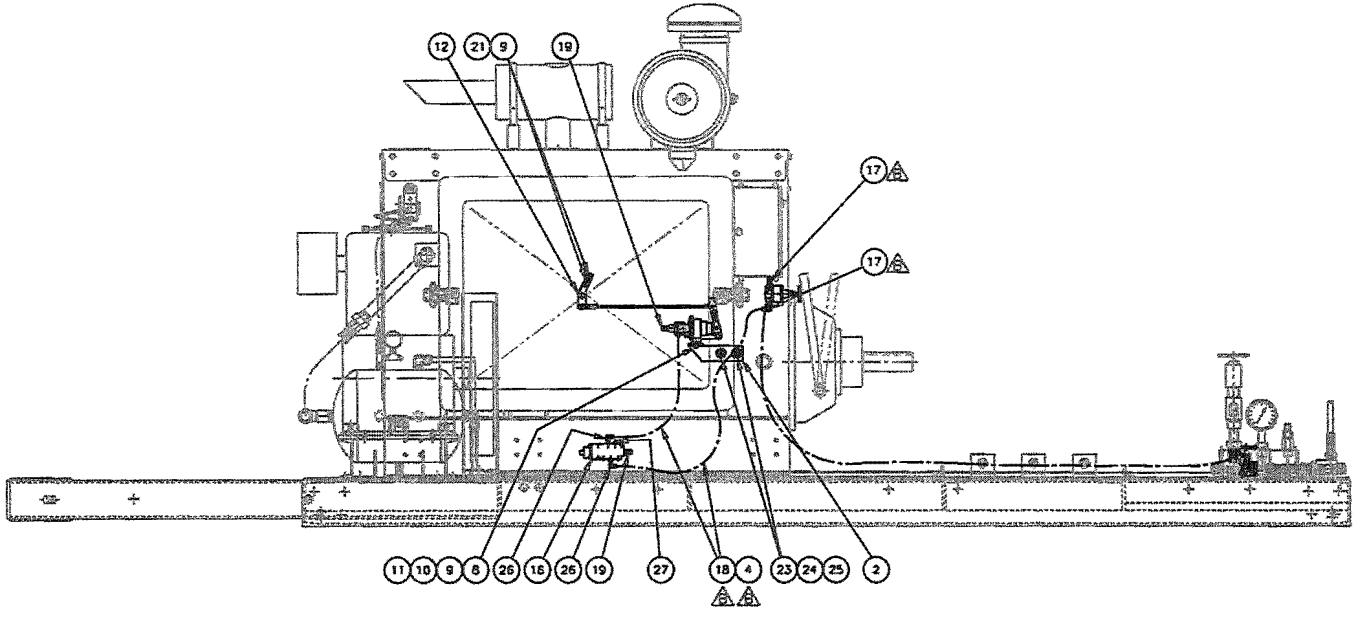
DRAWING NO. DM17611 REV. A

THROTTLE, COMPONENTS, 40201D

DM17611

ITEM #	PART#	DESCRIPTION	QTY,
	DM17611	THROTTLE, COMPONENTS, 40201D	1 EA
1	CM17584	BRACKET, MOUNTING, THROTTLE, 1012D & 10150D	1 EA
2	4071-40	CONTROL, THROTTLE, 20K	1 EA
3	DM6023-253	ELBOW, 9/16, 40K	2 EA
4	NP40-5/16-6M	HOSE, 5/16 X 6', 40K, 9/16HP NIP, MALE ENDS	1 EA
5	DM6023-238	NIPPLE, 9/16" HP X 4", 40K	2 EA
6	DM6023-211	GLAND, HIGH PRESSURE, 60K, 9/16	1 EA
7	DM6023-214	COLLAR, HIGH PRESSURE, 60K, 9/16"	1 EA
8	1171-24-4BTA	ROD, THROTTLE CONTROL, 30"	1 EA
9	1171-19	BUSHING, CONTROL ROD	1 EA
10	7/16-20HN	NUT, HEX, GRADE 8, PLATED	1 EA
11	7/16 FW	WASHER, FLAT, 7/16" ID, PLATED	1 EA
12	2875	GROMMET, 60 DURO	1 EA
13	1171-25	CLEVIS, CONTROL ROD	1 EA
14	1171-4	PIN, CLEVISS	1 EA
15	CM8544	ARM, THROTTLE CONTROL 6CTA8.3	1 EA
16	CP3901	BRACKET, THROTTLE RETURN,SPRING, 6C8.3 SERIES	1 EA
17	DD-5125716	SPRING, THROTTLE RETURN, 6V53	1 EA
18	DD-5134051	BOLT, EYE, 3/8", 453 THROTTLE	1 EA
19	10M-1.5X25MMHH	BOLT, HEX HEAD, METRIC, PLATED M10 X 25MM, GRADE 8.8	1 EA
20	16M-2.0X1-3/4HH	BOLT, HEX HEAD, GRADE 8.8, PLATED ZINC DICHROMATE (YELLOW)	2 EA
21	PM3776	CLAMP, HEAVY SERIES, 3/4" TUBE	1 EA





REV	DESCRIPTION	DATE	BY
B	#4, 4400C-30, POLYLOOM, QTY (15) WAS QTY (30);	6/29/02	SS
	#17, Y0012, FITTING, QTY (3) WAS QTY (4);		
	#18, DM2666-56, TUBING, QTY (15) WAS QTY (30)		
A	ITEM #13, 02-CL-NIP-40-SS, NIPPLE, QTY (1) WAS	9/14/01	SS
	WAS QTY (2); REMOVED ITEM #20, 02-TEE-40-SS,		
	TEE, QTY (1)		

MATERIAL: SEE B.O.M. DM14241

TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED

DO NOT SCALE DRAWING

NLB Corp.

DR. R BEUN — DATE 5/8/00

CK./APP. — DATE

SCALE 1/8"=1" — SHEET OF

TITLE: PIPING, AIR THROTTLE, 36201D & 40201D

DRAWING NO. DM14241 — REV. B

AUTOMATIC PNEUMATIC THROTTLE PIPING

DM14241

ITEM #	PART #	DESCRIPTION	QTY.
1	PM7876	CYLINDER, AIR THROTTLE CONTROL, 1/4" NPT	1 EA
2	BM11991	BRACKET, AIR THROTTLE CONTROL, 36200DG	1 EA
3	PM7880	VALVE, QUICK EXHAUST, 1/4" NPT	1 EA
4	4400C-30	POLYLOOM, 1/2" (PER FOOT)	30 FT
5	BM8439-2	ROD, THROTTLE CONTROL, 14"	1 EA
6	1171-4	PIN, CLEVIS	1 EA
7	1171-25	CLEVIS, CONTROL ROD	1 EA
8	1/4/20	NUT, HEX	2 EA
9	1/4 LW	WASHER, LOCK, 1/4" ID PLATED	4 EA
10	1/4 FW	WASHER, FLAT, 1/4" ID PLATED	2 EA
11	1/4-20X1HH	BOLT, HEX HEAD, GRADE 5 PLATED	2 EA
12	CM8544	ARM, THROTTLE CONTROL, 6CTA8.3	1 EA
13	02-CL-NIP-40-SS	NIPPLE, 1/4" X CLOSE, SCH 40, STAINLESS, 304	1 EA
14	CA10800-36A	SWITCH, ASS'Y, THROTTLE, 36K, AIR VERSION	1 EA
15	PM7927	REGULATOR, AIR, PRECISION, 1/4" NPT, 1-60 PSI	1 EA
16	PM8712	VALVE, SOLENOID, AIR, 12VDC	1 EA
17	Y0012	FITTING, 1/4" NPT X 1/4" TUBE, SWL ELBOW	4 EA
18	DM2266-56	TUBING, AIR, 1/4" O.D. BLACK POLYETHYLENE	30 FT
19	475-29	SILENCER, AIR, 1/4" NPT	2 EA
21	1/4-20X3/4HH	BOLT, HEX HEAD, PLATED	2 EA
22	DM6023-214	COLLAR, HIGH PRESSURE, 60K, 9/16"	1 EA
23	M12-1.75X25MM88	BOLT, HEX HEAD, METRIC, PLATED	2 EA
24	1/2 LW	WASHER, LOCK, 1/2" ID	2 EA
25	1/2 FW	WASHER, FLAT, 1/2" ID	2 EA
26	DM2666-14	FITTING, AIR, SWIVEL 90 ELBOW, 1/4" TUBE TO 1/8" NPT	2 EA
27	01-PLG-40-SS-SH	PLUG, 1/8", SOCKET HEAD, 304 STAINLESS	1 EA
28	DM6023-211	GLAND, HIGH PRESSURE	1 EA

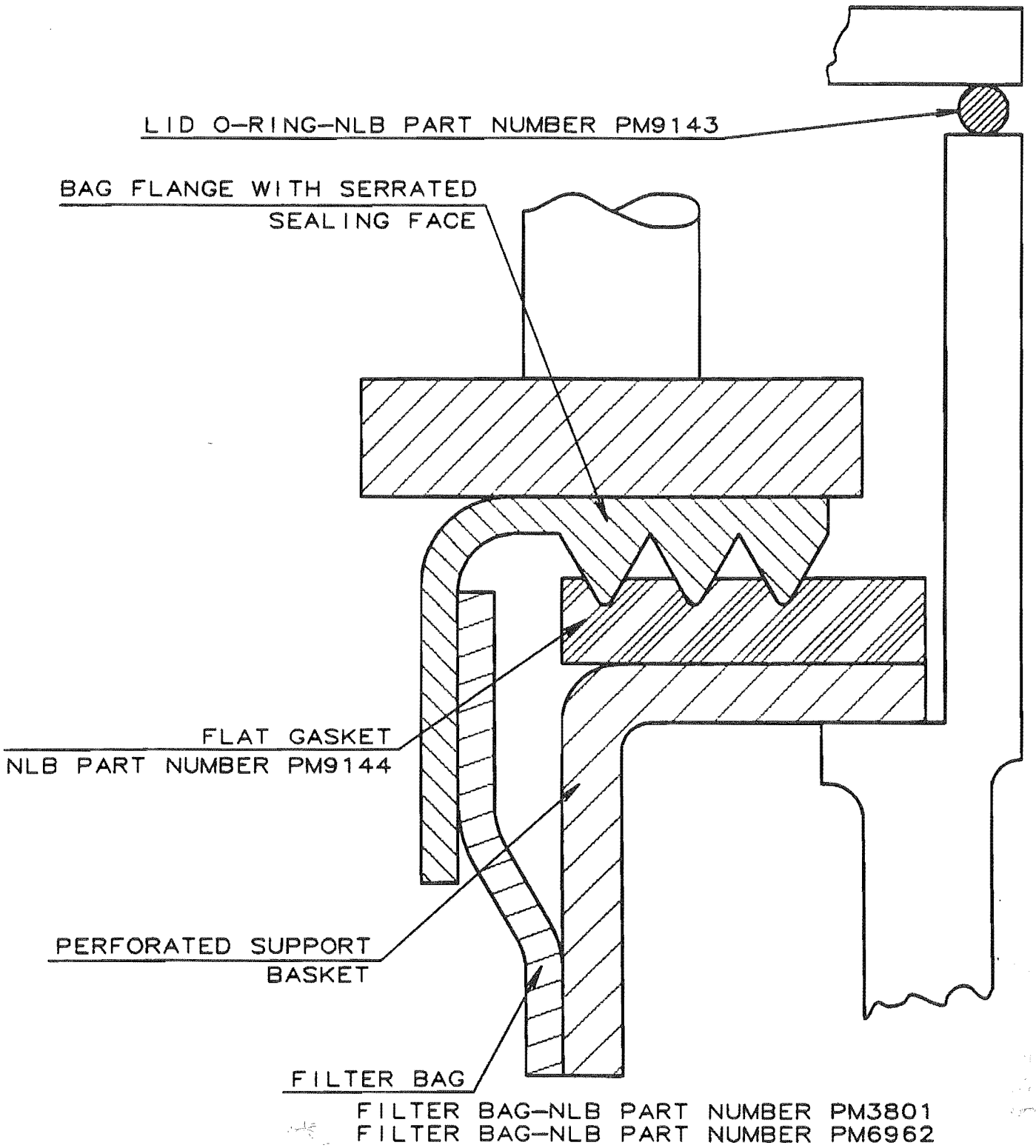
SHADED: RECOMMENDED FOR SPARE PARTS.

INLET WATER BAG FILTER & CANISTER FILTER

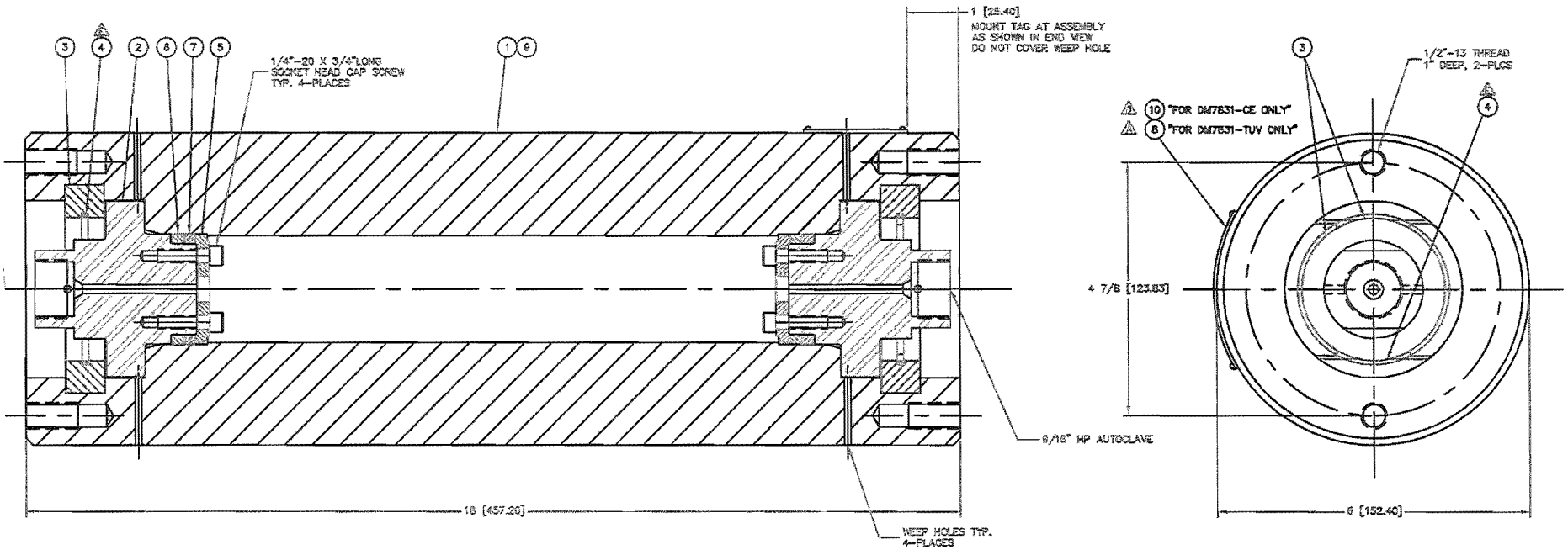
	PART #	DESCRIPTION	QTY.
	PM10512	HOUSING, 20", CARTRIDGE FILTER	1 EA
**	PM10511	ELEMENT, 20", CARTRIDGE	1 EA
	PM3350	BAG, FILTER, HOUSING	1 EA
	PM9143	O-RING	1 EA
	PM9144	GASKET, FLAT	1 EA
**	PM3801	BAG, FILTER, 5-10-MICRON	1 EA
	SHADED:	RECOMMENDED FOR SPARE PARTS.	

** ITEMS INCLUED IN 40K (40201) SPARE PARTS KIT #BP13901-05

REPLACEABLE COMPONENTS FOR PM3350 BAG FILTER



CLOSE-UP VIEW OF MODEL PM3350 POSITIVE BAG SEALING ARRANGEMENT



SPECIFICATIONS:

DRY WEIGHT	135 LBS (APPROX.)
OPERATING PRESSURE	40,000 PSI (2720 BAR)
INTERNAL VOLUME	39 IN (.64 L)

⚠ [ ] DENOTES MILLIMETERS

NOTE:

⚠ BOM# DM7831-TUV FOR CERTIFICATION ASS'Y.

⚠ BOM# DM7831 FOR NLB STANDARD UNITS.

⚠ TAG ITEM #9 NOT SHOWN.

⚠ BOM# DM7831-CE FOR CE CERTIFICATION ASS'Y.

APPROX. WEIGHT = 130 LBS

REV	DESCRIPTION	DATE	BY
E	ITEM #4, PM23316, QTY. (2) WAS PM7835, QTY. (2)	11/20/05	MA
D	ADDED ITEM #10, BM22460, QTY. (1)	11/14/05	MA
	ADDED NOTE: BOM #DM7831-CE FOR CE CERTIFICATION ASSEMBLY		
C	ADDED NOTE ABOUT TAG ITEM #9	4/27/99	SS
B	ADDED NOTES FOR TUV CERTIFIED ASSEMBLIES	9/19/97	BB
A	REDRAW ON CAD, OPERATING PRESSURE WAS 38,00 PSI, ADDED MILLIMETERS, ADDED ITEM #8 BM11621	8/11/97	BB

MATERIAL: SEE B.O.M. DM7831

TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED

DO NOT SCALE DRAWING

DR. NLR DATE 4/15/03

CK. JACK HENSHAW DATE 5/6/03

SCALE FULL. SHEET OF

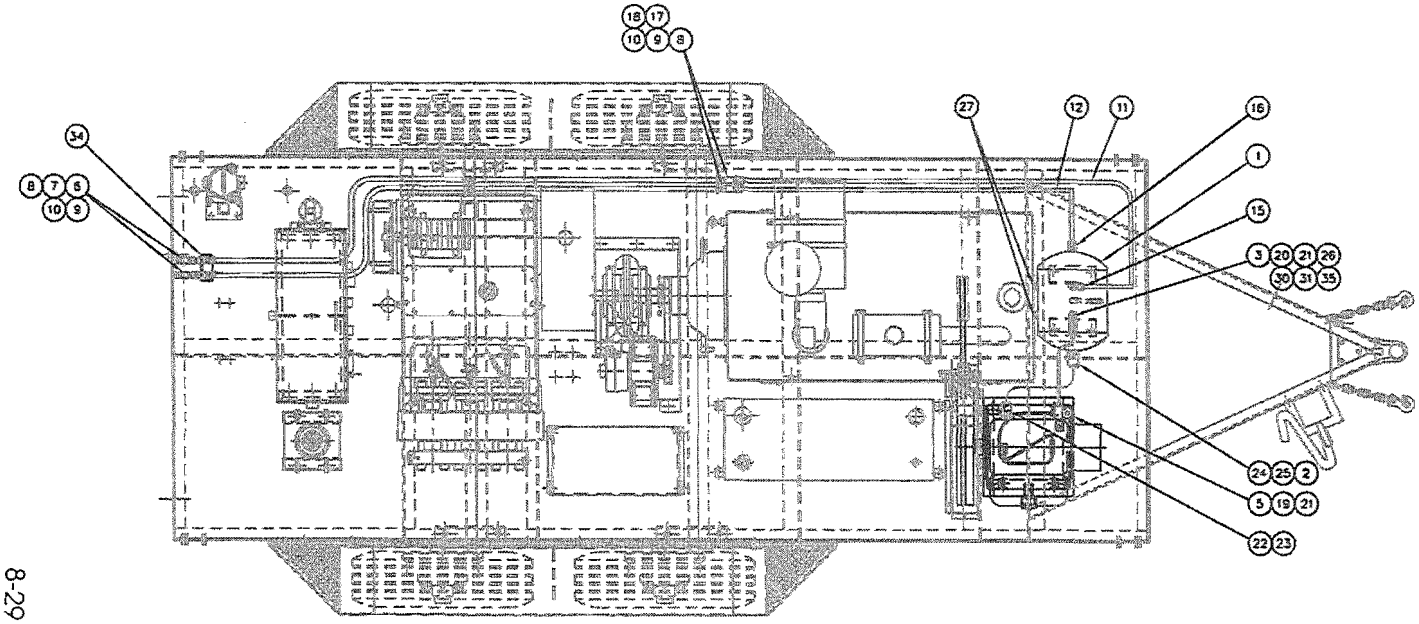
TITLE: DAMPENER, ASSEMBLY, PULSATION, 40K

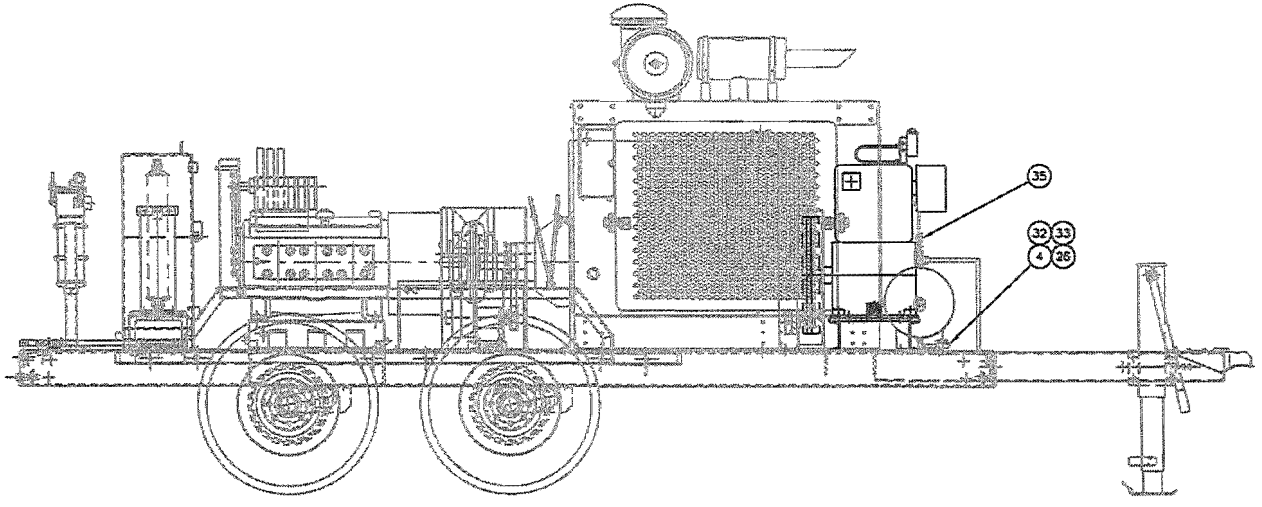
NLB Corp.

DRAWING NO. DM7831 REV. E

PULSATION DAMPENER ASSEMBLY

ITEM #	PART#	DESCRIPTION	QTY.
1	DM7832	CYLINDER, PULSATION DAMPENER	1 EA
2	CM7833	HEAD, PULSATION DAMPENER	2 EA
3	CM7834	RING, SEGMENTED	2 EA
4	PM23318	RING, RETAINING, INTERNAL	2 EA
5	BM7836	PLATE, RETAINER	2 EA
6	BM7837	RING, SEAL BACK-UP	2 EA
7	PM7838	SEAL, LIP	2 EA
9	PM13413	TAG, CAUTION	1 EA
10	BM22460	TAG, CE SELF-CERTIFICATION	2 EA
SHADED:	RECOMMENDED SPARE PARTS		





REV	DESCRIPTION	DATE	BY

MATERIAL: REFER TO B.O.M. DM12258

TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED

.XX ±.010 machined surface 63

.XXX ±.005

.XXXX ±.0025 other surface 125

FRACTIONS ±1/32 BREAK ALL SHARP EDGES REMOVE ALL BURRS AND SHARP EDGES

DO NOT SCALE DRAWING

NLB Corp.

DR. AESCHLIMAN DATE 8/24/98

CH./APP. DATE

SCALE 3/32"=1" 1 SHEET OF 1

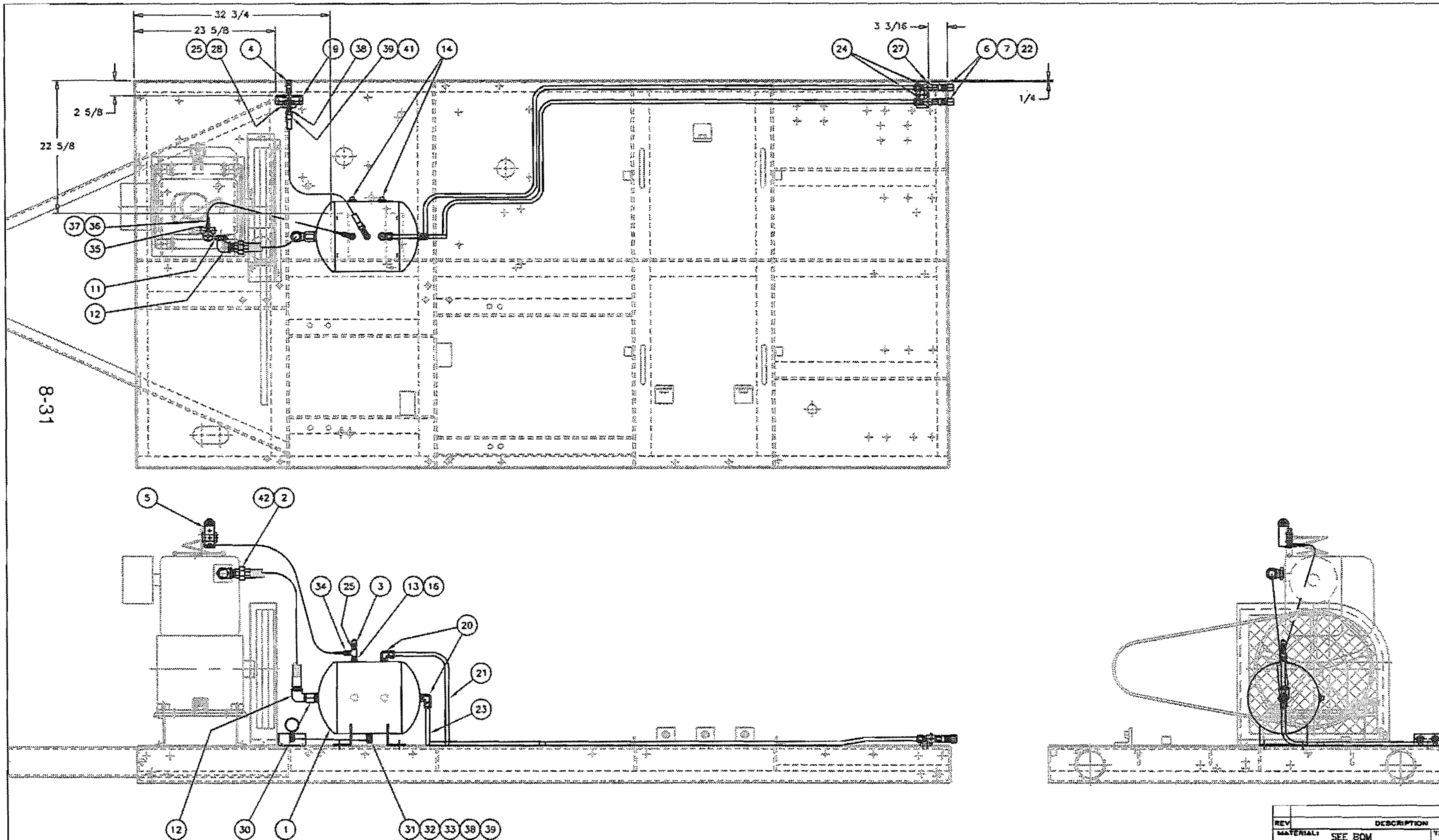
TITLE: SCHEMATIC, PNUEMATIC 36201DG-TRA, AIR COMPRESSOR

DRAWING NO. DM12258 REV.

40201DG/40201DG PIPING, AIR

DM12258

ITEM #	PART #	DESCRIPTION	QTY
1	PM3969	TANK, AIR RECEIVER, 7 GAL., ASME CODE, HOR W/ MTG. FEET	1 EA
2	PM9952	HOSE, METAL, 1" X 36' LG, STAINLESS, ASSY TYPE "B" 1" NPT	1 EA
3	PM3970	VALVE, AIR, ASME SAFETY RELIEF, 125 PSI PRESET PRESSURE	1 EA
4	BP1205	VALVE, PLUG	1 EA
5	PM10061	GOVERNOR, AIR COMPRESSOR	1 EA
6	PM6874	COUPLER, QUICK, AIR, 1/2 FEMALE X 1/2 FNPT	2 EA
7	PM9991	COUPLER, QUICK, AIR, 1/2" MALE BODY X 1/2" NPT FEMALE	2 EA
8	141-15321	HOSE, AIR, 1/2", 200 PSI, BLACK	20 FT
9	Y0079	BARB, HOSE, 1/2"	4 EA
10	V-550-53	CLAMP, HOSE, 1/2" TO 1-1/8"	4 EA
11	CM10067	TUBE, 5/8" O.D. SPECIAL BENT FOR 36200DG, .049 WALL, 304 S.S.	1 EA
12	CM10068	TUBE, 5/8" O.D. SPECIAL BENT FOR 36200DG, .049 WALL, 304 S.S.	1 EA
15	PM2705	ADAPTER, HOSE, ELBOW, #10 JIC TO 3/4" NPT	1 EA
16	PM2691	ADAPTER, HOSE, #10 JIC TO 3/4" NPT	1 EA
17	PM2448	ADAPTER, HOSE, #10 JIC X 1/2" NPT, BODY ONLY	2 EA
18	04-CPL-40-SS	COUPLING, 1/2", 150LB., THREADED, STAINLESS 304	2 EA
19	Y0011	FITTING, 1/8" NPT X 1/4" TUBE	1 EA
20	DM2666-5	FITTING, AIR, MALE CONNECTOR, 1/4" TUBE TO 1/4" NPT	1 EA
21	DM2666-56	TUBING, AIR, 1/4"O.D., BLACK POLYETHYLENE	10 FT
22	12-10-RB-40-SS	BUSHING, REDUCER, 1-1/4" X 1", THREADED, 304 STAINLESS, 150LB	1 EA
23	10-ST-ELB-40-SS	ELBOW, STREET, 1", 150 LB., THREADED, STAINLESS 304	1 EA
24	10-CL-NIP-40-SS	NIPPLE, 1" X CLOSE, SCH 40, STAINLESS 304	2 EA
25	10-ELB-45-40-SS	ELBOW, 1", 45°, 150LB., STAINLESS 304	1 EA
26	04-02-RB-6T	BUSHING, REDUCER, 1/2" X 1/4", THREADED	1 EA
27	06-PLG-40	PLUG, 3/4", SQUARE HEAD, 150 LB.	2 EA
29	04-02-RB-40	BUSHING, REDUCER, 1/2" X 1/4",150 LB., THREADED	1 EA
30	02-CL-NIP-40	NIPPLE, 1/4" X CLOSE, SCH 40	4 EA
31	02-TEE-40-SS	TEE, 1/4", 150LB, THREADED, STAINLESS 304	2 EA
32	02-ST-ELB-40	ELBOW, STREET, 1/4", 90°, 150LB., THREADED	1 EA
33	02-30-NIP-40	NIPPLE, 1/4" X 3", SCH 40	1 EA
34	BM11509	BRACKET, MNTG., AIR LINE, 36250D	1 EA
35	PM12159	GAUGE, AIR, 0-200 PSI, 1/4" MNPT., 2" DIAL FACE, BOTTOM MNT.	1 EA



REV	DESCRIPTION	DATE	BY

MATERIAL: SEE BOM 'DM23917'

TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND SHARP EDGES

DO NOT SCALE DRAWING

NLB Corp.

DR. DEARNLEY DATE 6/9/06

CK./APP. DATE

SCALE 1/8=1 | 1 | SHEET 1 OF 1

TITLE PIPING, AIR 40201D, W/ COMPRESSOR CAT C6.6

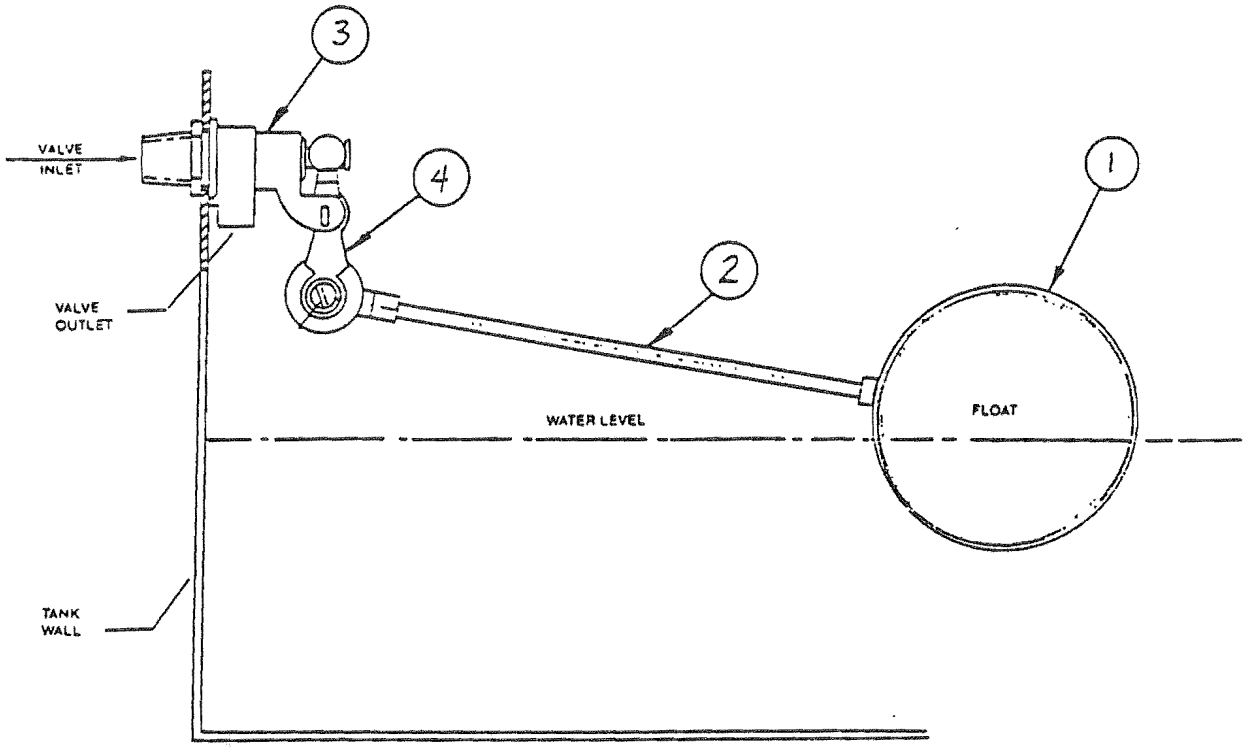
DRAWING NO. DM23917 REV.

40201D PIPING, AIR W/AIR COMPRESSOR

DM23917

ITEM #	PART #	DESCRIPTION	QTY
1	PM3969	TANK, AIR RECEIVER, 7 GALLON ASME CODE, HOR W/ MTG. FEET	1 EA
2	PM9952	HOSE, METAL, 1" X 36' LG, STAINLESS, ASSY TYPE "B" 1" NPT	1 EA
3	PM3970	VALVE, AIR, ASME SAFETY RELIEF, 125 PSI PRESET PRESSURE	1 EA
4	BP1205	VALVE, PLUG, 1/4" NPT	1 EA
5	PM10061	GOVERNOR, AIR COMPRESSOR	1 EA
6	PM6874	COUPLER, QUICK, AIR 1/2 FEMALE X 1/2 FNPT	2 EA
7	PM9991	COUPLER, QUICK, AIR, 1/2" MALE BODY X 1/2" NPT FEMALE	2 EA
11	12-10-RB-6T-SS	BUSHING, REDUCER, 1-1/4" X 1" THREADED, STAINLESS, 304	1 EA
12	10-ST-ELB-40-SS	ELBOW, STREET, 1", 150 LB, THREADED, STAINLESS, 304	2 EA
13	04-02-RB-6T-S	BUSHING, REDUCER, 1/2" X 1/4", THREADED, STAINLESS, 304	2 EA
14	06-PLG-6T-S	PLUG, 3/4" SQUARE HEAD, THREADED, STAINLESS, 304	2 EA
16	02-CL-NIP-40-SS	NIPPLE, 1/4" X CLOSE, SCH 40, STAINLESS, 304	1 EA
19	CM23916	BRACKET, MOUNTING	1 EA
20	PM2705	ADAPTER, HOSE, ELBOW, #10 JIC TO 3/4" NPT	2 EA
21	CM23911	TUBE, AIR, 5/8" O.D., TOP TANK, AIR, 36201D, .040 WALL, 304 SS	1 EA
22	04-CL-NIP-40-S	NIPPLE, 1/2" X CLOSE, SCH 40, STAINLESS 304	2 EA
23	CM23912	TUBE, AIR	1 EA
24	PM2448	ADAPTER, HOSE #10 JIC X 1/2" NPT, BODY ONLY	2 EA
25	02-TEE-40-SS	TEE, 1/4"	2 EA
27	BM11509	BRACKET, MOUNTING, AIR LINE, 36250D	1 EA
28	PM12159	GAUGE, AIR, 0-200 PSI/BAR, 1/4" MNPT, 2" DIAL FACE, BOTTOM MNT.	1 EA
30	PM13740	VALVE, AIR, CHECK, 1" NPT	1 EA
31	04-03-RB-6T-S	BUSHING, REDUCER, 1/2" X 3/8" THREADED, STAINLESS, 304	1 EA
32	PM12714	ADAPTER, 3/8 MNPT X 3/8 FNPT, STREET ELBOW, BRASS	1 EA
33	03-02-RB-6T-S	BUSHING, REDUCER, 3/8" X 1/4" THREADED, STAINLESS, 304	1 EA
34	PM14966	FITTING, COMPRESSION, BRASS, 1/4" TUBE X 1/4" MNPT	2 EA
35	BMS1739	FITTING, BRASS COMPRESSION TUBE, 1/4" TUBE TO 1/8" NPT	1 EA
36	PM10895	TUBING, COPPER	4 FT
37	PM12965	CLIP, THROTTLE CABLE	1 EA
38	PM2404	ADAPTER, HOSE	2 EA
39	BCB1643	FITTING, HOSE	2 EA
41	BCB1648	HOSE, HYDRAULIC #4"	3 FT
42	10-20-NIP-40-S	NIPPLE, 1" X 2", SCH 40, STAINLESS, 304	1 EA

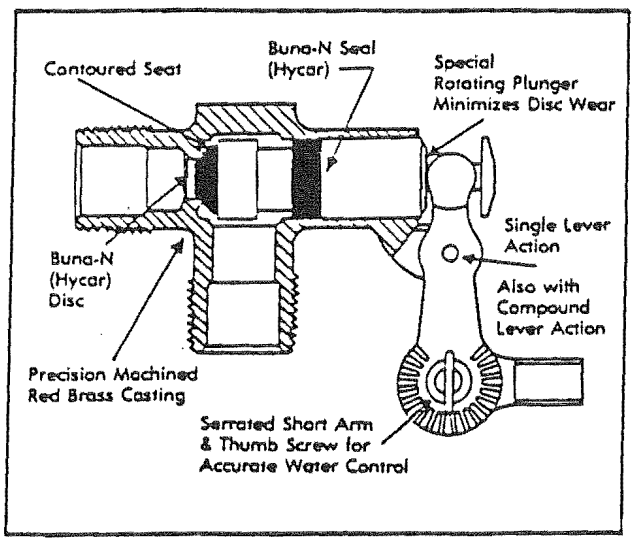
NLB MODEL 2180 FLOAT VALVE PARTS BREAKDOWN



INSTALLATION INSTRUCTIONS

1. Attach valve to tank wall and connect valve inlet to water supply.
2. Valve outlet must be 90° to water level for bind-free operation.
3. Screw stem and float to short arm.
4. Rotate arm and stem for desired water level, tighten short arm thumbscrew.

Proven STANDARDS OF RELIABILITY in design and construction



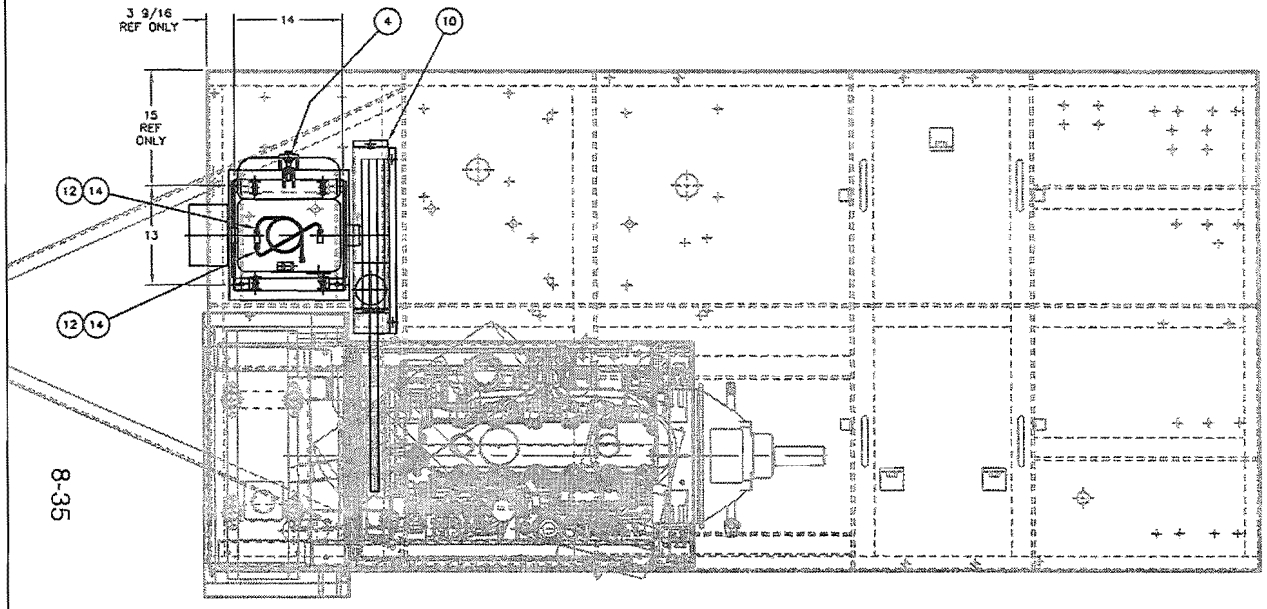
General Guidelines for Seal (Cup) & Disc Requirements			
Working Conditions	*Buna-N (Hycar)	**Viton or Silicone	***Teflon
Max.-Heat Temp.	180°F.	450°F.	550°F.
Max.-Cold Temp.	35°F.	-45°F.	-60°F.
Gasoline-Kerosene	Excellent	Excellent	Excellent
Lubricants-Oils	Poor	Excellent	Excellent
Solvents	Poor	Excellent	Excellent
Abrasion	Excellent	Good	Poor
Hydraulic Fluids	Poor	Excellent	Excellent
Alcohol	Excellent	Excellent	Excellent
Acids	Some (check type)	Most (check type)	Excellent

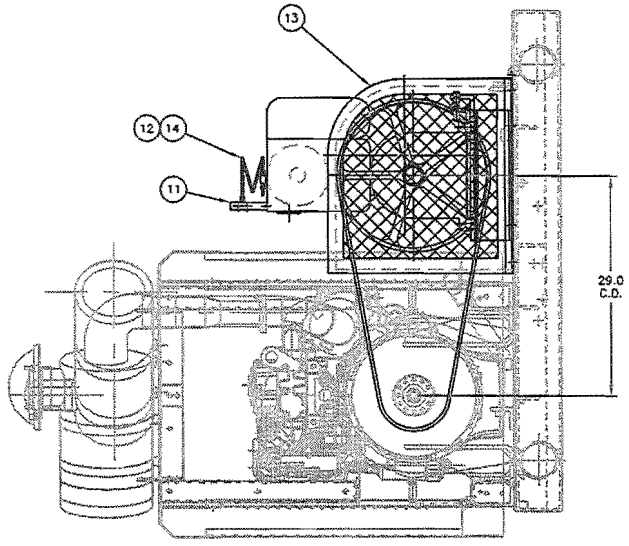
*Buna-N Standard All Brass Valves
**Viton Standard All Stainless Steel Valves
***Teflon available Stainless Steel Valves

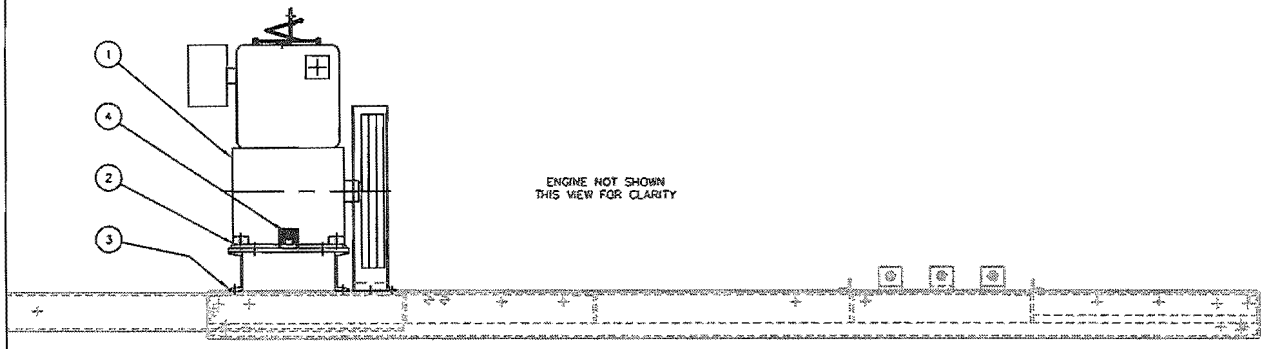
NLB MODEL 2180

FLOAT VALVE 1-1/2"

ITEM #	PART #	DESCRIPTION	QTY.
1	PM9599	BALL, FLOAT VALVE, 8" PLASTIC	1 EA
2	2180-2	ROD, FLOAT VALVE, 18"	1 EA
3	2180-3	BODY, FLOAT VALVE CONSISTING OF: (1) 2180-12 PLUNGER ASSEMBLY (1) 2180-4 LINKAGE, VALVE (1) 2180-5 SEAL/DISC (SET)	
4	PM9601	ADAPTER, ROD, 3/8" NPTM X 3/8-16, S.S.	1 EA
5	2180-5	SEAL (NOT SHOWN)	1 EA
SHADED:	RECOMMENDED FOR SPARE PARTS.		







ENGINE NOT SHOWN
THIS VIEW FOR CLARITY

REV.	DESCRIPTION	DATE	BY

MATERIAL: REFER TO BOM DM23873

TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED
.00 ±.010 MACHINED SURFACES 63
.000 ±.005
.0000 ±.00005 OTHER SURFACES 125
FRACTIONS 1/32 ANGLES ± 1°
REMOVE ALL BURRS AND SHARP EDGES

DO NOT SCALE DRAWING

NLB Corp.

DR: HEYMER DATE 06/08/06

CK./APP. DATE

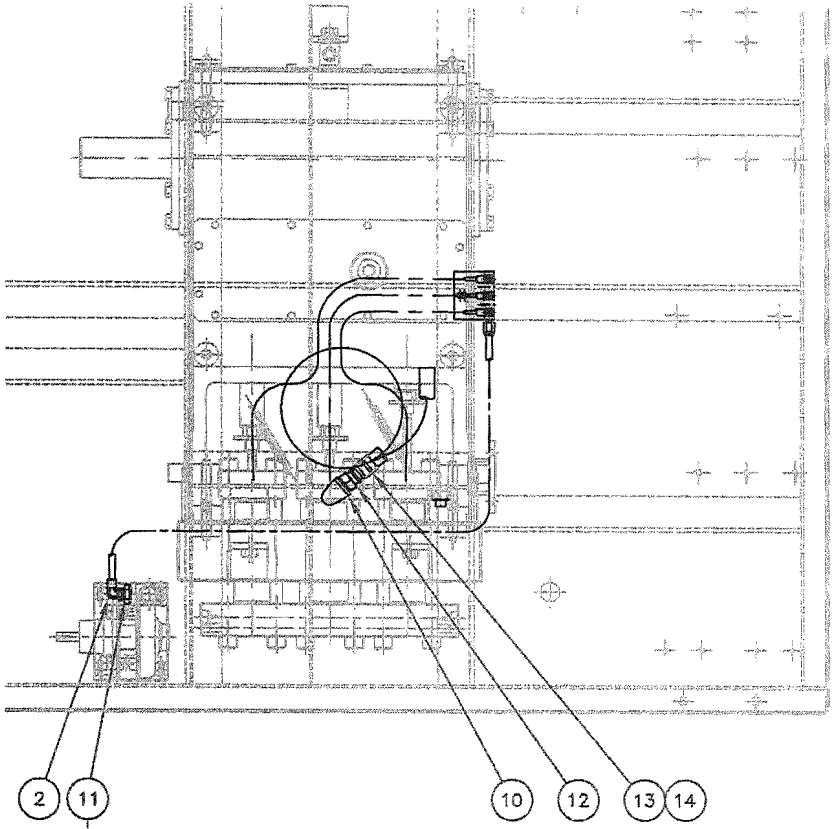
SCALE 1/8"= 1" | 1 SHEET 1 OF 1

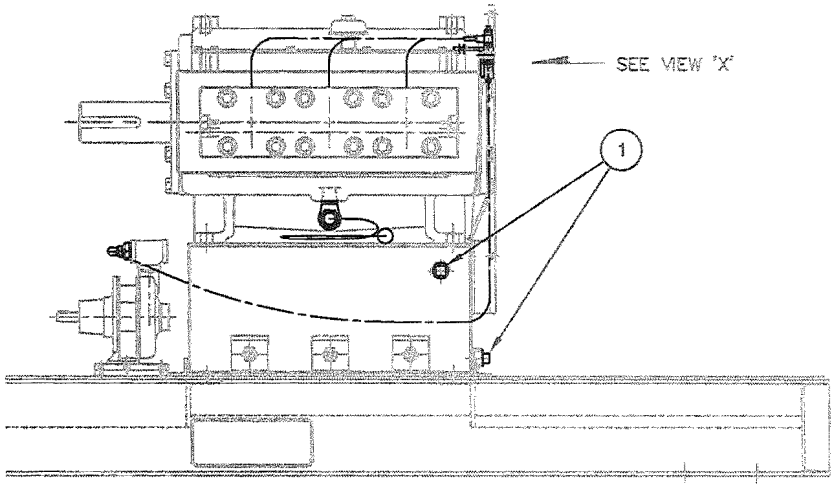
TITLE
COMPRESSOR ASSEMBLY
40201DBA WITH C6.6

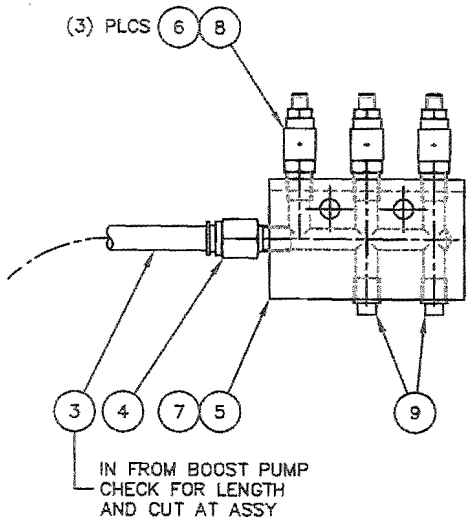
DRAWING NO. DM23873 REV.

COMPRESSOR, ASSEMBLY
40K 40201D
DM23873

ITEM #	PART #	DESCRIPTION	QTY.
1	PM9360	COMPRESSOR, AIR 15 HP/52.2CFM 830 RPM. 2CYL	1 EA
2	CM9927	PLATE, AIR COMPRESSOR, MOUNTING	1 EA
3	CM9928	BASE, AIR COMPRESSOR	1 EA
4	BM9929	SCREW, ADJUSTMENT, AIR COMPRESSOR	1 EA
10	DM23874	GUARD, BELT, AIR COMPRESSOR, 36201D	1 EA
11	BM10059	BRACKET, AIR GOVERNOR	1 EA
12	BMS1739	FITTING, BRASS COMPRESSION TUBE, 1/4" TUBE TO 1/8" NPT	4 EA
13	Y0066	TAG, GREASE DAILY	1 EA
14	PM10895	TUBING, COPPER, 1/4 O.D.	2 FT
15	PM23867	BELT, BX103	1 EA







VIEW 'X'
SCALE: 1/2"=1"

REV	DESCRIPTION	DATE	BY

MATERIAL: SEE BOM 'CM23030'

TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED
.00 ±.010 MACHINED SURFACES 63
.000 ±.005
.0000 ±.0005 OTHER SURFACES 125
FRACTIONS ±1/32 ANGLES ± .5°
REMOVE ALL BURRS AND SHARP EDGES

DO NOT SCALE DRAWING

DR. DEARNLEY DATE 1/25/06

CK./APP. DATE

SCALE 1/8"=1" SHEET 1 OF 1

TITLE
PIPING, WATER LUBE,
40201D

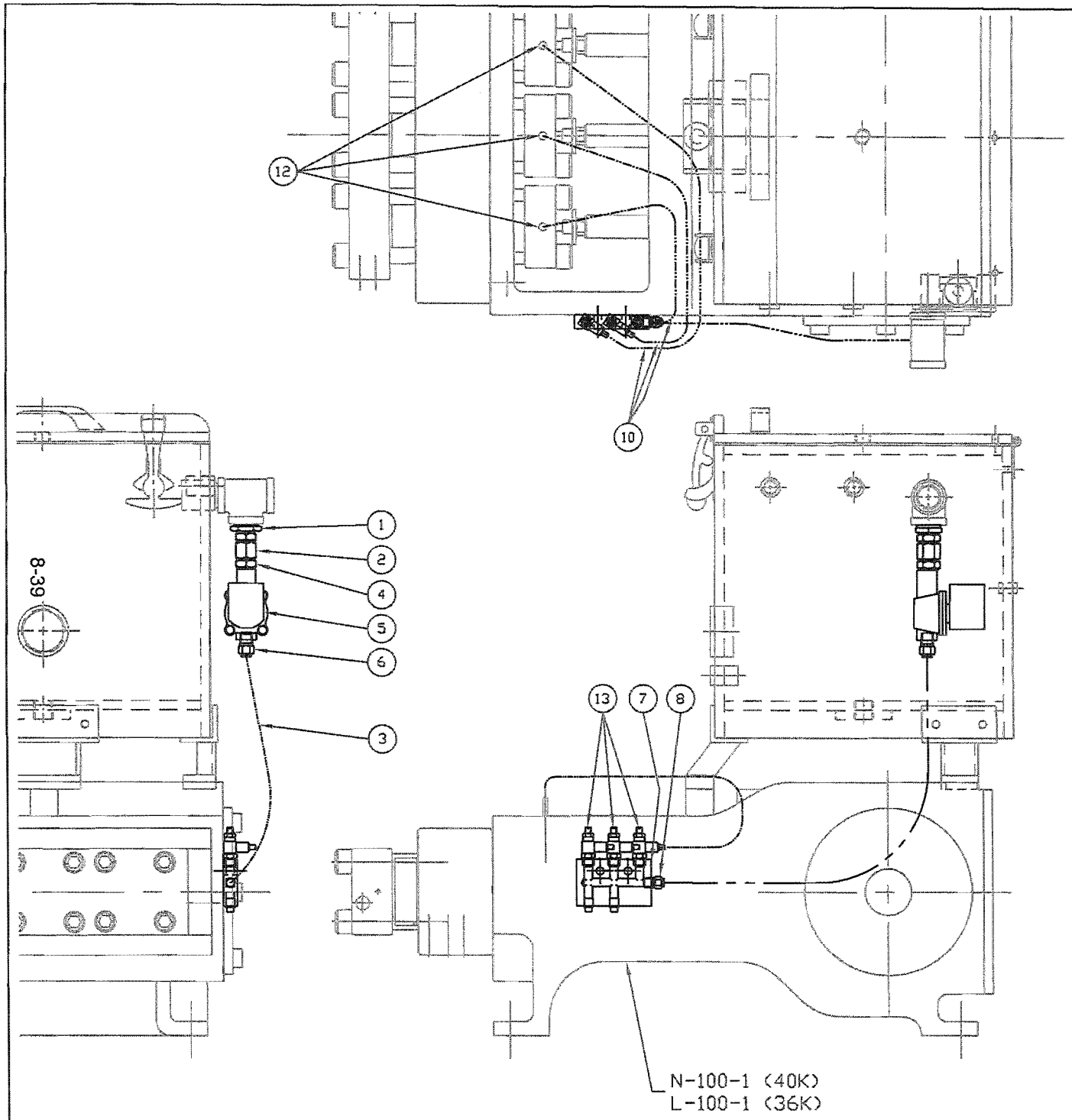
NLB Corp.
MANUFACTURERS OF THE NATIONAL LIQUID HEATER
29830 BECK RD.–WIXOM, MICHIGAN 48393
TELEPHONE (248) 624-5555

DRAWING NO. CM23030 REV.

PIPING, WATER LUBE, AC, 3 PL, 40K UNIT

CM23030

ITEM #	PART #	DESCRIPTION	QTY.
1	10-PLG-6T-S	PLUG, 1" NPT, SQUARE HEAD	2 EA
2	DM2666-15	FITTING, AIR, SWIVEL 90 DEGREE ELBOW	1 EA
3	DM2666-59	TUBING, AIR, 1/4" O.D. BLACK POLYETHYLENE	5 FT
4	DM2666-10	CONNECTOR, MALE TUBING	1 EA
5	BM12032	MANIFOLD, WATER LUBE	1 EA
6	PM2518	TUBING, PARFLEX CLEAR PVC	9 FT
7	BM14811	BRACKET, MOUNTING, WATER LUBE MANIFOLD	1 EA
8	PM4136	VALVE, FLOW CONTROL, AIR	3 EA
9	02-PLG-6T-S	PLUG, SQUARE HEAD, 1/4", 150 LB THREADED, STAINLESS, 304	2 EA
10	10-ST-ELB-40-SS	ELBOW, STREET	1 EA
11	10-04-RB-6T-S	BUSHING, REDUCER	1 EA
12	PM3906	BARB, HOSE	1 EA
13	PM8277	TUBING, CLEAR THERMOPLASTIC	4 FT
14	Y0005	CLAMP, HOSE	2 EA



REV	DESCRIPTION	DATE	BY

MATERIAL: SEE BOM
CLE6001-25

TREATMENT:

STANDARD TOLERANCES
UNLESS OTHERWISE SPECIFIED
.00 ±.010 MACHINED SURFACES 63
.000 ±.005
.0000 ±.0005 OTHER SURFACES 125
FRACTIONS ±1/32 ANGLES ± .5°
REMOVE ALL BURRS AND SHARP EDGES

DO NOT SCALE DRAWING

DR. AESCHLIMAN DATE 3/1/99

CK./APP. DATE

SCALE 1/4"=1" SHEET OF

TITLE
PIPING, WATER
5 PLUNGER
LUBE,36 AND 40K UNITS

NLB Corp.
MANUFACTURER OF THE NATIONAL LIQUID BLASTER
29830 BECK RD.-WIXOM,MICHIGAN 48393
TELEPHONE (248) 624-5555

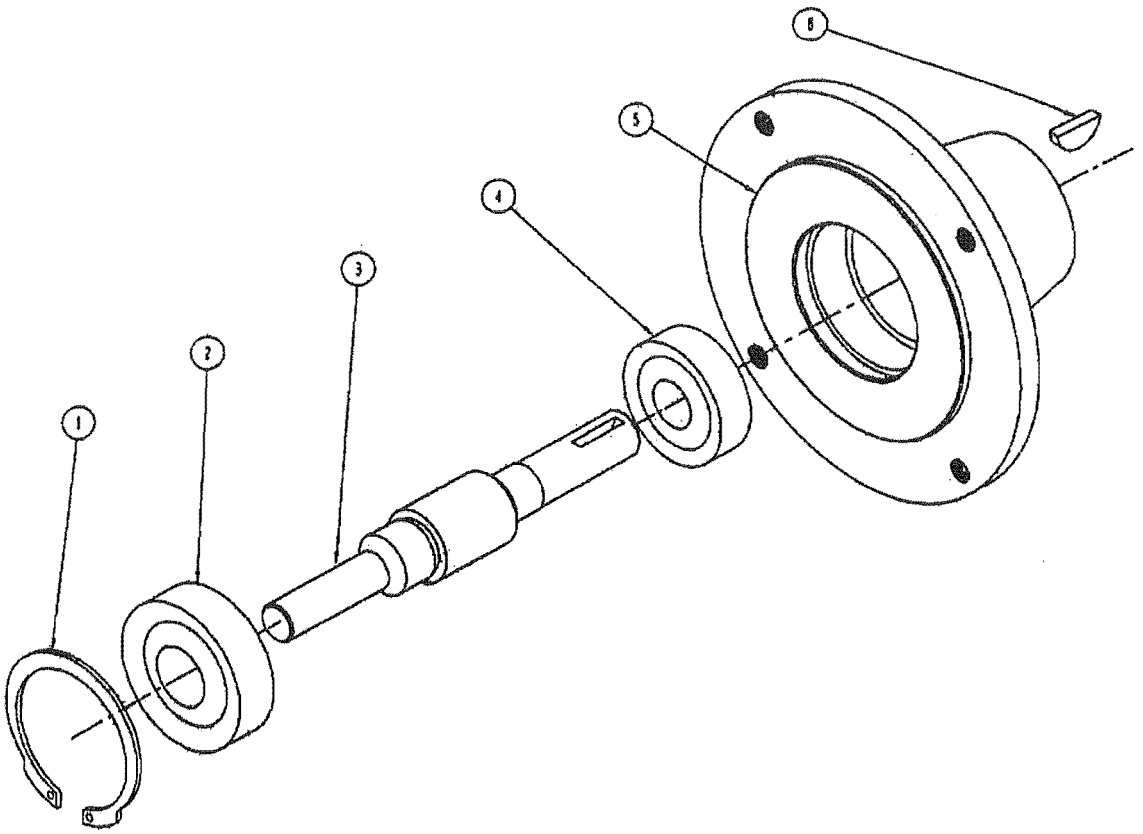
DRAWING NO. CLE6001-25 REV.

PIPING, WATER LUBE, 5 PL, 40K UNIT

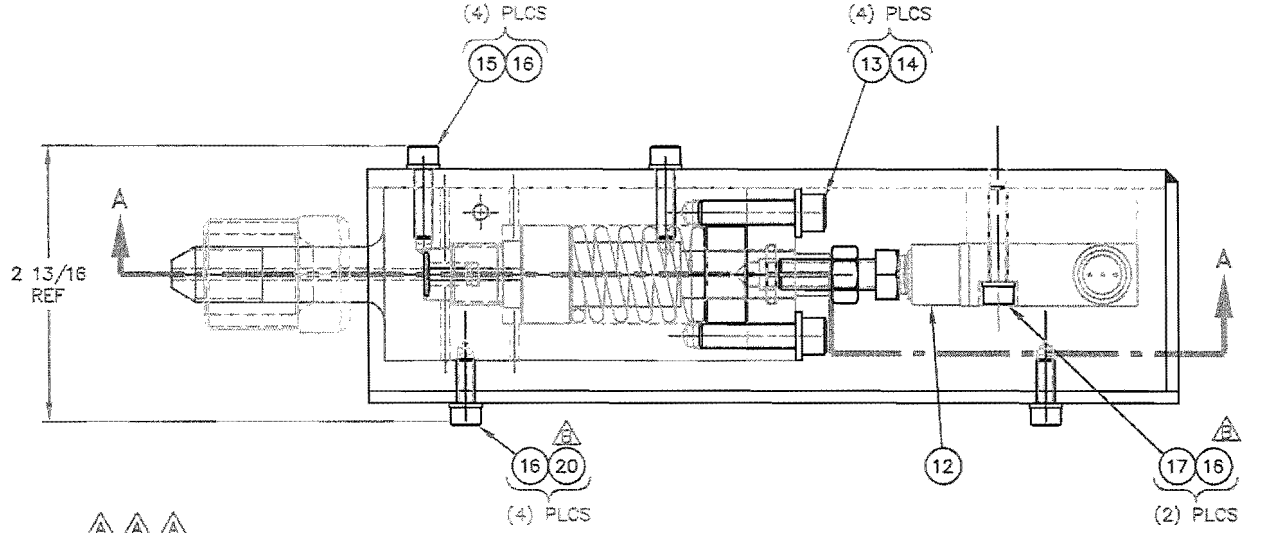
CLE6001-25

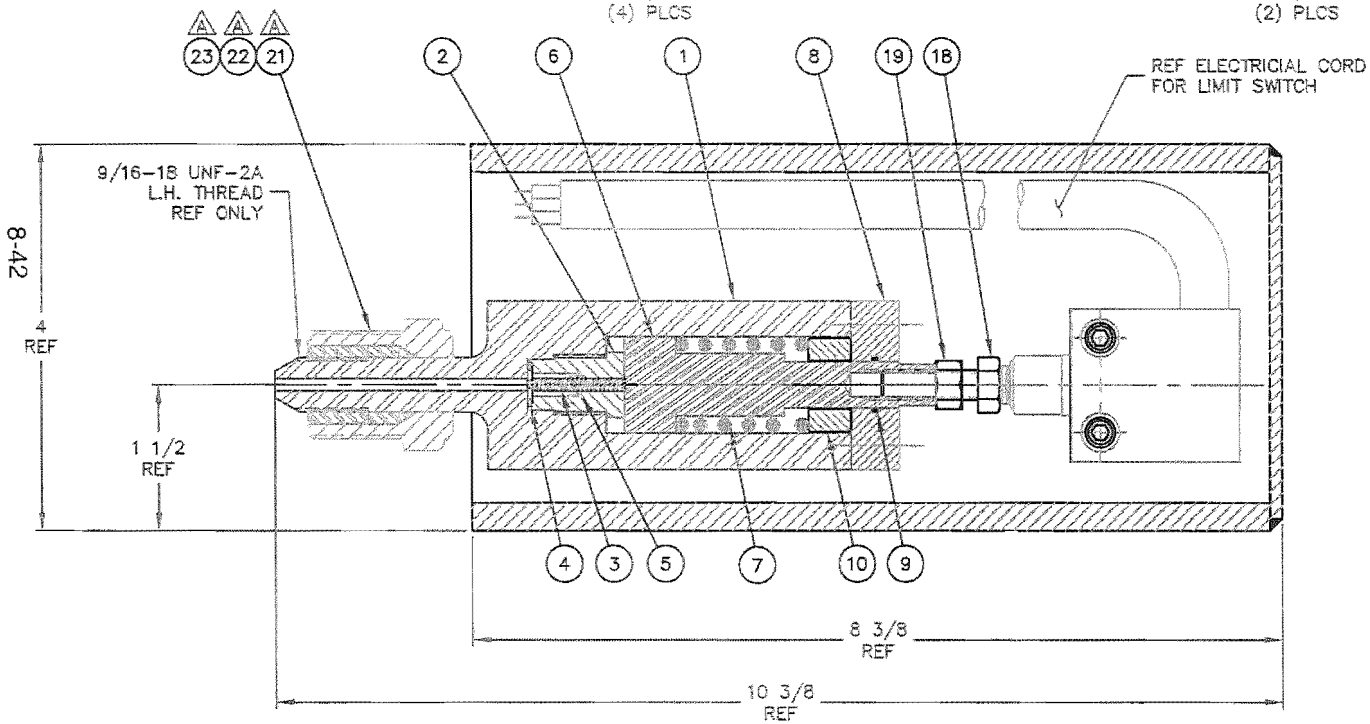
ITEM #	PART #	DESCRIPTION	QTY.
1	10-03-RB-6T-SS	BUSHING, REDUCER, 1" X 3/8", THREADED, STAINLESS	1 EA
2	PM12599	ADAPTER, #8 JIC SWVL. X 3/8"NPT	1 EA
3	DM2666-56	TUBING, AIR, 1/4" O.D. BLACK POLYETHYLENE	2 FT
4	4400B-42	FITTING, HYDRAULIC	1 EA
5	PM11616	VALVE, SOLENOID, 2-POS, 2-WAY SPRING RET, 120V/60HZ, 3/8NPTF	1 EA
6	DM2666-6	FITTING, AIR, 1/4" TUBE X 3/8" MNPT MALE CONNECTOR	1 EA
7	BM12032	MANIFOLD, WATER LUBE	1 EA
8	Y0012	FITTING, 1/4" NPT X 1/4" TUBE SWL ELBOW	1 EA
9	02-PLG-40-S	PLUG, SUARE HEAD, 1/4", 150 LB THREADED, STAINLESS, 304	2 EA
10	PM2518	TUBING, PARFLEX CLEAR PVC	20 FT
11	BM14811	BRACKET, MOUNTING, WATER LUBE, MANIFOLD	1 EA
12	PM2520	CLAMP, HOSE 1/4" OD	5 EA
13	PM4136	VALVE, FLOW CONTROL, AIR, 1/4" TUBE X 1/4" MNPT	5 EA

Boost Pump #29670 Pedestal Assembly

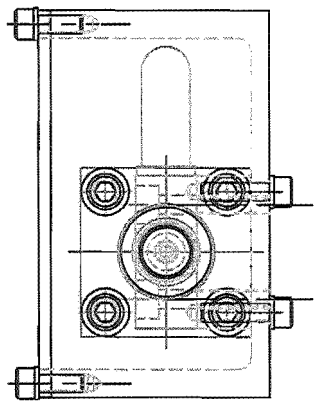


ITEM #	PART #	DESCRIPTION	QTY.
1	29665	Snap Ring - Steel	1
2	29023	Single Row Bearing	1
3	29666	Shaft - Steel	1
4	22300	Single Row Bearing	1
5	29669	Pedestal - Cast Iron	1
6	22321	Woodruff Key - Steel	1





SECTION A-A



REV	DESCRIPTION	DATE	BY
B	ITEM #20 WAS 10-32X3/8SHSS, ADDED LOCK WASHER	2/9/07	AEC
A	ADDED ITEM #21, DM6023-226, QTY. (1)	5/6/05	MA
	ADDED ITEM #22, DM6023-225, QTY. (1)		
	ADDED ITEM #23, DM6023-214, QTY. (1)		

MATERIAL: SEE BOM CA10800-40E

TREATMENT:

STANDARD TOLERANCES UNLESS OTHERWISE SPECIFIED
.00 ±.010 MACHINED SURFACES 63
.000 ±.005
.0000 ±.0005 OTHER SURFACES 125
FRACTIONS ±1/32 ANGLES ± .5°
REMOVE ALL BURRS AND SHARP EDGES

DO NOT SCALE DRAWING

DR. SPRAGUE DATE 5/12/03

CK./APP. DATE

SCALE FULL SHEET OF

TITLE
SWITCH, ASSEMBLY
THROTTLE, 40K,
WITH MINI SWITCH

NLB Corp.
MANUFACTURER OF THE NATIONAL LIQUID HEATER
29830 BECK RD.-WIXOM,MICHIGAN 48393
TELEPHONE (248) 624-3333

DRAWING NO. CA10800-40E REV. B

BILL OF MATERIAL
THROTTLE OR PRESSURE SWITCH

CA10800-40E

ITEM #	PART #	DESCRIPTION	QTY.
1	CA9667	BODY, PRESSURE SWITCH	1 EA
2	BA9668	GUIDE, PIN, PRESSURE SWITCH	1 EA
3	BA8995-36	PIN, PRESSURE SWITCH	1 EA
4	AA-4032	O-RING	1 EA
5	PM8433	SEAL, LIP	1 EA
6	BM11231	GUIDE, SPRING, THROTTLE SWITCH	1 EA
7	PM11088	SPRING, COMPRESSION	1 EA
8	BA8991	RETAINER, SPRING, PRESS SWITCH	1 EA
9	AA-4033	O-RING	1 EA
10	BM11089	SPACER, SPRING	1 EA
11	CM15683	SWITCH, LIMIT, WATERPROOF	1 EA
12	PM15681	PLATE, MOUNTING, PRESSURE SWITCH	1 EA
13	1/4-28X1SHS	BOLT, SOCKET HEAD, STAINLESS	4 EA
14	1/4 I.D. LWSS	WASHER, LOCK	4 EA
15	10-32X3/4SHS	SCREW, SOCKET HEAD, CAP	4 EA
16	10 LWSS	WASHER, LOCK, STAINLESS	10 EA
17	10-32-X1SHS	SCREW, SOCKET HEAD CAP	2 EA
18	5/16-18XHHS	BOLT, HEX HEAD, STAINLESS	1 EA
19	5/16-18HNS	NUT, HEX, HEAD STAINLESS	1 EA
20	10-32X1-3/4SHS	SCREW, SOCKET HEAD, STAINLESS	4 EA
21	DM6023-226	GLAND, NUT, ANTI-VIBRATION	1 EA
22	DM6023-225	COLLET, SLOTTED, ANTI-VIBRATION	1 EA
23	DM6023-214	COLLAR, HIGH PRESSURE	1 EA
SHADED:	RECOMMENDED FOR SPARE PARTS.		

TABLE OF CONTENTS

CUSTOMER SUPPORT

SECTION 10

WARNING:

NLB WARRANTY WILL BE VOIDED IF NON-NLB MANUFACTURED REPLACEMENT PARTS ARE USED. NLB'S WARRANTY IS VOID AS TO ANY DAMAGES CAUSED TO THE EQUIPMENT OR BY THE EQUIPMENT AND TO EXCLUDE ANY LIABILITY AS A RESULT OF INJURY, IF SUCH DAMAGE OR INJURY CAN BE LINKED TO THE SUBSTANDARD REPLACEMENT PART.

I. NLB Corp. Customer Service Department

NLB Corp. recognizes the important role of the customer in eliminating and decreasing equipment downtime and/or unscheduled maintenance. For this purpose, NLB Corp. has pledged to contribute the technical assistance needed to help customers during equipment installation and/or operation through NLB Corp. Customer Service.

Located at NLB Corp.'s World Headquarters in Wixom, Michigan, USA, Customer Service is staffed with trained, knowledgeable representatives who are dedicated to customer support. Representatives can provide information such as parts availability, price information, technical support, warranty evaluation, and the parts Return Authorization (RA) process. NLB Corp. maintains an inventory of thousands of spare parts readily available for shipment within three business days.

A. Business Hours

Customer service personnel are conveniently available to assist customers by phone during business hours: (EST) **8:00am to 6:00pm - Monday through Friday**
8:00am to 12:00 noon - Saturday
as well as by mail and FAX.

B. How To Reach The NLB Corp. Customer Service Department

NLB Corp.
Customer Service
29830 Beck Road
Wixom, MI 48393-2824
(248) 624-5555 or 1-800-227-7652
FAX: (248) 624-0538

C. Non-Business Hours Emergency Customer Service

To order emergency parts during non-business hours contact NLB Corp. Customer Service in Wixom, Michigan, at the following number:
1-800 227-7652

II. Ordering Parts

Section 9: PARTS identifies the high pressure water jetting components and their accompanying part numbers. The section is typically arranged with major assemblies first, followed by subassemblies. Whenever possible, the parts list for complicated assemblies includes exploded view illustrations. These illustrations can be helpful in understanding how to operate and disassemble each assembly. Recommended spare parts are shown highlighted on the parts list.

A. Ordering Procedure

You must have the following information available when ordering parts:

1. Part name
2. Part number
3. Quantity ordered
4. Date required
5. Shipping information
6. Purchase order number

If the ordered part is in stock, it will be shipped within three (3) working days from the time the order is placed. If the part is not in stock, the customer will be given an estimated shipping date when the order is placed. Same-day shipments can be made in the event of an equipment breakdown only if the requested part is in stock and the order is received before 3:00 pm EST.

III. Warranty Policy

All components manufactured by the seller are warranted to be free from defects in material and workmanship under normal use and service for a period of one year from date of shipment. At its option, the seller may either repair defective parts or furnish new parts free of charge, FOB at the seller's factory. This warranty will only apply upon the seller's determination, after inspection, that such parts are defective in material or workmanship. The warranty expressed in this paragraph shall constitute buyer's exclusive remedy.

Equipment and accessories not manufactured by the seller are only warranted to the extent of the original manufacturer's warranty and are subject to their allowance to the seller.

Charges for labor and/or parts incidental to the removal and remounting of defective parts or accessories are the responsibility of the buyer and are not covered by this warranty.

This warranty does not apply to, and the company assumes no responsibility for, any equipment or parts that have been improperly installed, misused, altered, abused, or neglected. Under no conditions will the seller be liable for any delays or consequential damages or losses in the fulfillment of this warranty.

The seller's liability under this warranty is limited to the repair and replacement of defective parts as stated above and the seller is not responsible for any damages, expenses, or losses of income resulting from such defects.

IV. Parts Return Authorization (RA) Process

This section discusses the parts Return Authorization (RA) process. In order for parts returned to NLB Corp. to be processed quickly and efficiently, customers returning parts for any reason must follow the procedures in this section.

A. Parts Received Damaged

All shipments leaving NLB Corp. are packaged according to good standard packaging practice. NLB Corp. cannot be held responsible for any parts damaged in transit. Responsibility for damaged shipment lies with the common carrier. When parts are received in damaged condition but with shipping container intact, the customer should make a "CONCEALED DAMAGE REPORT" to the carrier within three business days of the delivery. All claims will be made by the customer to the common carrier. Whenever possible, NLB Corp. will be glad to render the customer all possible assistance to secure satisfactory adjustment of damage claims.

B. Parts Return Authorization (RA) Number

Customers returning parts to NLB for any reason must obtain a Return Authorization (RA) Number. Each RA Number issued by NLB Customer Service is unique and is used to track customer returned parts through the return process.

Note:

All parts returned to NLB Corp. for any purpose require an RA Number. Parts will not be accepted for return without an RA Number.

Obtaining an RA Number is no guarantee of warranty or credit.

1. How To Acquire An RA Number

Please use this method when returning parts for any purpose:

Contact NLB Customer Service by calling 1-800-227-7652 (in the USA and Canada), or (248) 624-5555, and ask for an RA Number and instruction on how to return parts.

Before You Call

NLB Customer Service representatives care about the quality of service they provide. You can help them to provide accurate, complete answers to your question by having the following information:

A. Company name, address, telephone number, and FAX number

B. Shipping address (if address is different from the company's address)

C. Your name, telephone number and FAX number (if your telephone number and FAX number is different from the company's numbers)

D. Original purchase order number

E. Itemized list of parts being returned, as well as quantity, part number or serial number, and physical description of each part

F. Details of the system from which the parts were removed, if appropriate, i.e., job number, model number, serial number, and hours of use, if available

G. Reasons for returning parts

H. Any additional information that will assist in resolving your request

C. Parts Return Directives

A. All returns must be pre-authorized by a Customer Service representative and will not be accepted without an RA Number. Unauthorized returns will be re-shipped at the customer's expense.

B. Parts built to a customer's specification, parts unique to custom engineered systems, or parts that have been modified by the customer cannot be returned for credit under any conditions.

D. Parts Return Authorization Procedures

All parts returned to NLB Corp. will be managed according to the Parts Return Authorization Procedures. Utilizing these procedures guarantees efficient and appropriate handling of all parts returned to NLB.

There are five different procedures to follow, depending upon the reason for returning the parts, as explained on the following pages.

1. Parts Ordered In Error By Customer– Returned For Credit

A. Acquire an RA Number. Return parts shipping prepaid to NLB Corp.

B. The parts will be examined by Customer Service to make sure they are unused, in new condition, and free of handling damage. If parts are determined to be new, the customer will receive full credit for the amount charged, minus a 20% restocking fee. Collect shipments will not be accepted by NLB Corp. A copy of the credit memorandum will be forwarded to the customer, and the credit can be used on future orders.

C. If the returned parts are not in new condition, NLB will notify the customer as to their disposition.

Note:
Non stocked or special parts are not returnable.

2. Unused Parts Returned For Credit – Less Than One Year Old

A. Acquire an RA Number. Return parts shipping prepaid to NLB Corp.

B. The parts will be examined by NLB Customer Service to make sure they are unused, in new condition, and free of handling damage. If parts are determined to be new, the customer will receive full credit for the amount charged, minus a 20% restocking fee. Collect shipments will not be accepted by NLB Corp. A copy of the credit memorandum will be forwarded to the customer, and the credit can be used on future orders.

C. If the returned parts are not in new condition, NLB will notify the customer as to their disposition.

Note:
Non stocked or special parts are not returnable.

3. Parts Shipped In Error By NLB Corp. – Returned For Credit

A. Acquire an RA Number.

B. The parts will be examined by NLB Customer Service to make sure they are unused, in new condition, and free of handling damage. If parts are determined to be new, the customer will receive full credit for the amount charged, and the originally ordered parts will be shipped to the customer along with a refund of shipping costs. When the claim is approved. a credit memorandum for the originally ordered parts will be forwarded to the customer. This credit can be used on future orders.

C. If returned parts are not in new condition, NLB will notify the customer as to their disposition.

D. If the replacement parts are in stock, they will be shipped within three business days or on the same day for urgent requests.

4. Parts Returned For Repair

A. Acquire an RA Number.

B. NLB will provide a verbal, or upon request, a written quotation for the repair cost, including labor, assuming the equipment can be repaired. Return freight will be charged as incurred.

C. Customer will issue a purchase order for the repair amount.

D. Damaged or worn parts will be returned to the customer along with the new parts. If the customer does not wish to have the damaged parts returned, he must notify NLB in writing.

E. If parts are not repairable, not cost effective to repair, or not approved for repair, they will be returned to the customer at his expense or scrapped at NLB upon receipt of written customer request.

5. Parts Returned For Warranty Repair Or Replacement

A. Acquire an RA Number.

B. Warranty replacement and/or repair will be handled according to NLB Corp.'s standard warranty. If you have questions, answers can be obtained by writing, calling, or Faxing NLB Customer Service.

Note:

Warranty service extends only to the original purchaser and is not transferable or assignable without NLB Corp.'s prior consent.

C. NLB Customer Service will evaluate and test all returned parts thought to be defective by the customer for warranty consideration to make sure they are covered by the NLB Corp. warranty. A warranty claim will be handled in the most prompt manner as possible. After a warranty determination is made, the parts will be handled accordingly.

Parts Found To Be Defective Under Terms Of This Warranty

A. If the parts are found to be defective under the terms of this warranty, NLB Customer Service will decide whether the parts will be repaired or replaced. The repaired or new replacement parts will be shipped to the customer without charge. Shipping charges, however, are not covered under warranty.

B. If parts are urgently needed while the new equipment is still under warranty, NLB Corp. recommends the customer issue a new purchase order for the required parts.

C. If the parts are in stock, they will be shipped within three business days. If they are not in stock, the parts will be sent as soon as possible.

D. If the warranty claim is approved, NLB Corp. will either repair, replace, or issue a credit memorandum for the parts. A copy of the credit memorandum will be sent to the customer, and the credit can be used on future orders.

Parts Found Not To Be Defective Under Terms Of This Warranty

A. If the parts are found not to be defective under the terms of this warranty, Customer Service will notify the customer.

B. The customer, at his option, may:

1. Issue a purchase order to have the parts repaired.
2. Request that the parts be returned (at his expense).
3. Request that the parts be scrapped at NLB (requires written request).
4. If no notification is received from the customer within 10 business days, the original parts will be returned at the customer's expense.

V. How To Package Parts To Be Returned

Please use this method when packaging parts to be returned:

A. Fill out the RA form with all applicable information and include in the package being returned. Use the preprinted label found on the RA form and ship prepaid to NLB Corp. "ATTENTION CUSTOMER SERVICE" or to a location stipulated by the contacted Customer Service representative. Confirmation of purchase is required before warranty service is rendered.

B. Except for parts sent for warranty or repair, all parts must be clean and in re-sellable condition and must be returned in their original packaging or other suitable protective container.

C. Parts returned must be carefully packed so as to reach NLB Corp. without damage.

Note:

Each RA Number is unique. This number must appear on the shipping label and all shipping documentation. All inquiries concerning the returned parts must also reference this number.

NLB Corp.

29830 Beck Road
Wixom, Michigan 48393-2824
Attn: Customer Service Department

Telephone (248) 624-5555 □ Customer Service: (800)227-7652
Fax: (248)624-0538

R.A. # _____

Cut along dotted line - use as mailing label

See your manual for Return Authorization instructions or call NLB Customer Service to find out how to acquire a Return Authorization (RA) number.

RETURN AUTHORIZATION

Return This Authorization Form with package

NLB Corp.

29830 Beck Road □ -Wixom, MI 48393
(248) 624-5555 □ Fax (248) 624-0538
Customer Service (800)227-7652

Ship To: _____

_____

_____

Phone: _____ _____

Fax: _____ _____

Contact Name: _____

Customer Account # _____

Repair and Service

NLB Model # _____ Hours _____

NLB Serial # _____ Customer PO # _____

Description of repair needed: _____

_____

_____

Warranty Consideration - Please review NLB warranty policy

NLB Model # _____ Purchase Date _____ NLB Part # _____

NLB Serial # _____ Failure Date _____

Hours _____ Customer PO # _____ Customer Invoice # _____

Customer description of failure and operating conditions at failure _____

_____

_____

_____

New Part Sent _____ Date _____ Customer Order # _____

Return to Stock - Please review NLB return policy

Customer PO # _____ NLB Part # _____

NLB Shipper # _____

Customer Invoice # _____

Reason for returning part _____

_____

_____

_____

Restocking Fee Yes ___ No ___

Customer comments _____

_____

_____

Customer Service Representative: _____ Date: _____

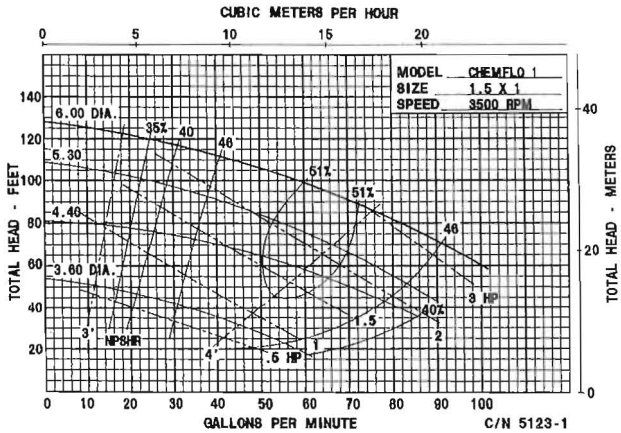
REV 1/03

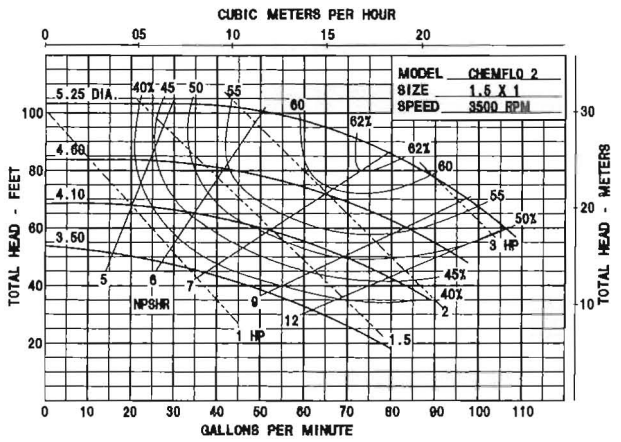
MANUFACTURERS' LITERATURE

Centrifugal Pumps

CHEMFLO 1 & 2

Pump Performance Curves

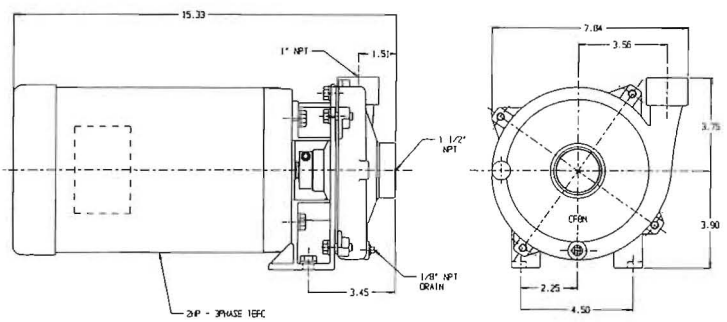


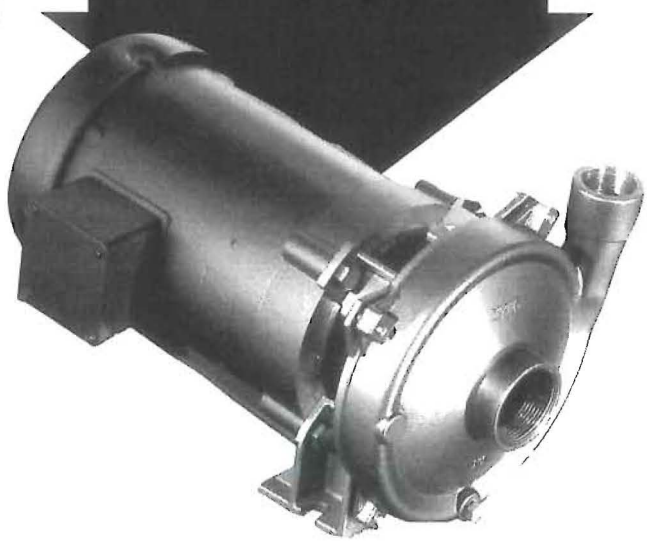


Features & Options

- Investment Cast, 316 CF8M Stainless Steel Housing, Adaptor & Impeller
- Standard—Viton "O"Ring
- Standard—Viton Type 2100 Mechanical Seal
- Optional—Teflon Type 9 and Hard Face Mechanical Seals
- Exotic Elastomers and Seals Available (Consult Factory)
- Semi Open Impellers
- SIZE: 1 1/2" X 1"
- 1 HP, 1.5 HP, 2 HP & 3 HP
- Pumpaks® For 56C Face-Motors
- Pedestal Models Available For Long-Coupling
- Flows To 100 GPM
- Pressures To 130 Feet Head

Dimensions





800-563-8006

MP PUMPS, INC.
TECUMSEH PRODUCTS COMPANY
34800 BENNETT DRIVE • FRASER, MI 48026-1686
(810) 293-8240 • FAX (810) 293-8469
www.mppumps.com

INSTRUCTION BULLETIN

MP CHEMFLO CENTRIFUGAL PUMPAKS
MODELS: CHEMLFLO 1, 2, 3, 4

READ THIS BULLETIN CAREFULLY BEFORE INSTALLING OR OPERATING THE PUMPAK

It is important that this instruction bulletin be read over carefully to fully familiarize yourself with the PUMPAK assembly arrangement. The instructions contained in this bulletin pertain to the installation and maintenance of the PUMPAK assembly only.

Check the PUMPAK over carefully to make certain that no parts are missing or broken in shipment. **CAUTION:** Do not disturb the assembly shim at the suction opening of the pump housing until **after** the PUMPAK has been completely assembled to the driver.

Packed separately with each unit are instruction bulletin, parts list, and literature describing this PUMPAK.

CONSTRUCTION:

The PUMPAK consists of a stainless steel housing, adaptor and shaft sleeve, shaft seal, impeller, drive clamp, o-ring, and stainless steel fasteners.

The impeller is screwed onto the shaft sleeve. The shaft sleeve is machined to precisely fit the shaft on your driver. No provision is made for an internal drive key and none is required. The drive clamp assembly takes the place of internal drive keys, securely locks the shaft sleeve to the driver shaft, and serves additionally as a liquid slinger to protect your motor.

The mechanical seal is the self-adjusting, greaseless type, being lubricated by the liquid in the pump. It requires no maintenance and provides long and trouble-free operation. Because the seal is lubricated by the liquid in the pump, **the pump should never be operated without liquid in the housing.**

In freezing weather, the pump should always be drained of liquid unless sufficient anti-freeze solution is in the system.

MOUNTING PUMPAK TO DRIVER:

ROTATION:

Check rotation of driver to be sure it coincides with the required rotation of the PUMPAK assembly. When viewed from the driver end PUMPAK rotation is Right Hand (Clockwise).

Loosen the drive clamp fasteners but do not remove. **NOTE:** If the driver shaft is a keyed shaft, remove the key before installing the MP PUMPAK. The drive clamp assembly on the MP PUMPAK is all that is required to drive the pump. Slide PUMPAK assembly onto the driver shaft, aligning capscrew holes in adaptor with the tapped holes in the driver mounting face, until adaptor contacts the mounting face.

Install fasteners and tighten to secure PUMPAK assembly to driver. First center, then tighten drive clamp assembly to lock shaft sleeve onto driver shaft.

After all fasteners are tight, including drive clamp assembly, remove the strip stock shim from the suction eye of the pump housing. This shim was inserted to establish clearance between the face of the impeller and pump housing. Rotate driver slowly by hand to make certain the impeller does not rub or hit the housing or adaptor.

If impeller is rubbing, this means the shim was displaced during shipment or handling.

MP PUMPS, INC.
TECUMSEH PRODUCTS COMPANY
34800 BENNETT DRIVE • FRASER, MI 48026-1686
(810) 293-8240 • FAX (810) 293-8469

FORM 3060-A
PRINTED IN U.S.A. (6-97)

ROTATION: (Cont.)

To adjust impeller clearance, do this:

1. Loosen the impeller drive sleeve clamp.

2. Move impeller either forward or back by using a screwdriver to push impeller back — or move impeller drive sleeve forward.

   Depending on the seal spring tension, you can do this by hand without removing the pump housing. Turn the driver to determine that you have adjusted the clearance so the impeller does not rub. Then tighten the impeller drive sleeve clamp.

IF THE SEAL SPRING TENSION PREVENTS THIS METHOD OF ADJUSTMENT, DO THIS:

1. Remove pump housing.

2. Loosen drive clamp, but do not remove.

3. Remove o-ring from housing.

4. Replace housing, pushing against impeller face. Secure housing with two fasteners, 180° apart.

5. Securely tighten drive clamp.

6. Remove housing and install o-ring.

7. Replace housing.

INSTALLATION:

The MP CHEMFLO centrifugal PUMPAKS should be installed with flooded suction or as near to the liquid source as possible.

If it is necessary to install the pump above the level of the liquid, a priming line should be connected directly to the suction line. A check valve must be used in conjunction with a priming line or the priming liquid will merely pass through the suction line to the liquid source. The priming of the suction line evacuates the air in the suction line and pump. This series of pumps will not handle air and therefore all air must be displaced from the suction line and pump before the pump can operate. Be sure that pump housing is filled with liquid before starting the pump. **THE MECHANICAL SEAL IN THE PUMP MUST NOT BE OPERATED DRY.**

Pipe or hose of the same size (or larger) as inlet and outlet openings should be used on the installation. When using pipe, avoid sharp bends and use long radius elbows wherever possible. This will keep friction loss at a minimum and allow the pump to operate more effectively. Use pipe dope on all connections and be sure all fittings are air-tight, especially on the suction side of the pump. An air leak on the suction side of the pump will prevent proper operation. A section of non-collapsible hose between piping and pump may be used as a vibration dampener.

TO DISASSEMBLE THE PUMP:

Drain the system of liquid, break suction and discharge pipe unions, and, if necessary, remove all piping from the suction and discharge openings. Remove the fasteners holding the pump adaptor to the driver, loosen the drive clamp assembly, and remove the PUMPAK.

To disassemble, remove the fasteners holding the pump housing to the adaptor. Remove the housing.

Remove the drive clamp assembly. The impeller, drive sleeve, seal bellows, and spring assembly will now slide forward free of the pump adaptor.

The seal seat and seat cup will remain in the pump adaptor. If not damaged or worn, do not remove. If necessary, remove from the adaptor counter bore with a piece of wood or a screwdriver handle inserted through the adaptor from the drive end. A sharp tap or two is usually sufficient to knock out the seal seat. Use caution in removing the seal seat so as not to crack a ceramic seat.

TO REMOVE IMPELLER:

Remove seal bellows and spring assembly. On some models, spring keeper can also be removed now before removing impeller.

NOTE: The seal bellows will be bonded to the shaft sleeve and will require some patience and caution in removal in order not to damage the seal bellow and cage.

Unscrew the impeller from the shaft sleeve counter-clockwise from the impeller end.

INSPECTION:

Check all parts for wear. For ease of reassembly shaft sleeve should have all nicks and burrs removed. Clean with light crocus cloth. Replace damaged parts with new parts.

Inspect the seal seat and washer, seat cup, and seal bellows for grooves, cuts, scuff marks, or other deterioration. If any of the parts are damaged, a complete new assembly should be installed.

REASSEMBLY:

All dirt and foreign matter should be removed. If seal is to be reused, use soft clean cloth to wipe seal faces.

Lubricate seal seat cup with liquid soap or clean grease and press seal seat into adaptor counter bore, seating it firmly and squarely. Use caution so as not to mar the lapped face of the seal seat.

Assemble shaft sleeve, seal spring keeper, and impeller. Before installing seal bellows and spring assembly, lubricate the shaft sleeve and rubber bellows with liquid soap or clean grease and press bellows and spring assembly onto the shaft sleeve. The spring should engage the spring keeper at the impeller end of the shaft sleeve.

To be properly positioned the washer must be firmly against the rubber bellows member and the driving lugs of the washer properly engaged. The raised shoulder on the seal washer should be facing away from the impeller to contact the lapped surface of the seal seat in the adaptor.

Slide impeller and seal assembly into the adaptor. Install drive clamp assembly on the shaft sleeve but do not tighten.

Proceed with mounting instructions shown under **MOUNTING PUMPAK TO DRIVER.**

DRIVER REPAIRS:

1. Remove piping, install strip stock impeller shim.
2. Remove four capscrews which fasten adaptor to driver.
3. Loosen drive clamp assembly.
4. Remove PUMPAK.

After driver repairs, reinstall PUMPAK according to instructions shown under **MOUNTING PUMPAK TO DRIVER.**

MP PUMPS, INC. LIMITED WARRANTY
FOR NEW PUMPS MANUFACTURED BY MP PUMPS

A. PRODUCTS WARRANTED

MP PUMPS, Inc., a Michigan Company ("MP PUMPS") subject to the limitations contained below, will at its option, repair or replace, without charge for parts or labor only, any part of a new pump manufactured by MP PUMPS (an "MP Pump") which is found, upon examination by MP PUMPS' factory in Fraser, Michigan, to be DEFECTIVE IN MATERIAL AND/OR WORKMANSHIP if received by such factory for such examination within 1 year from the date of sale to the original consumer purchaser.

B. PRODUCTS AND ITEMS NOT WARRANTED

1. Alterations or Modifications of MP Pump
   All obligations under this warranty shall be terminated if the new MP Pump is altered or modified in any way.

2. Accidents, Normal Maintenance, Failure To Follow MP PUMPS' Instruction Bulletin.

3. Any MP Pump which is not completely and properly decontaminated prior to return to MP PUMPS.

4. Any MP Pump returned without an identification of the material pumped by your MP Pump on the "Return Goods Authorization Form."

This warranty covers only parts of a new MP Pump which are found upon examination to be defective in material or workmanship as delivered to the original consumer purchaser. This warranty does not cover defects caused by depreciation or damage caused by normal wear, accidents, improper maintenance, improper use or abuse of the product, failure to follow the instructions contained in an Instruction Bulletin for the operation of the pump and parts. The cost of normal maintenance and replacement of service items which are not defective, shall be paid for by the original consumer purchaser. This warranty is VOID if an MP Pump is not decontaminated prior to return to MP PUMPS or if the material pumped is not identified as provided below.

C. SECURING WARRANTY SERVICE

Warranty service can be arranged by contacting MP PUMPS, Inc., c/o Service Manager, 34800 Bennett Drive, Fraser, Michigan 48026. Warranty service can only be performed by MP PUMPS at its factory in Fraser, Michigan. At the time of requesting warranty service, evidence must be presented of the date of sale to the original consumer purchaser. MP PUMPS, at its option, will supply you with a "Return Goods Authorization Form" ("RGA") or will prepare an RGA on your behalf and provide you with an RGA reference number. The product pumped must be identified on the RGA. All parts returned to MP PUMPS for any reason must be completely and properly decontaminated prior to delivery to MP PUMPS. If the product pumped requires a Material Safety Data Sheet ("MSDS"), reference to this fact must be indicated under "Application Information" on the RGA form which must be returned with the part(s) or if an RGA was completed on your behalf you must provide your RGA reference number. A copy of the MSDS must be included with the returned RGA forms or with your RGA reference number. New or unused parts need not be decontaminated. This fact must be indicated under "Application Information" on the RGA form which must be returned with the part(s). The original consumer purchaser shall pay any charges for making service calls and/or for transporting the product to and from the place where the inspection and/or warranty work is performed. The part submitted for inspection and/or warranty work will be returned to the sender at the sender's expense or scrapped at MP PUMPS. No credits will be issued. The original consumer purchaser shall be responsible for any damage or loss incurred in connection with the transportation of the MP Pump and/or of part or parts of the MP Pump submitted for inspection and/or warranty work.

D. NO ADDITIONAL WARRANTIES OR REPRESENTATIONS

The foregoing EXPRESS WARRANTY IS IN LIEU OF ALL OTHER EXPRESS WARRANTIES. Neither MP PUMPS nor any of its affiliates make any warranties, representations or promises, written or verbal, as to the quality of the MP PUMP or its parts other than those set forth herein.

ANY IMPLIED WARRANTIES (INCLUDING, BUT NOT LIMITED TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE) TO THE EXTENT EITHER APPLIES TO A PART OF AN MP PUMP SHALL BE LIMITED IN DURATION TO THE PERIODS OF THE EXPRESS WARRANTIES AS DEFINED IN PARAGRAPH A. Some States do not allow limitations on how long an implied warranty lasts, so the above limitations may not apply to you.

E. LIMITATION OF DAMAGES

IN NO EVENT WILL MP PUMPS BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES AND/OR EXPENSES. Some States do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation may not apply to you. This warranty gives you specific legal rights, and you may have other legal rights which vary from State to State.

F. NO DISTRIBUTOR/DEALER WARRANTY

MP PUMPS neither assumes nor authorizes any other person, natural or corporate, to assure for MP PUMPS any other obligations or liabilities in connection with or with respect to any part or parts of an MP Pump. The seller, dealer or distributor of a part or parts of an MP Pump has no authority to make any representations or promises on behalf of MP PUMPS or to modify the terms or limitations of this warranty in any way. The seller, dealer or distributor makes no warranty of his own on any item warranted by MP PUMPS and makes no warranty on other items, unless such seller or dealer delivers to the purchaser a separate written warranty document in which the seller or the dealer individually and specifically on its own behalf, warrants the terms of items.

MP PUMPS, INC.
TECUMSEH PRODUCTS COMPANY
34800 BENNETT DRIVE • FRASER, MI 48026-1686
(810) 293-8240 • FAX (810) 293-8469
(800) 563-8006

SHELCO FILTERS
Single-Shell Filters

FO-C, B, S
SERIES 80
FLUID FILTERS

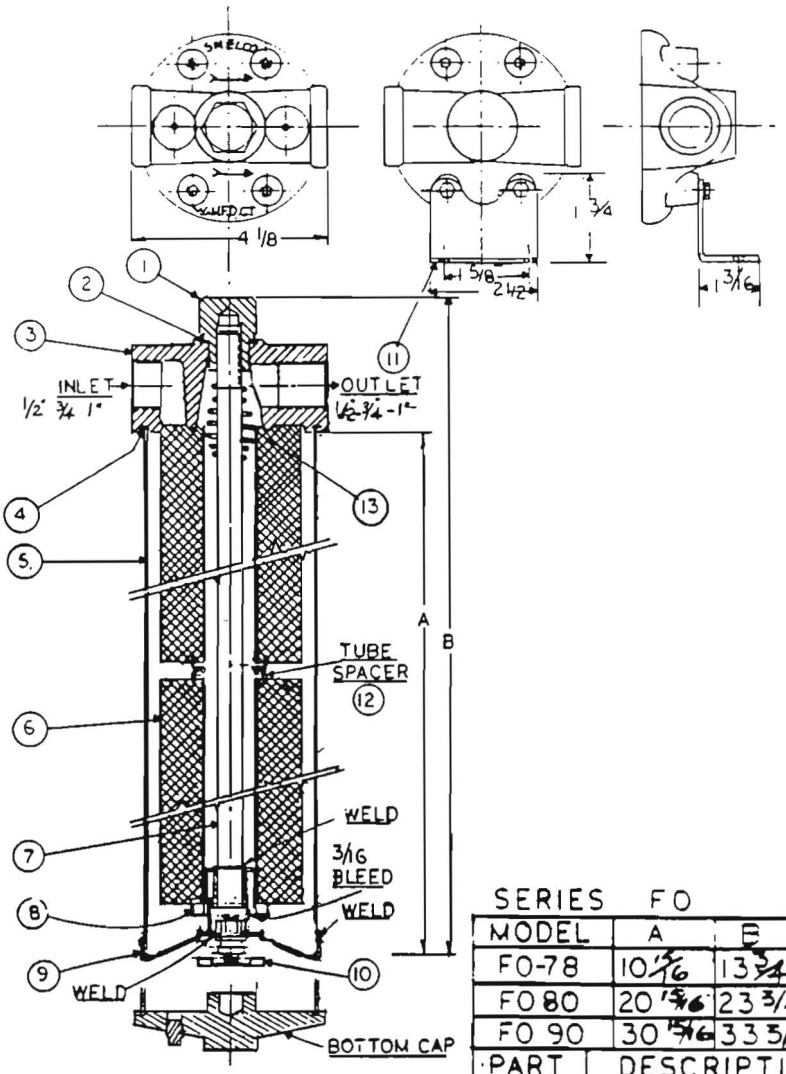
- Filters have cast heads with single bolt and unibody shell construction for quick, spillage-free cartridge change — or — break-a-way™ cast bottom for complete cleanable shell and base.
- In-line pipe connection for easy installation.
- Versatility - various capacities may be had with break-a-way™ filters. All you buy is the body and rod — and request appropriate cartridge length and micron desired.
- Machined groove in underside of head for "locked-in" "Life-long™" gasket for positive protection.
- Now — SHELCO leads the way with a built-in by-pass. Add suffix BP if desired — Available on 250' PSI Head only.

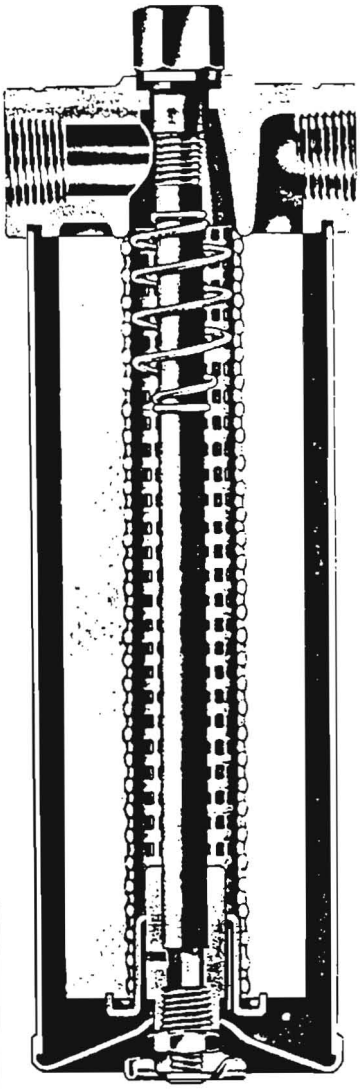
SPECIFICATIONS — SERIES 80

MODEL	RATED CAPACITY	MAXIMUM OPERATING PRESSURE	DIMENSIONS		CARTRIDGE LENGTH	PIPE SIZE (NPT)	WEIGHT LBS.
			HEIGHT	FACE TO FACE			
FO-804	20 GPM	250 PSI	23-¾"	4"	19 7/8" 20"	½"	10
FO-806	20 GPM	250 PSI	23-¾"	4"	19 7/8" 20"	¾"	10
FO-808	20 GPM	250 PSI	23-¾"	4"	19 7/8" 20"	1"	10

SUPPLEMENTAL DATA

Add "B" suffix to Model number if bracket is required
For carbon steel construction use Model Prefix FOC
For brass construction use Model Prefix FOB
For stainless steel construction use Model Prefix FOS
Standard Gasket Material — Buna-n — other materials available upon request.





SERIES FO

MODEL	A	B	CARTRIDGE
FO-78	10 5/16	13 3/4	10"
FO 80	20 5/16	23 3/4	20"
FO 90	30 5/16	33 3/4	30"

PART NO.	DESCRIPTION	ITEM NO.
2071-S	TOP CAP NUT	1
2072-B	GASKET - CAP NUT	2
2032-8-S	HEAD STAIN. STEEL	3
20041-B	GASKET - SHELL	4
2014	SHELL STAIN STEEL	5
	CARTRIDGE	6
2016	CENTER POST BOLT	7
8036	CARTRIDGE SEAL PLATE	8
2016	BOTTOM CAP	9
2022-8	PETCOCK DRAIN	10
2023	BRACKET	11
2024	TUBE SPACER	12
2105-S	SPRING LOCATOR	13

CARTRIDGE TYPE FILTER HOUSING FOR FLUIDS

SHELCO FILTER DIVISION
WEST HARTFORD, CT. 06110

WHEN ORDERING PARTS SPECIFY:

1- FILTER MODEL
2- ITEM NO. AND DESCRIPTION OF PART
3- MATERIAL
4- QUANITY REQUIRED

CONTROLS, INCORPORATED

Control Systems & Solutions

TECHNICAL MANUAL

Model EMT2-C10135

System Control Unit

Revision 1

7/18/05

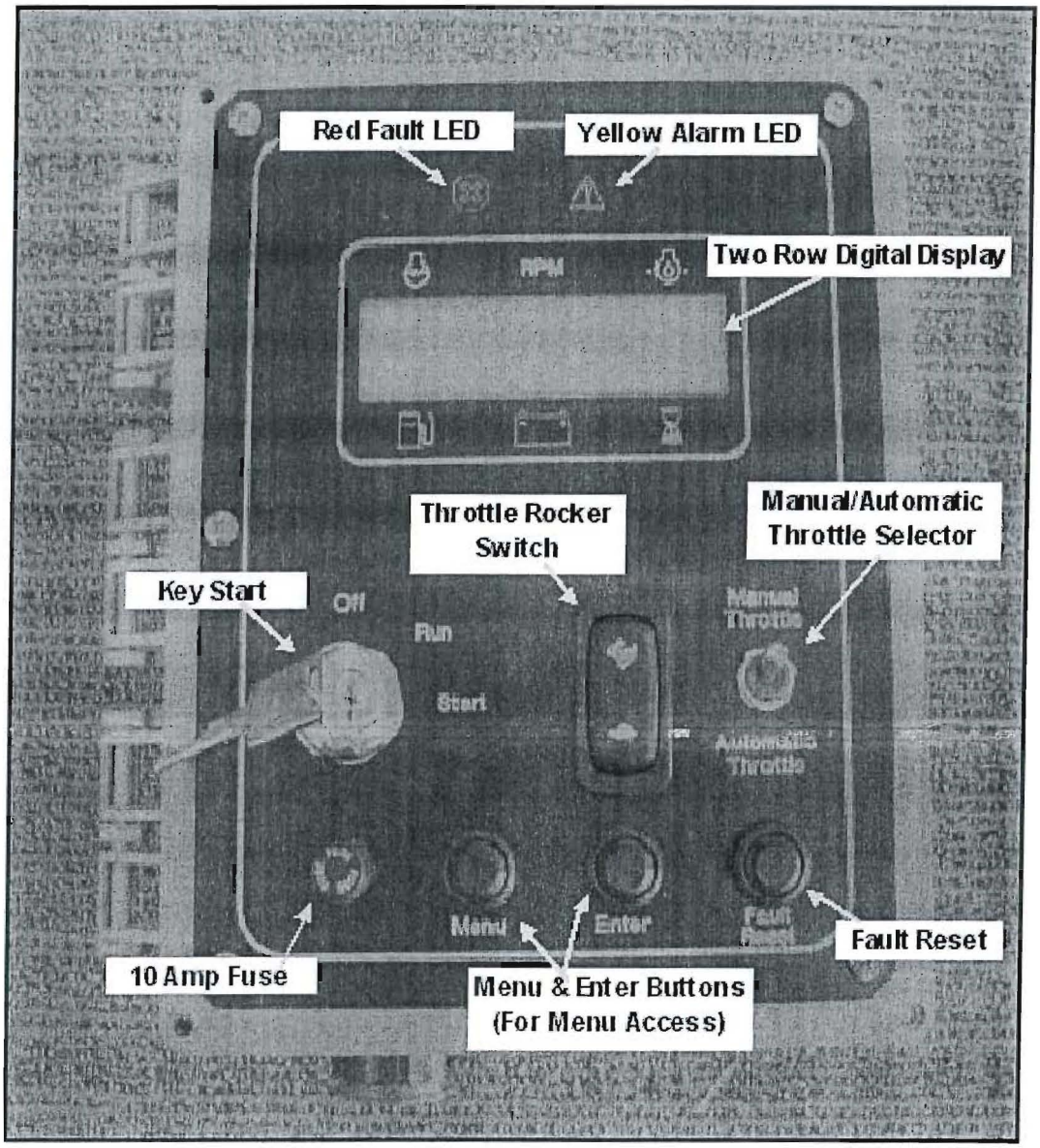
P.O. Box 368 • Sharon Center, OH 44274

Phone 330.239.4345 • Fax 330.239.2845 • www.controlsinc.com

Table of Contents

1) Product Overview

Picture of the EMT2-C10135 with identifying labels.



The EMT2-C10135 is a complete system control. Functions include:

2) Engine Start & Stop

Key switch with Off/Run/Start to start and stop the engine.

3) Engine Throttle Control System

Automatic Throttle
With the "Manual/Automatic" selector switch in the "Automatic" position, the throttle system is designed to operate as a 2 speed, multi-state system.

1) The engine will start at 800 rpm.
2) When wand is engaged, engine increases to 1000 rpm (Speed 1).
3) While the wand is engaged, engine speed can be adjusted to the necessary operating speed via the hare/turtle throttle switch. This operating speed (Speed 2) is stored.
4) Engine speed will switch between Speed 2 and Speed 1 dependent on wand being engaged or disengaged.

Throttle Calibration in Automatic Position
Each time the engine is started, it is necessary to calibrate the Speed 2 setting. The engine will start at idle speed (800 rpm). The calibration process begins when the wand is engaged. The engine will accelerate to 1000 rpm (Speed 1). Speed 2 is set by adjusting the engine to the operating speed and disengaging the wand. The engine speed at the time of disengagement is stored as Speed 2.

While engine is running at Speed 2 and the wand engaged, the operator can adjust engine speed up or down using the hare/turtle throttle switch. Each time the wand is engaged, the engine will return to the new Speed 2.

Upon a restart of the engine, the Speed 2 setting will revert to the default value of 1000 RPM.

Manual Throttle
With the "Manual/Automatic" selector switch is in the "Manual" position, engine speed can be adjusted via the hare/turtle throttle switch and is independent of the wand position.

4) Digital Display Information

Full-time display parameters:

1) Water Temperature
2) Engine RMP
3) Oil Pressure
4) Fuel Rate (or Fuel Level with Sender)
5) Battery Voltage
6) Engine Hours

5) Engine Alarms & Faults

All "engine" alarms and faults are managed by the engine ECU (Electronic Control Unit). The ECU is monitored by the EMT2-C10135 via the J1939 CAN Bus.

Engine Alarms

In the case of an engine alarm, the yellow LED will illuminate (the engine will continue to run). If the alarm is in reference to a full-time display parameter, that value will flash. If the alarm is for engine parameter that is not displayed full-time, a message will appear on the LCD every 15 seconds.

All engine alarms correspond to a specific SPN.FMI (Suspect Parameter Number/Failure Mode Identifier) code. SPN.FMI codes are standardized codes used with the J1939 CAN Bus system. Each code represents a specific engine issue.

The specific SPN.FMI code can be accessed and viewed via the menu options (See Menus, Page 8). Active and Stored SPN.FMI codes can be retrieved.

Engine Faults

In the case of an engine fault, the red LED will illuminate and the engine will shut down. A message will appear on the digital display. The message will be a brief description and/or a reference to check the SPN.FMI code.

All engine faults correspond to a specific SPN.FMI (Suspect Parameter Number/Failure Mode Identifier) code. Each code represents a specific engine issue.

The specific SPN.FMI code can be accessed and viewed via the menu options (See Menus, Page 8). Both Active and Stored SPN.FMI codes can be retrieved.

6) Other System Alarms & Faults

The EMT2-C10135 monitors a number of "system" digital inputs directly including air compressor temperature, inlet water pressure, lube oil level, crank case oil level, low water level, pump fault #1, and pump fault #2.

An analog input for fuel level sender is also available with use of a standard fuel level sender (S&W 240 – 33 ohm) for which an alarm is activated when the level is below the programmed level.

An alarm condition is defined as a closed circuit to ground, which has been opened for the time delay period. The time delay periods are:

- Air Compressor Temp. 1 Sec delay to alarm
- Inlet Water Pressure 1 Sec delay to alarm
- Lube Oil level 1 Sec delay to alarm
- Low Water Level 5 Sec delay to alarm
- Crank Case Oil Level 1 Sec delay to alarm
- Pump Fault #1 1 Sec delay to alarm
- Pump Fault #2 1 Sec delay to alarm

Once the alarm condition occurs,

1) the condition is "latched",
2) the engine speed is reduced to idle,
3) the yellow LED will illuminate,
4) a message will flash on the digital display.

(The alarm condition remains true even if the switch is put back in the normally closed position.)

If the condition continues for more than five minutes (without the "Fault Reset" button being pressed) the alarm condition will become a fault condition. Pressing the fault reset button while an alarm condition is present will reset the five-minute alarm period and allow the engine to continue running at idle in alarm mode. To clear an alarm condition, it is necessary to eliminate the cause of the alarm and press the fault reset button.

With a fault condition,

1) the engine will shut down,
2) the red LED will illuminate,
3) a message will appear on the digital display.

To clear a fault condition, it is necessary to eliminate the cause of the alarm and cycle power to the controller (turn off and back on).

6) Wiring Connections

Engine Connection

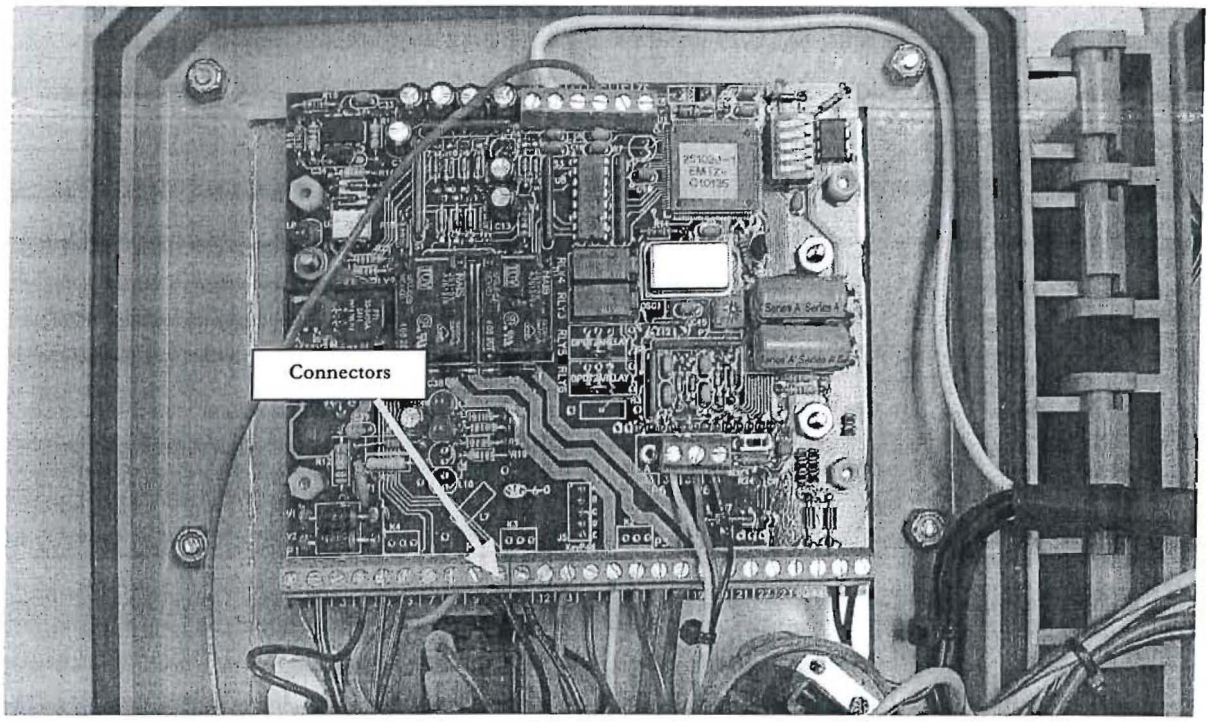
The controller is connected to the engine via a 21 pin Deutsch plug. The pin out for the harness is shown below.

Pin B Battery + to EMT2-C10135
Pin D Battery + to Start Slave Relay
Pin E Battery -
Pin F CAN Shield
Pin V CAN High
Pin U CAN Low

Pin J Battery + to Alternator
Pin G Battery + to ECU/ECM
Pin L Deere Analog Throttle Emulator
Pin M Deere Analog Throttle Emulator
Pin C Deere Analog Throttle Emulator
Pin R Deere Analog Throttle Emulator
Pin S Deere Analog Throttle Emulator

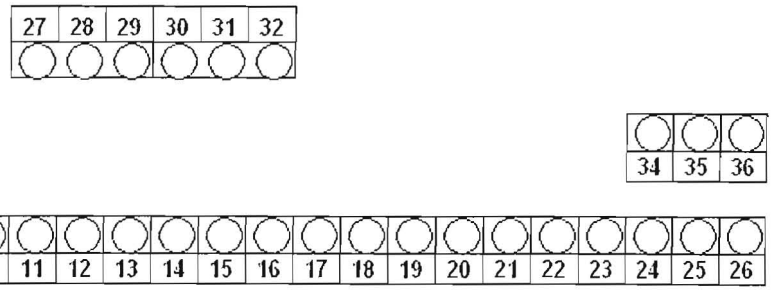
System "Digital" & "Analog" Connections

Terminal strip connectors located on the circuit board inside the EMT2-C10135 enclosure are used for digital and analog system inputs. Connections are identified on the following page.



EMT2-C10135
INPUT/OUTPUT Configuration

TERMINAL STRIP PINOUT
(Location on Circuit Board)



(Terminal Strip Definitions)

Term #	Connection	Term #	Connection
1	Battery Positive	17	Battery Positive Common Contact
2	Battery Negative	18	Switched Power to ECU
3	Not Used	19	Switched Power to Crank Solenoid
4	Ground	20	Pre Alarm Common
5	**Air Compressor Temp**	21	Pre Alarm Normally Open
6	**Inlet Water Pressure**	22	Fault Common
7	Analog Fuel Level	23	Fault Normally Open
8	**Discharge Pressure Switch**	24	Not Used
9	**Lube Oil level**	25	**Pump Fault #1**
10	**Crank Case Oil Level**	26	**Pump Fault #2**
11	**Low Water Level**	30	Fault Reset
12	Emergency Stop	31	Ground
13	Enter	32	
14	Throttle Down	34	CAN J1939 Hi
15	Throttle Up	35	CAN J1939 Low
16	Menu	36	CAN J1939 Shield

BOLD CONNECTIONS MUST BE GROUNDED IF NOT USED

7) Menus

The control panel has menus to view engine and controller parameters. These menus are accessible via a four-button pad located on the face of the control panel.

Available Menus

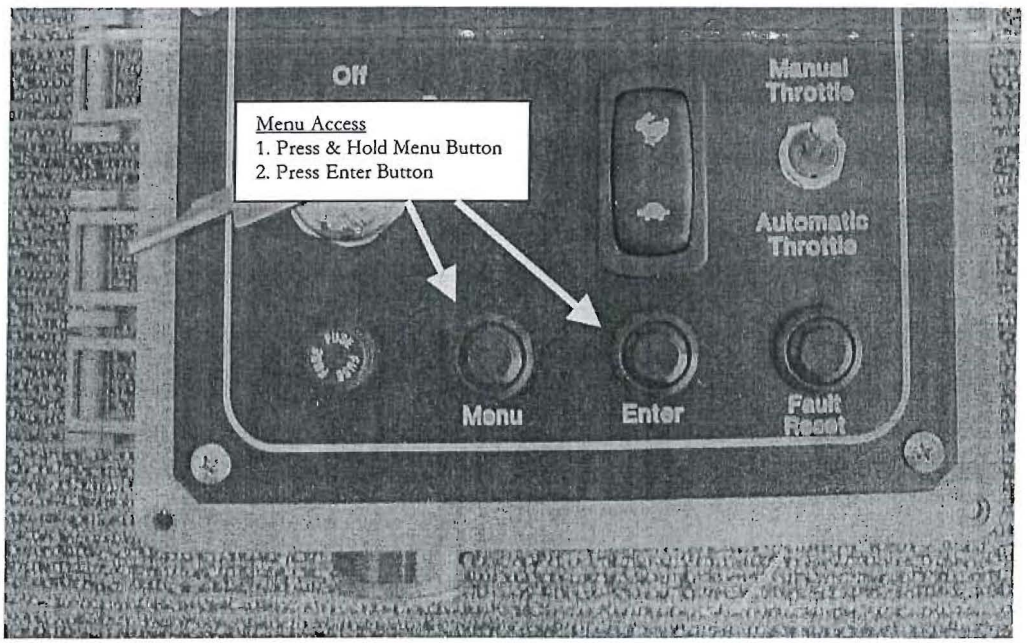
Profile Throttle:	Allows user to view throttle settings.
Engine Parameter:	View active J1939 CAN Bus engine parameters.
Active SPN.FMI:	View active SPN.FMI trouble codes.
Stored SPN.FMI:	Retrieve stored SPN.FMI trouble codes.
Erasing SPN.FMI:	Ability to clear all stored codes on the engine ECU.
Engine Configuration:	View Speed, Torque and Governor Gain Information.

Menu Access

1) Press and Hold MENU Button, then press ENTER button simultaneously.

   This will bring up the "PROFILE THROTTLE FUNCTIONS" menu.

2) Pressing the DN Button will scroll down through the other menus listed above. The UP Button will scroll up.
3) Press ENTER Button to access/enter a menu option.
4) Press MENU Button to back out of a menu option.



9) Warranty

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The Liability of Seller thereunder is limited to replacing or repairing at Seller's factory any part or parts which have been returned to the Seller and which are proved by buyer as defective or not conforming to Seller's specifications, drawings or other written descriptions, accepted by Seller, provided that such part or parts are returned by the buyer within thirty (30) days after such defect is discovered. All items returned to Seller for repair or replacement must be sent freight prepaid to its factory. Buyer must obtain Seller's Return Goods Authorization prior to returning items. The above conditions must be met if warranty is valid. Seller will not be liable for any damage done by unauthorized repair work, unauthorized misapplication in non-suitable environment.

In no event shall the Seller be liable for loss, damage, or expense directly or indirectly arising from the use of the units, or from any other cause, except as expressly stated in the warranty. Seller makes no warranties, express or implied, including any warranty as to merchantability of fitness for a particular purpose or use. Seller is not liable for and buyer waives any right or action it has or may have against seller for any consequential or special damages arising out of any breach of warranty, and for any damages buyer may claim for damage to any property or injury or death to any person arising out of its purchase or the use, operation or maintenance of the product. Seller will not be liable for any labor subcontracted or performed by buyer for preparation of warranted item for return to Seller's factory or for preparation work for field repair or replacement. The Seller will not consider invoicing of Seller for labor either performed or subcontracted by buyer as a liability. This warranty shall be exclusive of any and all other warranties express or implied and may be modified only by a writing signed by an officer of the Seller. With respect to accessories supplied by Seller, but manufactured by others, there is no warranty of any kind, express or implied, and specifically there is no warranty of merchantability or fitness, except as may be set forth in any warranty the manufactures have made to Seller and which can be passed to the Buyer.