

**NLB MODELS**  
**NCG8400A-3 ULTRA-CLEAN<sup>®</sup> &**  
**NCG8400A-3L ULTRA-CLEAN<sup>®</sup>**  
**ROTATING LANCES**

**OPERATION,**  
**MAINTENANCE, &**  
**PARTS**  
**MANUAL**



*Manufacturer of the National Liquid Blaster*

**29830 BECK ROAD**  
**WIXOM, MI 48393-2824**  
**(248) 624-5555**  
**FAX (248) 624-0538**

**PARTS**  
**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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# **IMPORTANT NOTICE**

PLEASE READ THE **SAFETY SECTION** IN THIS  
MANUAL BEFORE OPERATING THIS OR ANY PIECE OF HIGH  
PRESSURE EQUIPMENT



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## SECTION 1

### DESCRIPTION & SPECIFICATIONS

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## I. GENERAL DATA

### A. MODEL AND SERIAL NUMBER INFORMATION

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 LANCE/BI-MODE VALVE ASSEMBLY CAN BE IDENTIFIED. IT IS IMPORTANT THAT WHEN ORDERING REPLACEMENT PARTS FOR EACH LANCE/BI-MODE VALVE ASSEMBLY THAT THE MODEL AND SERIAL NUMBERS ARE INCLUDED IN THE ORDER. (SEE FIGURE 1-1 FOR LOCATION). PICTURE SHOWN WITH OPTIONAL BI-MODE TO NCG8400A-3/3L HOSE ASSEMBLY (DM14150).

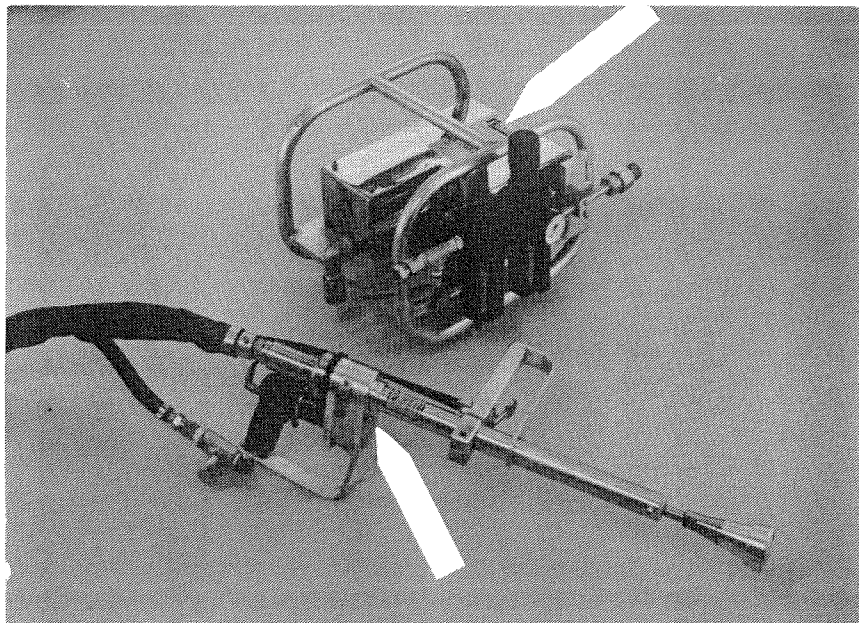


FIGURE 1-1

## **B. DESCRIPTION**

THE NCG8400A-3 AND NCG8400A-3L LANCES ARE CONTROLLED BY A BI-MODE VALVE WHICH IS MOUNTED IN THE WATER SUPPLY LINE AND RESTS ON THE GROUND. DURING THE CLEANING PROCESS THE BI-MODE VALVE TRAILS THE OPERATOR AS HE MOVES ABOUT THE CLEANING AREA.

WHEN THE SYSTEM IS STARTED UP THE WATER WILL BE DUMPING AT THE VALVE DUMP PORT AND FLOW TO THE NOZZLE WILL BE SHUT-OFF.

THERE ARE TWO TRIGGERS ON THE LANCE, ONE ON THE FORWARD GRIP AND ONE ON THE REAR GRIP. WHEN BOTH TRIGGERS ARE SQUEEZED THE DUMP PORT ON THE WATER VALVE CLOSES AND THE PRESSURE PORT OPENS DIRECTING HIGH PRESSURE WATER TO THE NOZZLE.

WHEN THE TRIGGERS ARE RELEASED THE WATER FLOW TO THE NOZZLE IS SHUT OFF AND THE WATER IS DIRECTED TO THE DUMP PORT.

THE WATER CONTROL VALVE ASSEMBLY WILL HAVE TWO SUPPLY LINES, ONE FOR HIGH PRESSURE WATER THE OTHER FOR THE AIR SUPPLY. THE AIR IS USED FOR BOTH THE NOZZLE ROTATION AND FOR POWERING AN AIR ACTUATOR WHICH CONTROLS THE WATER VALVE. AN AIR FILTER, LUBRICATOR AND REGULATOR ARE INCLUDED AND MOUNTED WITH THE BI-MODE VALVE ASSEMBLY.

THE LINES BETWEEN THE BI-MODE VALVE AND LANCE INCLUDE HIGH PRESSURE WATER, AIR SUPPLY TO THE LANCE AND PILOT AIR RETURN LINE. THE PILOT AIR RETURN LINE PROVIDES THE MEANS OF ACTUATING THE AIR CONTROL VALVE WHICH CONTROLS THE AIR ACTUATOR.

IN OPERATION WHEN THE TWO TRIGGERS ON THE LANCE ARE PULLED AIR FLOWS FROM THE SUPPLY LINE THROUGH THE AIR MOTOR AND BACK THE PILOT AIR RETURN LINE TO THE BI-MODE VALVE ASSEMBLY. THE PILOT AIR ACTUATES THE AIR VALVE SHIFTING THE AIR ACTUATOR WHICH CLOSES THE DUMP PORT AND DIRECTS THE WATER TO THE LANCE.

### **C. SPECIFICATIONS**

**ROTATING LANCE:** NLB MODELS NCG8400A-3/3L

**MATERIAL:** STAINLESS STEEL AND ALUMINUM

**WORKING PRESSURE:** 40,000 PSI (2,758.6 bar)

**VOLUME:** 6 GPM (22.7 lpm) MAXIMUM

**TRIGGER OPERATING FORCE:** LESS THAN ONE POUND (.45 kg)

**TRIGGER DESIGN:** TWO TRIGGERS ARE PROVIDED  
REQUIRING THE USE OF BOTH HANDS TO  
INITIATE THE DUMP VALVE AND PROVIDE  
FLOW AT THE NOZZLE.

**NOZZLE ROTATION:** RECOMMENDED MAXIMUM SPEED-3000 RPM

**FORWARD GRIP:** ADJUSTABLE

**CAUTION: AIR SUPPLY TO MOTOR MUST BE LUBRICATED USING SAE 10W OR AIR TOOL OIL (E.G., KILFROST®). LACK OF PROPER LUBRICATION WILL DESTROY AIR MOTOR AND WARRANTY WILL BE VOIDED. ADJUST LUBRICATOR FOR A DRIP RATE OF 30 DROPS PER MINUTE.**

|              |                                                                                                                           |
|--------------|---------------------------------------------------------------------------------------------------------------------------|
| <b>NOTE:</b> | <b>THE SYSTEM CAN BE SET UP FOR EITHER SINGLE OR MULTIPLE LANCE OPERATION. SEE PAGE 1-7 FOR DESCRIPTION OF OPERATION.</b> |
|--------------|---------------------------------------------------------------------------------------------------------------------------|

**D.     FEATURES OF THE NCG8400A-3/3L**  
**ROTATING LANCES**

AIR FLOW ADJUST LOCATED ON THE LANCE FOR CONTROL OF NOZZLE RPM.

ADJUSTABLE FORWARD GRIP FOR RIGHT-HANDED AND LEFT HANDED OPERATORS.

LOW OPERATOR FORCE REQUIRED FOR TRIGGER, REDUCING OPERATOR FATIGUE

THE ROTATE DRIVE MECHANISM IS LOCATED AT THE REAR OF THE LANCE NEAR THE OPERATOR TO MINIMIZE ARM STRAIN.

## **E. ROTATING SWIVEL**

### **DESCRIPTION**

**NLB** MODEL DS8800A ULTRA HIGH PRESSURE SWIVEL IS DESIGNED TO OPERATE AT WATER PRESSURES FROM 30,000 PSI (2,068.9 bar) TO 40,000 PSI (2,758.6 bar) AND FLOW RATES UP TO 6 GPM (22.7 lpm).

THE SWIVEL MAY BE DRIVEN BY AN AIR MOTOR AT ROTATIONAL SPEEDS TO A MAXIMUM OF 3000 RPM.

THE SWIVEL IS DESIGNED TO BE AN INTEGRAL PART OF THE MODEL NCG8400A-3/3L ROTATING LANCES.

THE DYNAMIC HIGH PRESSURE SEAL IS DESIGNED FOR QUICK AND EASY CHANGE-OUT TO MINIMIZE OPERATIONAL DOWN-TIME.

## **1.    TYPE OF OPERATIONS**

### **SINGLE LANCE OPERATION:**

ALL OF THE AVAILABLE FLOW IS DIRECTED TO THE LANCE WHICH HAVE TWO EQUAL NOZZLES SIZED TO SUIT THE VOLUME. WHEN THE OPERATOR RELEASES THE TRIGGER THE WATER DUMPS AT LOW PRESSURE.

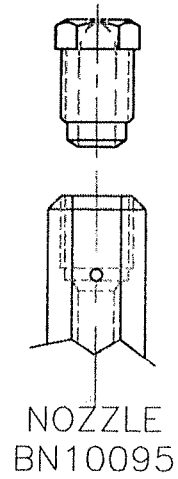
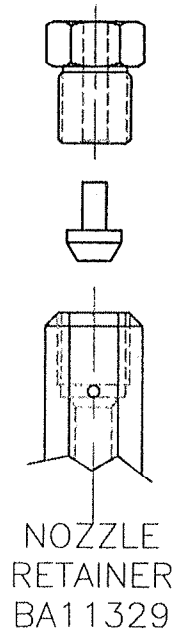
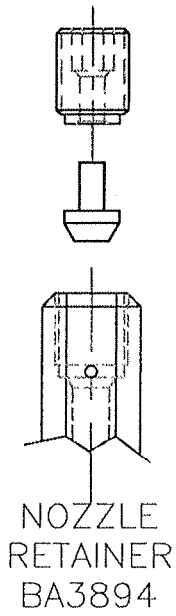
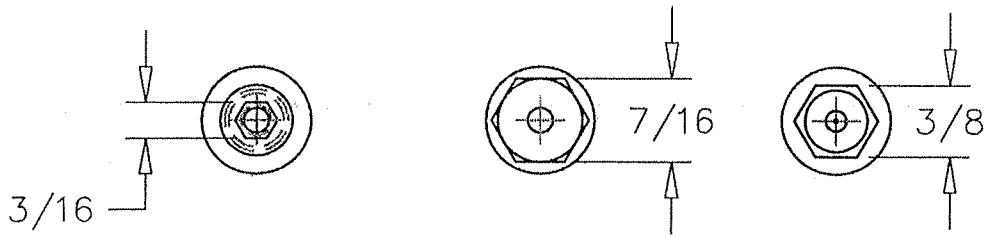
USE TWO BN3539-025 OR BN10095-25 SAPPHIRE NOZZLES IN LANCE AT  
2.67 GPM (10.09 LPM)  
TOTAL = 5.34 GPM (20.18 LPM)

### **DUAL LANCE OPERATION:**

ALL OF THE AVAILABLE FLOW IS EVENLY DISTRIBUTED TO EACH LANCE WHICH HAVE THE SAME SIZE NOZZLES. WHEN THE TRIGGERS ARE RELEASED ON ANY ONE OR ALL OF THE LANCES, A CONNECTION TO THE PUMP ACTUATES THE DUMP VALVE THROUGH AN ORIFICE WHICH CAUSES THE SYSTEM PRESSURE TO REMAIN CONSTANT. THE LANCE OR LANCES STILL WORKING WILL NOT SEE A PRESSURE CHANGE.

USE TWO BN3539-018 OR BN10095-18 SAPPHIRE NOZZLES IN LANCES AT  
1.38 GPM (5.23 LPM)  
TOTAL = 5.52 GPM (22.08 LPM)

## F. ULTRA-HIGH PRESSURE SAPPHIRE NOZZLE IDENTIFICATION & CHART





## NLB ULTRA-HIGH PRESSURE SAPPHIRE NOZZLES

|                                                     |                                                        | TYPICAL NOZZLE CONFIGURATION QUANTITIES                                                                                       |              |              |   |                             |                           |       |        |             |             |
|-----------------------------------------------------|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|--------------|--------------|---|-----------------------------|---------------------------|-------|--------|-------------|-------------|
| STANDARD<br>0 DEGREE<br>NLB P/N AND<br>ORIFICE SIZE | HI-COHESIVE<br>0 DEGREE<br>NLB P/N AND<br>ORIFICE SIZE | THEORETICAL FLOW<br>IN GPM (LPM)<br>PRESSURE PSI (BAR)<br>32,000 PSI 36,000 PSI 40,000PSI<br>(2210 BAR) (2500 BAR) (2760 BAR) |              |              |   | SINGLE<br>GUN<br>NCG8400A-2 | DUAL<br>GUN<br>NCG8400A-2 | SRT-6 | SRT-10 | 36-9900-15A | 36-9950-15A |
| BN3539-007                                          | BN10095-7                                              | 0.19 (0.72)                                                                                                                   | 0.20 (0.76)  | 0.21 (0.79)  |   |                             |                           |       | 2      |             |             |
| BN3539-008                                          | BN10095-8                                              | 0.24 (0.91)                                                                                                                   | 0.26 (0.98)  | 0.27 (1.02)  |   |                             |                           |       | 2      |             |             |
| BN3539-009                                          | BN10095-9                                              | 0.31 (1.17)                                                                                                                   | 0.33 (1.25)  | 0.35 (1.32)  |   |                             |                           |       | 2      | 2           | 2           |
| BN3539-010                                          | BN10095-10                                             | 0.38 (1.45)                                                                                                                   | 0.40 (1.54)  | 0.43 (1.61)  |   |                             |                           |       | 2      |             |             |
| BN3539-011                                          | BN10095-11                                             | 0.46 (1.75)                                                                                                                   | 0.49 (1.86)  | 0.52 (1.95)  |   |                             |                           | 2     | 2      |             |             |
| BN3539-012                                          | BN10095-12                                             | 0.55 (2.08)                                                                                                                   | 0.58 (2.21)  | 0.61 (2.33)  |   |                             |                           | 2     | 2      |             |             |
| BN3539-013                                          | BN10095-13                                             | 0.65 (2.44)                                                                                                                   | 0.68 (2.59)  | 0.72 (2.73)  |   |                             |                           | 2     | 2      |             |             |
| BN3539-014                                          | BN10095-14                                             | 0.75 (2.83)                                                                                                                   | 0.79 (3.00)  | 0.84 (3.17)  |   |                             |                           | 2     |        | 6           | 6           |
| BN3539-016                                          | BN10095-16                                             | 0.98 (3.70)                                                                                                                   | 1.04 (3.93)  | 1.09 (4.13)  |   |                             |                           |       |        |             |             |
| BN3539-018                                          | BN10095-18                                             | 1.24 (4.68)                                                                                                                   | 1.31 (4.97)  | 1.38 (5.23)  |   | 4                           |                           |       |        |             |             |
| BN3539-020                                          | BN10095-20                                             | 1.53 (5.78)                                                                                                                   | 1.62 (6.13)  | 1.71 (6.46)  |   |                             |                           |       |        |             |             |
| BN3539-023                                          | BN10095-23                                             | 2.02 (7.65)                                                                                                                   | 2.14 (8.11)  | 2.26 (8.54)  |   |                             |                           |       |        |             |             |
| BN3539-025                                          | BN10095-25                                             | 2.39 (9.04)                                                                                                                   | 2.53 (9.58)  | 2.67 (10.09) | 2 |                             |                           |       |        |             |             |
| BN3539-032                                          | BN10095-32                                             | 3.91 (14.80)                                                                                                                  | 4.15 (15.70) | 4.37 (16.54) |   |                             |                           |       |        |             |             |
| BN3539-PLUG                                         |                                                        | 0                                                                                                                             | 0            | 0            |   |                             |                           |       |        | 6           | 6           |
| REQUIRES<br>NOZZLE<br>RETAINER                      | NO NOZZLE<br>RETAINER<br>REQUIRED                      | NOZZLE SIZE AND QUANTITIES WILL VARY WITH HIGH PRESSURE<br>PUMP MODEL USED AND CLEANING CONDITIONS                            |              |              |   |                             |                           |       |        |             |             |

OTHER NOZZLE SIZES ARE AVAILABLE. SEE ACCESSORY CATALOG OR CONSULT NLB.

ON DIESEL UNITS, FOR OPTIMUM OPERATION, ADJUST ENGINE SPEED AND BY-PASS VALVE SO THAT LITTLE OR NO WATER FLOWS FROM BY-PASS VALVE. ON DIESEL AND ELECTRIC UNITS, TOTAL NOZZLE FLOW SHOULD BE 92% TO 98% OF UNIT CAPACITY. THIS ALLOWS AN EXTRA CAPACITY (0.25 TO 0.50 GPM ON A 6.00 GPM PUMP) TO COMPENSATE FOR NOZZLE WEAR.

**G. FEATURES OF THE OPTIONAL BI-MODE TO NCG8400A-3/3L HOSE ASSEMBLY (DM14150).**

- A. KEVLAR® PROTECTIVE SHEATH IS PROVIDED OVER THE HOSES BETWEEN THE LANCE AND BI-MODE VALVE ASSEMBLY.

## SECTION 2 – SAFETY AND RECOMMENDED PRACTICES



**NLB's 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 and to exclude any liability as a result of injury, if such damage or injury can be linked to the substandard replacement part.**

### 2.1 – 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 (800) 227-7652 for a free copy.

**Safety Signs:** All NLB high-pressure water jetting equipment has 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 the supervision's responsibility to call these signs to the attention of all personnel.

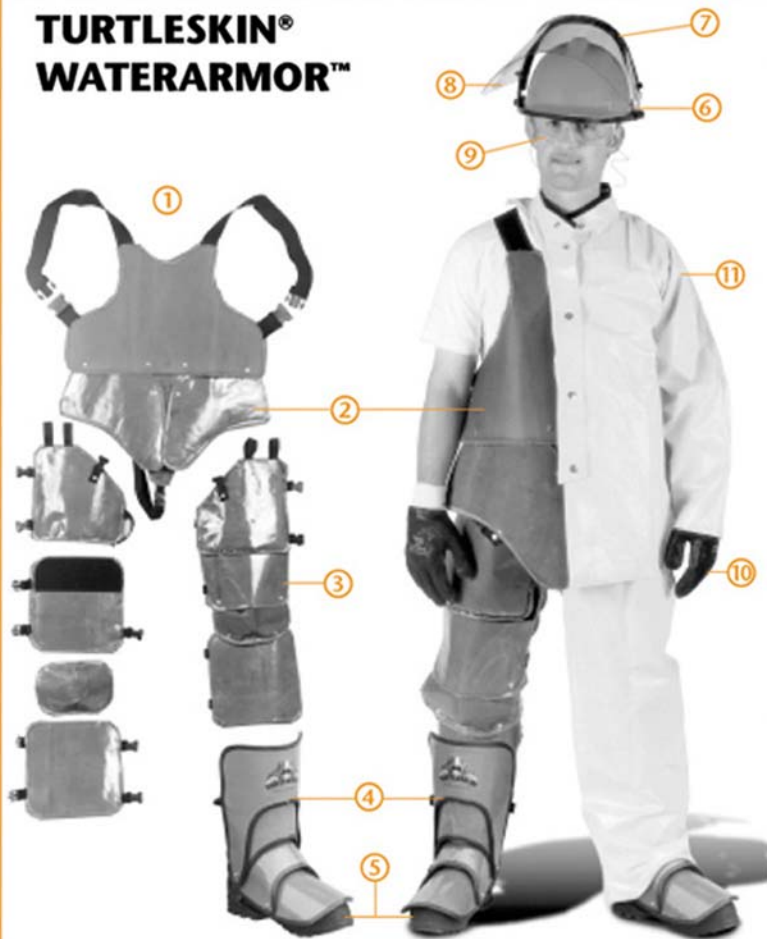
#### 2.1.1 – Operator Safety Equipment

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.



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

| Item | Part Number  | Description        |
|------|--------------|--------------------|
| 10   | <b>6780</b>  | Rubber Gloves      |
| 11   | <b>MX-01</b> | Wet Suit, Small    |
|      | <b>MX-02</b> | Wet Suit, Medium   |
|      | <b>MX-03</b> | Wet Suit, Large    |
|      | <b>MX-04</b> | Wet Suit, X-Large  |
|      | <b>MX-05</b> | 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

## 2.1.2 – Pre-Service Safety Checklist

The Pre-Service Safety Checklist 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. Is the area, including other end of unit being serviced, clean, roped off, and are 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 line 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 condensate and ground lance to 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 is "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 flushed prior to installing nozzle?                                                                                                  |     |    |     |
| 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?                                                                                                                                |     |    |     |

SIGNED \_\_\_\_\_

**NLB Corp.**

29830 Beck Road - Wilson, Michigan 48393-2824  
PH. 248-624-5555

### 2.1.3 – Recommended Safety Procedures Decal

The Recommended Safety Procedures Decal 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.



**NLB Corp.**

29830 Beck Road • Wixom, Michigan 48393-2824  
**PH. 248-624-5555**

## 2.2 – Safety Aspects of High-Pressure Water Cleaning Systems

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

### 2.2.1 – Equipment

**High-Pressure Pump:** The principle 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 cleaning or 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 either be fail-safe, low voltage or protected with an approved ground fault circuit interrupter.



## 2.2.2 – 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.

## 2.2.3 – 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 checklist 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.



## 2.2.4 – Operation 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.



**Never leave the system unattended when pressurized.**

## 2.2.5 – 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 minimal 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 anytime the system is not in use. The system shall be de-pressurized anytime an unauthorized person enters the barricaded area. The system shall be de-pressurized when any replacement or repairs are made to the system.

## 2.3 – Recommended Practices

### 2.3.1 – 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 far 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.

### 2.3.2 – Scope

- The recommended practices are intended to provide guidance on the proper operation of high-pressure water jet cleaning and cutting equipment.
- In this document, the word “shall” indicates a requirement that is to be adopted in order to comply with these recommended practices.
- 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.
- 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 – measure in psi (*bar*), times flow – measure in gallons per minute (*liters per minute*) exceeds 2,000 psi times gpm (560 *bar* times *lpm*).
- 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.

### 2.3.3 – Definition of Terms

**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.

**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).



**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 principles of these recommended practices. Adequate precautions, similar to those of these recommended practices, are required at all pressures.**

**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 1000 psi (69 bar).

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

**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.

**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.

**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 distributed 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.

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

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

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

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

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

#### **2.3.4 – Equipment Definitions and Standards**

**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.
- Product 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.

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

**Automatic Pressure Relief Devices:** These may Take the form of:

- **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.
- **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.
- **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.
- **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.
- **Filter or Strainer:** The water system should be equipped with a filter or strainer to prevent particles from restricting 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 the high-pressure pumps, etc.
- **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. This valve may alternatively be actuated by solenoid or pilot pressure system.



**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.**

- **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.
- **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 a solenoid or pilot pressure mechanism.
- **Solenoid and Electronically Operated Control Dump Systems:** All electrically controlled dump systems should be of a fail safe design. Voltage of an alternating current (AC) or direct current (DC) dump system handled by personnel should not exceed 24 volts.

**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.

**End Fittings and Couplings:** High-pressure hose, end fittings and couplings shall be manufactured to be compatible with the hose and tested as a unit.

**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. The extension shall have a minimum burst strength of at least two and one-half (2.5) times the highest actual operating pressure being used.

**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.

**Water Jet:** A jet stream of water produced from an 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.

- **Straight-Jet:** Concentrates the stream of water over a small area of the work piece by minimizing the spread. A typical application is for cutting or for general cleaning of matter with higher shear and/or bond strength.
- **Fan Jet:** Spreads the stream of water on 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.

**Jetting Hand Manifold and Spray Bars:** These are pieces of equipment into which individual nozzles are fitted.

**Foot Control Valve:** The lance/gun operator's control valve 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, the layout should ensure that the dump line, if used, is restrained from whipping when the valve is released.

**Jetting Gun:** A portable combination of operator's control valve and nozzle 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, or dump 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.

**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 themselves.

**Changeover Valve:** An operator-controlled valve designed to properly direct high-pressure water flow from the pump 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.

### 2.3.5 – Care and Maintenance of Equipment

**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:

- **Drive:** Lubricating oil, water, hydraulic fluid and fluid levels.
- **High-Pressure Pump:** Lubrication oil and gearbox oil levels.
- **Hydraulic Hose Reel:** Lubricating oil and fluid levels.
- **Condition of Guards and Shields:** Wear and/or damage.

**Filters and Strainers:** All water filters should be checked at regular intervals, dependant 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.

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

- Correct pressure rating and size.
- Free from external damage – e.g., exposed or broken wires.
- All end fittings and couplings are in good order and of the correct pressure rating for the unit operating pressure.

**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.

**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 shutdown and the connection repaired or replaced before further operation.

**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.



**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.

**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.

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

**Maintenance Servicing and Repair:** The following operations should only be carried out by competent personnel:

- NLB's servicing requirements.

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

**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., piping wrenches) which can damage equipment, is not recommended, particularly on the crimped portion of a hose fitting.

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

### 2.3.6 – Protective Clothing and Personal Protection

**OSHA Compliance:** All applicable OSHA regulations covering personal protective equipment shall be followed.

**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.

**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. 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 face shield.**

**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.

**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.

**Foot Protection:** All operators should be supplied with waterproof boots with steel or aluminum toe-caps. A metatarsal guard should be used by water jetting lance/gun operators.

**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.

**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.

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

### **2.3.7 – Pre-Operating Procedures**

**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 personnel that will be doing the work and outline potential hazards of the work area, environmental problems, safety standards, and emergency aid procedures.

**Check list:** A check list shall be used to assure that the proper procedures and proper equipment selection are followed.

**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.

**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 whenever possible. Barriers may be of rope, safety tape, barrels, etc., as long as they give an effective warning and are highly visible.

#### **Hook-Up:**

- **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 vertical runs.
- **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.
- **Hose:** All hoses shall be checked for evidence of damage, wear or imperfection. The check shall be made periodically during the operation.
- **Pre-Flushing:** The system shall be completely flushed with sufficient water to remove any contaminants before installing the nozzle.
- **Nozzle:** All orifices shall be checked in all nozzles for any stoppage, damage or imperfections.
- **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.

### 2.3.8 – Procedures

**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.

- **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”**

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

**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.

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

- **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.
- **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.
- **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.
- **Second Operator:** The second operator of the team shall attend the high-pressure 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.
- **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) person. To provide communication if the lance operator is out of sight of the high-pressure water jetting unit operator.
- **Job Rotation:** The team members should rotate their duties during any job to minimize fatigue to the operator holding the lance/gun.
- **Team Leader:** The team leader is responsible for basic equipment checks, the preparation of the working area for safe operation and for obtaining a permit to work where and when required.
- **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.
- **Fitness:** The operator and other team members shall be physically and mentally capable of performing the required operations.

**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).

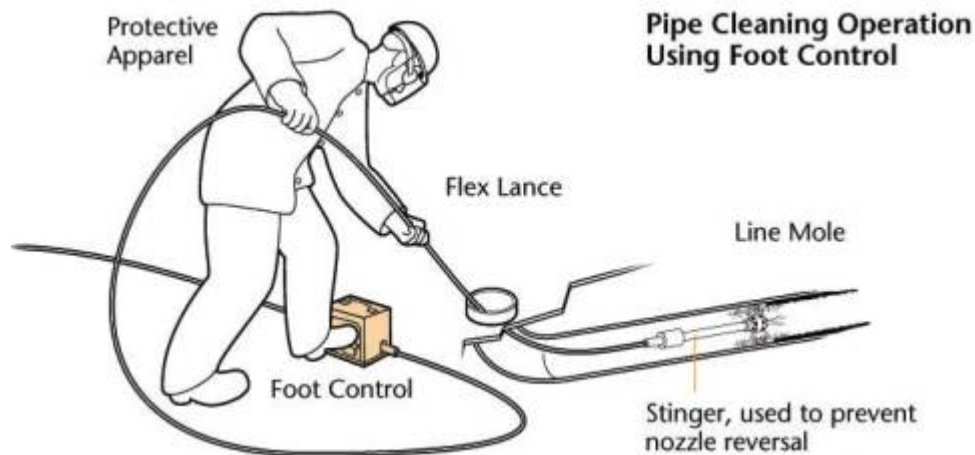
- **Single Operator Guidelines:** All other recommendations pertaining to team operations shall hold.

### **Shotgunning:**

- **Attendance:** The system shall never be left unattended when pressurized.
- **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 of high-pressure water.
- **Target Holding:** Objects to be cleaned shall never be held manually.
- **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.
- **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.
- **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.

### **Moleing or Flex Lancing:**

- **Control:** The operator inserting the nozzle shall have direct control of the dump system.
- **Reversing:** A positive method shall be used to prevent the nozzle from reversing direction inside the item being cleaned, such as using a pipe 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”.



- **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.
- **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.
- **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.
- **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.
- **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.

#### **Rigid Lancing:**

- **Control:** The operator inserting the nozzle shall have direct control of the dump system.
- **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.
- **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.
- **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.

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

### **Proper Operation:**

- **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.
- **Adjustments:** Apart from operation 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.



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

- **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.
- **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.
- **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 operated. To minimize this effect, total hose lengths should be kept as short as possible. Damping devices can be introduced into the system.
- **Thermo-Plastic Hoses:** Thermo-plastic hose should not be used for water jetting unless specifically designed for this purpose.
- **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.



- **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.
- **Hose Protection:** All the hoses should be protected from being run over and crushed by vehicles, fork lift trucks, etc.
- **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 measured in psi



**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.**

### 2.3.9 – Use of Lances and Nozzles

**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.

**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.

**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.

**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.

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

**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 their weight when climbing up or down.

**“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.

**Confined Working:** Before entry into a confined work space for high-pressure water jetting, a certificate of clearance shall be obtained to ensure access is safe.

### 2.3.10 – Operational & Training Requirements

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

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

**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.).

**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.

**System Operation:** The operation of a system shall be explained with potential problems pointed out and proper corrective action.

**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.

**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.

**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.

**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.

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

**General:**

The 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.

**Refresher Training:** Operator training shall be on an annual basis or more frequently, if needed.

**2.3.11 – Permanent Cleaning Areas**

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

**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.

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

**2.3.12 – Freeze Precautions**

**Freeze Precautions:** During the periods where there is a risk of freezing, follow NLB's recommendations or take the following precautions on shutdown:

- Remove the gun or nozzle from the delivery hose
- Pump water from supply tank until level of water is just above the filter.
- Add recommended quantity of anti-freeze into the water tank.
- Place delivery hose into water tank and secure.
- Run the pump until the anti-freeze works through the system.
- Move the selector level to dump or recycle position until; the anti-freeze shows in the water tank.
- If no supply tank is fitted, follow NLB's recommendations.



**If a high-pressure pump or hose appears frozen, on no account shall the pump be engaged (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 including the end of the lance. Make sure that the lance does not have a restriction or nozzle during this process.**

### **2.3.13 – Accidents**

**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.

**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 (800) 227-7652 for a replacement.

**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.

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

### 2.3.14 – Responsibility

Purpose: These recommended practices are provided to assist persons unfamiliar with the operation 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 familiarize themselves 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.....**

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.).

**DO.....**

Contact site engineer, obtain necessary permits and note special precautions.

Erect barriers, rope off the clear area.  
Erect warning signs.

Ensure adequate water supply.

Check fluid levels on engine, gearbox and pump (lubrication oil, fuel and water).

Lay out equipment and visually inspect for damage (hoses, connections, etc.).

Assemble equipment, checking all joints.

Ensure that filters are clean.

Fully prime equipment and bleed where necessary.

Fit gun or lances and/or control valves.  
Visually check that correct size and type of nozzle is fitted for the application.

Increase pressure slowly until operating conditions are reached.

Re-check hose couplings and joints for leaks.

Rectify all leaks, ensuring that the unit is shut down and line pressure is released before making adjustments.

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 NOT.....**

**DO NOT** commence work on site without necessary permission.

**DO NOT** commence any jetting operation until warning signs are on show and area is roped off.

**DO NOT** operate without adequate personal protection for eyes, head, ears, hands, feet, and body.

**DO NOT** run any equipment with leakage whatsoever, without rectifying.

**DO NOT** attempt to tighten any pressure joint while equipment is under pressure.

**DO NOT** by-pass safety cut-outs.  
*DO* check reasons for malfunctions (low water, blocked filters, low oil level, etc.).

**DO NOT** operate with guns and control valves not functioning correctly (leaking or failing to shut off).

**DO NOT** operate guns or control valves with the operating lever tied back, wedged or locked in the "ON" position.

**DO NOT** operate with badly worn or undersize nozzles.

**DO NOT** continue to operate if any unauthorized personnel enter the operating area.

**DO NOT** operate equipment at power levels which can produce a reaction force greater than the lance/gun operator can comfortably absorb.

**DO NOT** leave high pressure water jetting unit running unattended.

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## SECTION 3

### OPERATION

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| A. DS8800A ULTRA HIGH PRESSURE<br>ROTATING NOZZLE SWIVEL | 3-3                |
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| C. OPERATION INSTRUCTIONS                                | 3-8                |

## I. OPERATION OF NCG8400A-3/3L ROTATING LANCES

ALL THE VARIOUS METHODS OF HIGH PRESSURE WATER CLEANING OPERATIONS REQUIRE THAT TWO OPERATORS ARE ON THE JOB AT ALL TIMES. IT IS PARTICULARLY IMPORTANT WHEN OPERATING THE LANCE BECAUSE THE REACTION FORCE FROM THE LANCE CAN BE TIRING AFTER A WHILE. BECAUSE OF THIS, IT IS RECOMMENDED THAT THE OPERATORS TAKE TURNS QUITE OFTEN TO ALLOW SUFFICIENT REST AND TO AVOID FATIGUE. THE OPERATOR SHOULD BE FAMILIAR WITH THE LANCE AND ITS OPERATING PARTS, REFER TO FIGURE 3-1.

**NOTE: FIGURE 3-1 MAY NOT LOOK EXACTLY LIKE YOUR UNIT, IT IS FOR COMPONENT IDENTIFICATION PURPOSES ONLY.**

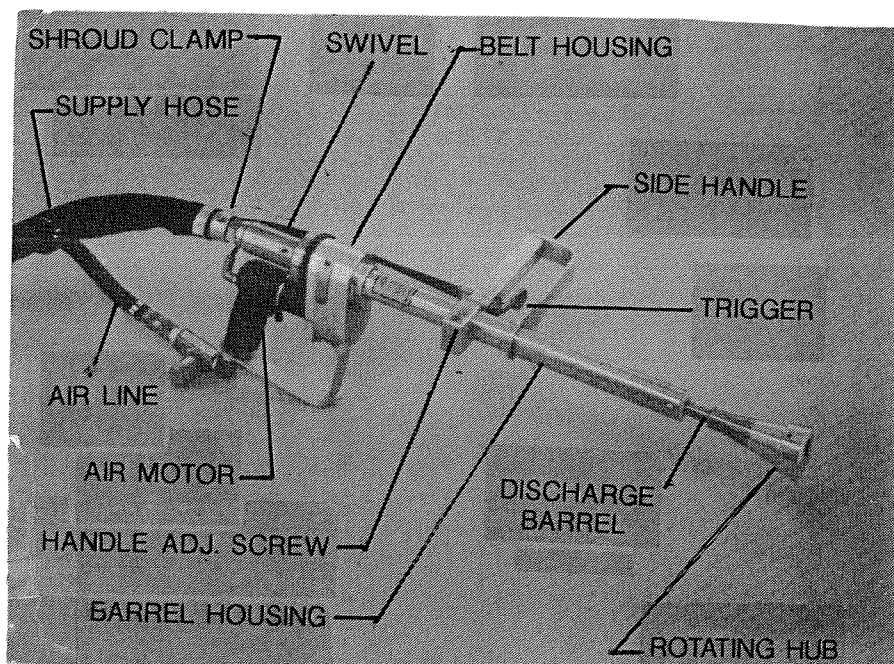


FIGURE 3-1

**NOTE:**

THE LANCE IS SHOWN WITH THE OPTIONAL 35 FOOT (4.2m) LONG HOSE ASSEMBLY (DM14150). WE RECOMMEND THAT THIS LENGTH NOT BE EXCEEDED AS IT INCREASES THE DUMP VALVE REACTION TIME RESULTING IN A DELAYED SHUT-OFF.

**A. DS8800A ULTRA HIGH PRESSURE ROTATING NOZZLE**  
**SWIVEL**

**OPERATION AND SWIVEL OPERATION**

THE **NLB** DS8800A SWIVEL IS DESIGNED TO OPERATE AT PRESSURES FROM 30,000 PSI (2,068.9 bar) TO 40,000 PSI (2,857.1 bar) AND UP TO 6 GPM (22.7 lpm).

IT IS DESIGNED TO BE AN INTEGRAL PART OF THE ROTATING LANCE USED WITH A DUMP TYPE VALVE AND A PLUNGER TYPE POWER PUMP.

THE SWIVEL IS DRIVEN BY AN AIR MOTOR THROUGH A TIMING BELT. A HOUSING IS PROVIDED TO PROTECT THE TIMING BELT.

**CAUTION:**

**THE NLB DS8800A SWIVEL SHOULD NEVER BE ROTATED WITHOUT HIGH PRESSURE WATER FLOWING THROUGH THE SWIVEL.**

THE AIR MOTOR IS DESIGNED TO RUN AT UP TO A MAXIMUM OF 3,000 RPM.

DURING NORMAL OPERATION, THERE SHOULD BE NO WATER DRIPPING FROM THE WEEP HOLES IN THE SWIVEL HOUSING. AS THE HIGH PRESSURE SEAL STARTS TO WEAR, DRIPPING WILL START OCCURRING. WHEN THE DROPS REACH A LEVEL OF 10 DROPS PER MINUTE, THE HIGH PRESSURE SEAL SHOULD BE REPLACED.

IF THE SWIVEL IS OPERATED BEYOND THE ABOVE SUGGESTED DRIP EMISSION FREQUENCY, THE SEAL COULD COMPLETELY FAIL AND CAUSE WATER TO ENTER THE BEARING HOUSING. THIS WILL REQUIRE A COMPLETE TEARDOWN OF THE SWIVEL. IT IS MUCH EASIER TO SIMPLY CHANGE THE SEAL AT THE SUGGESTED DRIP FREQUENCY (I.E., 10 DROPS/MINUTE) THAN TO PROLONG THE CHANGE AND HAVE A VERY TIME CONSUMING COMPLETE TEAR DOWN TO CONTEND WITH.

THE NOZZLES ARE SAPPHIRE ORIFICE ASSEMBLIES, AND ARE HELD IN PLACE WITH A GLAND WITH AN INTERNAL HEX. MANY ORIFICE SIZES ARE AVAILABLE, FROM .010 (.25 mm) TO .038 (.96 mm) IN .001 (.02 mm) INCREMENTS. SIZING IS DETERMINED BY THE JOB REQUIREMENTS. BOTH NOZZLE ORIFICES MUST BE THE SAME SIZE TO MAINTAIN BALANCED AND SMOOTH ROTATION.

### **BI-MODE VALVE ASSEMBLY**

THE VALVE ASSEMBLY CONSISTS OF A FRAME ON WHICH THE FOLLOWING ITEMS ARE MOUNTED; AIR FILTER, REGULATOR AND LUBRICATOR, AIR VALVE, AIR ACTUATOR, DUMP ACTUATOR, AND WATER VALVE.

PRIOR TO STARTING UP THE SYSTEM THE VALVE ASSEMBLY SHOULD BE VISUALLY INSPECTED FOR OBVIOUSLY DAMAGED COMPONENTS, LOOSE AIR, WATER FITTINGS, OR MOUNTING BOLTS, ETC.

THE AIR LUBRICATOR SHOULD BE CHECKED FOR PROPER OIL LEVEL AND THE REGULATOR SET BETWEEN 80 (5.5 bar) AND 90 PSI (6.2 bar). THE INCOMING AND OUTGOING AIR AND WATER LINES SHOULD ALSO BE CHECKED FOR ANY LOOSE FITTINGS.

### **C. OPERATION INSTRUCTIONS**

AFTER THE HIGH PRESSURE HOSES AND LANCE HAVE BEEN PROPERLY CONNECTED AND ALL PRE-OPERATING AND SAFETY CHECKS HAVE BEEN COMPLETED, THE OPERATOR SHOULD GRASP THE REAR GRIP FIRMLY IN ONE HAND AND THE FORWARD GRIP IN THE OTHER AS SHOWN IN FIGURE 3-3. THE OPERATOR SHOULD HAVE FIRM FOOTING AND BE PREPARED TO REACT TO THE FORCE FROM THE LANCE. THE LANCE SHOULD ALWAYS BE POINTED AT THE WORK AREA, AND HE SHOULD MAKE SURE THAT THERE ARE NO OTHER PERSONNEL IN THE IMMEDIATE WORK AREA.



FIGURE 3-3

#### **PROCEDURE FOR DIESEL UNITS**

ON THE NLB DIESEL POWERED UNITS WITH THROTTLE CONTROL WHEN THE OPERATOR ACTUATES THE OPERATING HANDLE, THE WATER PRESSURE IS INCREASED AND THE ENGINE SPEED INCREASED TO THE PRESET RPM, WHEN THE OPERATING HANDLE IS RELEASED, THE WATER PRESSURE DROPS TO A LOW LEVEL AND THE RPM ON THE ENGINE IS REDUCED TO AN IDLE CONDITION.

1. MAKE SURE THAT THE THROTTLE CONTROL IS ADJUSTED TO AN IDLE POSITION BEFORE OPERATION.

2. THE CLUTCH IS THEN ENGAGED ON THE HIGH PRESSURE PUMP UNIT. THE PUMP IS NOW OPERATING AT IDLE SPEED AND WATER IS BEING DISCHARGED FROM THE DUMP PORT OF THE VALVE.
3. THE OPERATOR SHOULD PULL ON THE TRIGGERS OF BOTH THE FORWARD AND REAR GRIPS.
4. THE OPERATOR AT THE PUMP SHOULD NOW ADJUST THE THROTTLE CONTROL TO INCREASE THE ENGINE RPM TO CAUSE THE PRESSURE TO INCREASE TO THE PROPER SETTING WHICH WILL ALLOW THE LANCE OPERATOR TO CLEAN MOST EFFICIENTLY. IT IS IMPORTANT TO ADJUST THE PRESSURE HIGH ENOUGH TO DO A GOOD CLEANING JOB, YET NOT TOO HIGH. THE PRESSURE IS INCREASED BY TURNING THE ADJUSTMENT HANDLE IN A COUNTER-CLOCKWISE DIRECTION.
5. WHEN THE OPERATOR WANTS TO STOP THE CLEANING OPERATION, HE SIMPLY RELEASES THE TRIGGERS. THIS ALLOWS THE WATER TO BE DISCHARGED FROM THE DUMP PORT OF THE VALVE, AND CAUSES THE PRESSURE TO DECREASE, SIMULTANEOUSLY, THE ENGINE SPEED IS REDUCED TO IDLE.
6. WHEN THE OPERATOR AGAIN ACTUATES THE TRIGGERS WATER PRESSURE IS INCREASED AND THE ENGINE SPEED INCREASES TO THE PRESET RPM.

|                                                                                                                                                                                                                                             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>NOTE:</b> WHEN THE SYSTEM IS SET UP FOR MULTIPLE LANCE OPERATION THE DUMP PORT IS SIZED TO MAINTAIN OPERATING PRESSURE WHILE DUMPING. AS THE SYSTEM REMAINS AT WORKING PRESSURE WHEN ONE LANCE IS IDLE THE ENGINE SPEED WILL NOT CHANGE. |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## **B. PROCEDURE FOR THE ELECTRIC UNITS**

ON THE ELECTRIC POWER UNITS WHEN THE OPERATOR ACTUATES THE TRIGGERS THE WATER PRESSURE IS INCREASED TO THE PRESSURE THAT HAS BEEN PRESET ON THE BY-PASS VALVE.

1. WHEN FIRST STARTING THE CLEANING SYSTEM, MAKE SURE THE BY-PASS VALVE IS ADJUSTED TO FULL BY-PASS SETTING. (OPENED IN A COUNTER CLOCKWISE DIRECTION.)

2. ACTUATE THE DISCONNECT SWITCH LEVER ON THE MOTOR STARTER TO "ON" POSITION.
3. PUSH THE "HIGH PRESSURE PUMP" START BUTTON - AFTER THE PUMP STARTS, ALLOW IT TO RUN FOR APPROXIMATELY 30 SECONDS BEFORE OPERATING THE LANCE. THE PUMP IS NOW DELIVERING WATER TO THE LANCE UNDER LOW PRESSURE.
4. TO ADJUST TO THE PROPER PRESSURE NEEDED, HAVE THE OPERATOR PULL THE TRIGGERS TO THE OPERATE POSITION. THEN HAVE THE SECOND OPERATOR ADJUST THE PRESSURE WITH THE BY-PASS VALVE TO THE DESIRED PRESSURE NEEDED TO PROPERLY PERFORM THE CLEANING TASK.
5. IT IS IMPORTANT TO ADJUST THE PRESSURE HIGH ENOUGH TO DO A GOOD CLEANING JOB, YET NOT TOO HIGH. THE PRESSURE IS INCREASED BY TURNING THE ADJUSTMENT NUT ON THE BY-PASS VALVE IN A CLOCKWISE DIRECTION. AFTER THE PRESSURE IS ADJUSTED PROPERLY, THE LOCK NUT SHOULD BE TIGHTENED SO THAT THE ADJUSTMENT WILL NOT BE DISTURBED BY VIBRATION.
6. WHEN THE OPERATOR WANTS TO STOP THE CLEANING OPERATION, HE SIMPLY RELEASES THE TRIGGERS. THIS DIRECTS ALL THE WATER TO THE DUMP PORT AND STOPS WATER FLOW TO THE LANCE.

WHEN CLEANING, THE OPERATOR SHOULD HOLD THE NOZZLE ABOUT 2 FEET (60.9 cm) AWAY FROM THE SURFACE TO BE CLEANED AND AT AN ANGLE OF APPROXIMATELY 60°. THE NOZZLE SHOULD THEN BE SLOWLY MOVED CLOSER TO THE JOB UNTIL THE DESIRED CLEANING IS ACHIEVED.

DURING AND AFTER EACH USE OF THE LANCE, IT SHOULD BE INSPECTED FOR LEAKS AND ACCUMULATED DIRT AND PRODUCT BUILD UP.

### **FORWARD GRIP ADJUSTMENT**

THE FORWARD GRIPING POSITION MAY BE LENGTHENED OR SHORTENED BY UNLOOSENING THE 1/4" SOCKET HEAD CAP SCREW AS SHOWN IN FIGURE 3-1 WITH A 3/16" ALLEN WRENCH. THIS WILL ALLOW THE FORWARD GRIP TO BE MOVED TO A COMFORTABLE POSITION FOR A PARTICULAR OPERATOR. AFTER THE DESIRED POSITION HAS BEEN ESTABLISHED, TIGHTEN THE SCREW WITH AN ALLEN WRENCH TO LOCK IT SECURELY IN THE NEW POSITION.

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## SECTION 4

### TROUBLE - SHOOTING

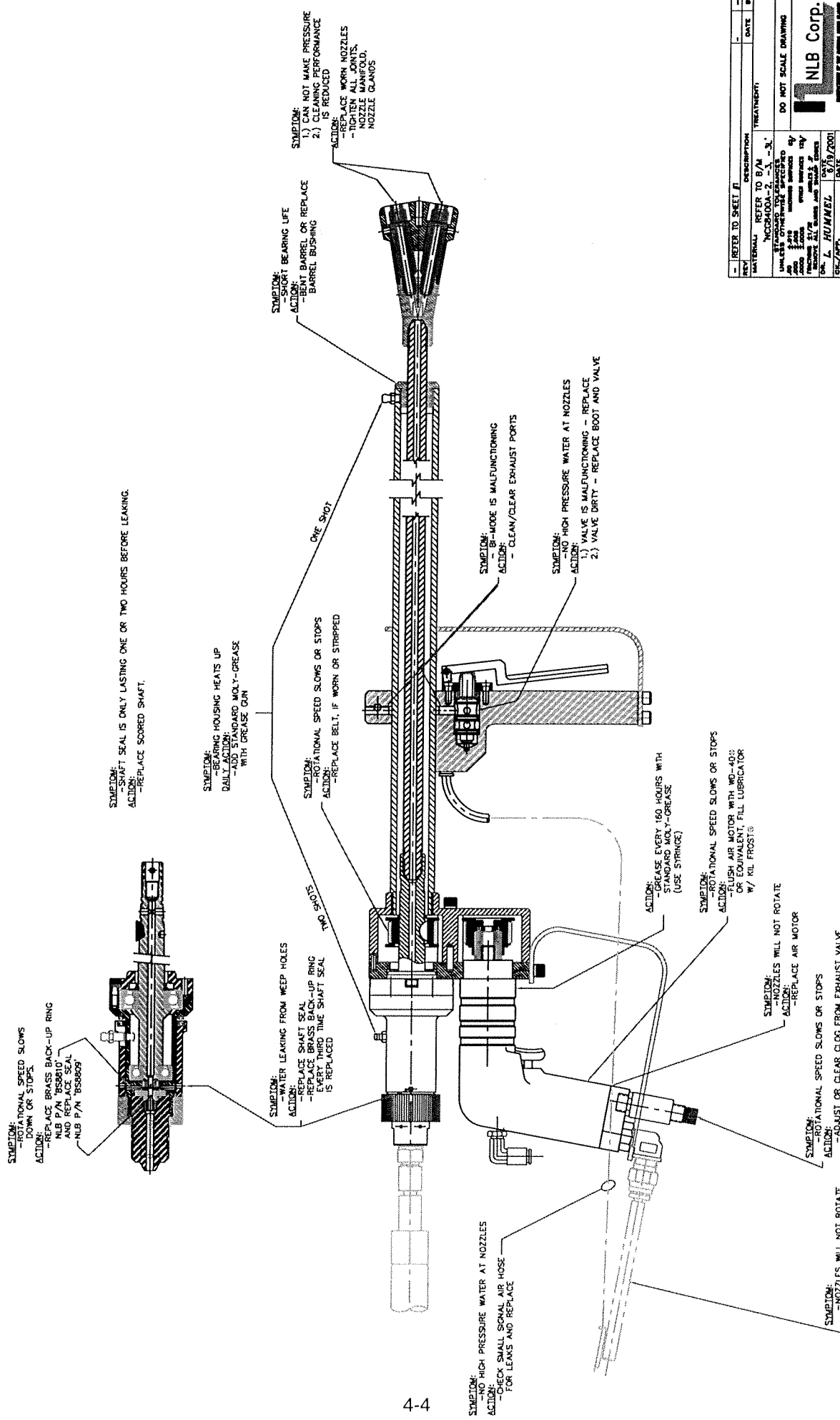
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| I. TROUBLE-SHOOTING GUIDE | 4-2                |



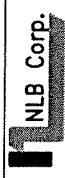
## **I. TROUBLE-SHOOTING GUIDE**

### **MODEL NCG8400A-3/3L ROTATING LANCES & DS8800A ROTATING SEAL**

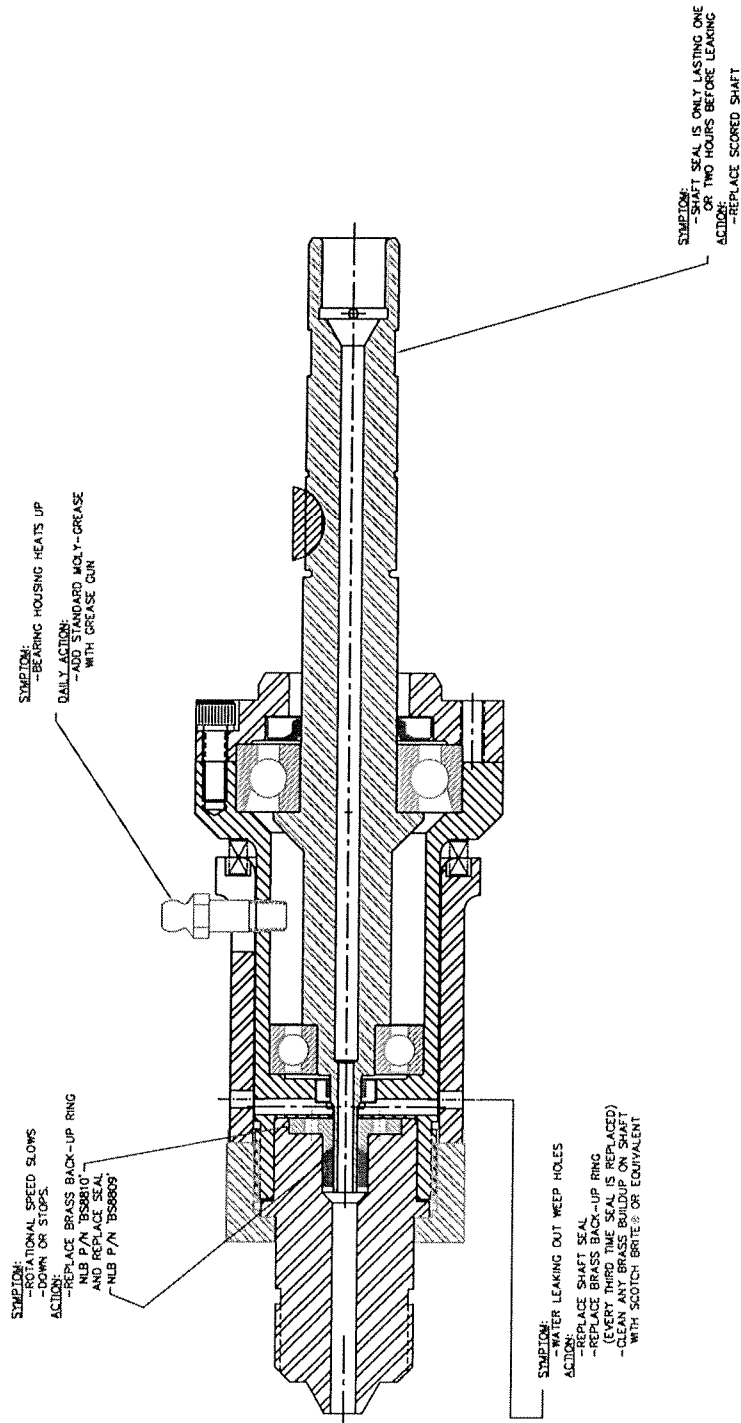
| <b><u>SYMPTOM</u></b>                                            | <b><u>POSSIBLE PROBLEM</u></b>                             | <b><u>ACTION</u></b>                                                          |
|------------------------------------------------------------------|------------------------------------------------------------|-------------------------------------------------------------------------------|
| ROTATIONAL SPEED<br>SLOWS DOWN OR STOPS                          | TOO MUCH MOISTURE IN<br>AIR CAUSES EXHAUST<br>TO FREEZE UP | USE AIR TOOL OIL<br>KILFROST® OR EQUIVALENT.                                  |
|                                                                  | NO LUBE OIL IN AIR                                         | CHECK LUBRICATOR<br>RESERVOIR, ADD AIR TOOL OIL<br>KILFROST® OR EQUIVALENT.   |
|                                                                  | NOT ENOUGH LUBE OIL IN AIR                                 | ADJUST FLOW RATE ON<br>LUBRICATOR.                                            |
|                                                                  | AIR MOTOR GUMMED UP OR<br>VANES SWOLLEN                    | FLUSH WITH WD40® OR<br>EQUIVALENT.                                            |
|                                                                  | DYNAMIC BACK-UP RING<br>RUBBING ON SHAFT                   | REPLACE RING.                                                                 |
| CLEANING PERFORMANCE<br>IS REDUCED                               | WORN OR BROKEN NOZZLE<br>ORIFICES                          | REMOVE AND INSPECT.<br>REPLACE WITH SAME<br>SIZE ORIFICE.                     |
|                                                                  | LEAKING CONNECTIONS                                        | TIGHTEN ALL JOINTS,<br>NOZZLE MANIFOLD,<br>NOZZLE GLANDS.                     |
| BEARING HOUSING HEATS                                            | STANDARD MOLY-GREASE<br>IN BEARING HOUSING                 | ADD GREASE, IF PROBLEM<br>PERSISTS CHANGE BEARING.                            |
| WATER LEAKS OUT OF<br>WEEP HOLES                                 | HIGH PRESSURE SEALS<br>WORN                                | CHANGE SEALS.                                                                 |
|                                                                  | WORN SHAFT                                                 | CHANGE SHAFT AND<br>DYNAMIC BACK-UP RING.                                     |
| NOZZLES WILL NOT ROTATE                                          | INSUFFICIENT AIR SUPPLY                                    | CHECK AIR SOURCE AND<br>ADJUST REGULATOR (MIN<br>OF 80 PSI [5.5 BAR] SUPPLY). |
|                                                                  | CONTROL VALVE NOT<br>WORKING                               | CHECK/ADJUST OR<br>REPLACE VALVE.                                             |
|                                                                  | AIR MOTOR FAILURE                                          | REPLACE AIR MOTOR,<br>CHECK LUBRICATOR,<br>ADJUST FLOW RATE.                  |
|                                                                  | SEAL COMPONENTS BINDING                                    | DISASSEMBLE/CHECK SEAL.                                                       |
| SHAFT SEAL IS ONLY<br>LASTING ONE OR TWO<br>HOURS BEFORE LEAKING | SHAFT IS SCORED                                            | REPLACE SHAFT.                                                                |



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| 1   |      |    | REFER TO SHEET #1 |
| 2   |      |    | REFER TO B/M      |
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| 100 |      |    | REFER TO B/M      |



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|----------------------|
| DO NOT SCALE DRAWING |
| DATE 10/1/2001       |
| SCALE 3/4"=1"        |
| TITLE 36K SPIN GUN   |
| REV. DA12700         |

[illegible]

| MODEL / B.O.M. | SHEAF ②  | HOUSING SEAL ③ |
|----------------|----------|----------------|
| DS9800A        | DS102666 | CS5807         |
| DS9800A-1      | DS10648  | CS5807         |
| DS9800A-2      | DS10648  | CS10596        |
| DS9800A-3      | DS12687  | CS10596        |
| DS9800A-4      | DM13284  | CS5807         |
| DS9800A-5      | DM13284  | CM13783        |

APPROXIMATE WEIGHT: 3 LBS. 10 OZ

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## SECTION 5

### MAINTENANCE

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## **I. Service & Repair**

THE MODEL NCG8400A-3/3L ROTATING LANCES AND NLB8466-1 BI-MODE VALVE ASSEMBLY HAVE BEEN SPECIFICALLY DESIGNED TO PROVIDE RELIABLE OPERATION WHEN USED PROPERLY. NO ALTERATIONS OR MODIFICATIONS SHOULD BE MADE UNLESS SPECIFICALLY AUTHORIZED BY **NLB CORPORATION**. BECAUSE OF THE CLOSE TOLERANCES REQUIRED FOR HIGH PRESSURE WATER PERFORMANCE, ONLY FACTORY REPLACEMENT PARTS SHOULD BE USED WHEN REPAIRING THE LANCE.

IN THE FOLLOWING REPAIR PROCEDURES, ALL PARTS ARE IDENTIFIED WITH AN ITEM NUMBER IN PARENTHESIS (X). REFER TO THE PARTS BILL OF MATERIAL AND PARTS BREAKDOWN FOR THE ACTUAL PART NUMBER AND LOCATION WITHIN THE ASSEMBLY, LOCATED IN SECTION 7.

### **CAUTION:**

**BEFORE PERFORMING ANY SERVICE WORK, DISCONNECT THE  
HIGH PRESSURE SUPPLY HOSE.**

### **NOTE:**

FOR INFORMATION ON THE MAINTENANCE OF THE AIR MOTOR REFER TO THE MANUFACTURERS' LITERATURE SECTION.

#### **1. DS8800A HIGH PRESSURE SEAL**

##### **CAUTION:**

IT IS NOT NECESSARY TO DISCONNECT THE WATER LINE TO CHANGE THE SEAL, HOWEVER, FOR DIESEL ENGINE DRIVEN HIGH PRESSURE WATER JETTING UNIT, BEFORE STARTING DISASSEMBLY THE LINE MUST BE DEPRESSURIZED, THE HIGH PRESSURE PUMP SHUT DOWN AND THE IGNITION KEY REMOVED FROM THE ENGINE. FOR AN ELECTRIC MOTOR DRIVEN HIGH PRESSURE WATER JETTING UNIT, THE HIGH PRESSURE PUMP MUST BE SHUTDOWN AND DISCONNECT SWITCH TURNED TO THE "OFF" POSITION.

IF THE FEMALE SWIVEL HOSE, (#1), ON THE HOSE ASSEMBLY (DM14150) HAS BEEN LOOSENED TO DISCONNECT THE WATER LINE, MAKE SURE THE LINE BETWEEN THE LANCE AND THE BI-MODE VALVE IS NOT KINKED WHEN THE LANCE IS BEING HELD IN THE OPERATING POSITION.

BEFORE PRESSURIZING SYSTEM BE SURE THAT KEVLAR ® SHROUD TUBE IS COVERING THE WEEP HOLES IN THE FITTINGS AND THE SCREWS ARE TIGHTENED.

- A. SET THE LANCE ON A WORKBENCH AND USING A PAIR OF CHANNEL LOCKS, IF NECESSARY, UNSCREW RETAINER NUT, (#15), FROM THE SWIVEL BODY, (#1), AS SHOWN IN FIGURE 5-9.
- B. REMOVE THE SEAL HOUSING, (#3). NORMALLY THE SEAL, (#5), AND BACKUP RING, (#6), WILL COME OUT AS A UNIT FROM THE SWIVEL BODY (FIGURE 5-10).
- C. REMOVE THE BACKUP RING FROM THE SEAL HOUSING USING THE TAPPED HOLES IN THE RING FOR PULLING, IF NECESSARY.
- D. TURN THE SEAL HOUSING, (#3) UPSIDE DOWN, IF THE SEAL DOES NOT DROP OUT REACH THROUGH FROM THE OTHER SIDE AND PUSH THE SHAFT SEAL FROM THE SEAL HOUSING.
- E. INSPECT THE SEALING SURFACE OF THE SWIVEL SHAFT, (#2) FOR ANY SCRATCHES OR MARKS, SEE FIGURE 5-11. IF THERE ARE ANY MARKS OR IF SEAL LIFE IS NOT AS EXPECTED THE SWIVEL SHAFT, (#2) SHOULD BE POLISHED OR REPLACED.
- F. THE SWIVEL SHAFT, (#2) CAN BE POLISHED BY USING STEELWOOL OR CROCUS CLOTH WHILE SPINNING THE SHAFT. IF MARKS ARE NOT REMOVED BY THIS METHOD SEE SHAFT REPLACEMENT SECTION.
- G. IF THE SWIVEL SHAFT, (#2) IS IN GOOD CONDITION, A NEW SEAL MAY BE INSTALLED. APPLY SMALL AMOUNT OF GREASE TO THE SEAL AND INSTALL IN HOUSING. SMEAR ON SOME GREASE TO THE BACKUP RING AND INSTALL IN HOUSING. SPREAD GREASE ONTO THE BACKUP RING AND INSTALL IN HOUSING. RUB SOME GREASE TO THE BACKUP RING, (#6) AND INSTALL IN THE SEAL HOUSING, (#3).
- H. INSTALL THE SEAL HOUSING, (#3) BY SLIDING INTO THE SWIVEL BODY, (#1) AND OVER THE SWIVEL SHAFT, (#2).
- I. APPLY ANTI-SEIZE COMPOUND ON THE THREADS OF THE SWIVEL BODY, (#1). CAREFULLY TIGHTEN THE RETAINER NUT, (#15) ONTO THE SWIVEL BODY, (#1).

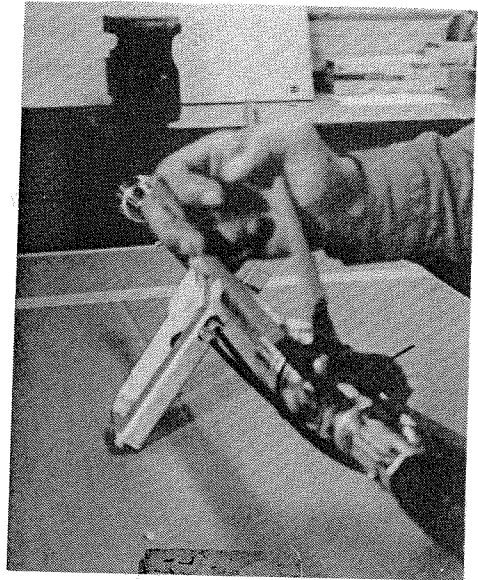


FIGURE 5-9

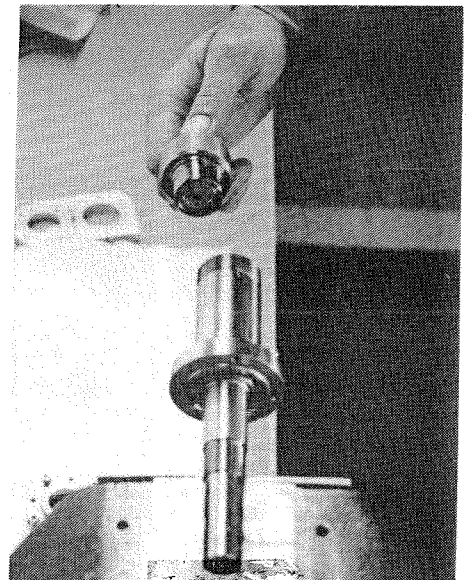


FIGURE 5-10

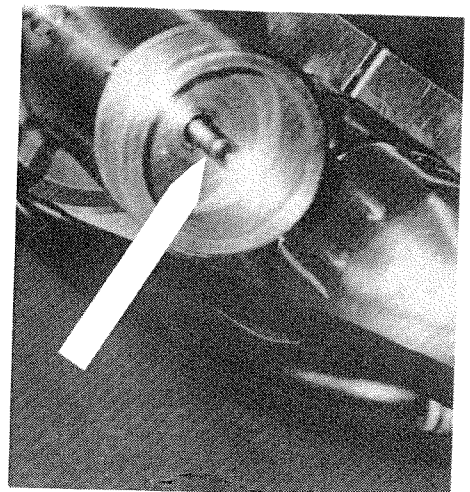


FIGURE 5-11

- J. PULL BACK THE ANTI-ROTATION SLEEVE, (#17) AND TIGHTEN RETAINER NUT, (#15) BY HAND UNTIL THE NUT CANNOT BE TIGHTENED FURTHER. THE RETAINER NUT, (#15) MUST BE FULLY ENGAGED ON THE THREADS OF THE SWIVEL BODY, (#1). RELEASE THE SPRING LOADED ANTI-ROTATION SLEEVE, (#17) SO THAT THE SLOTS ENGAGE WITH THOSE ON THE RETAINER NUT, (#15). IF THE SLOTS DO NOT LINE UP, LOOSEN THE RETAINER NUT, (#15) ONLY ENOUGH TO ENGAGE THE NEXT SLOT. VERIFY THAT THE RETAINER NUT, (#15) IS FULLY THREADED ONTO SWIVEL BODY, (#1) BY CHECKING THAT LITTLE OR NO THREADS ARE VISIBLE, REFER TO FIGURE 5-12.

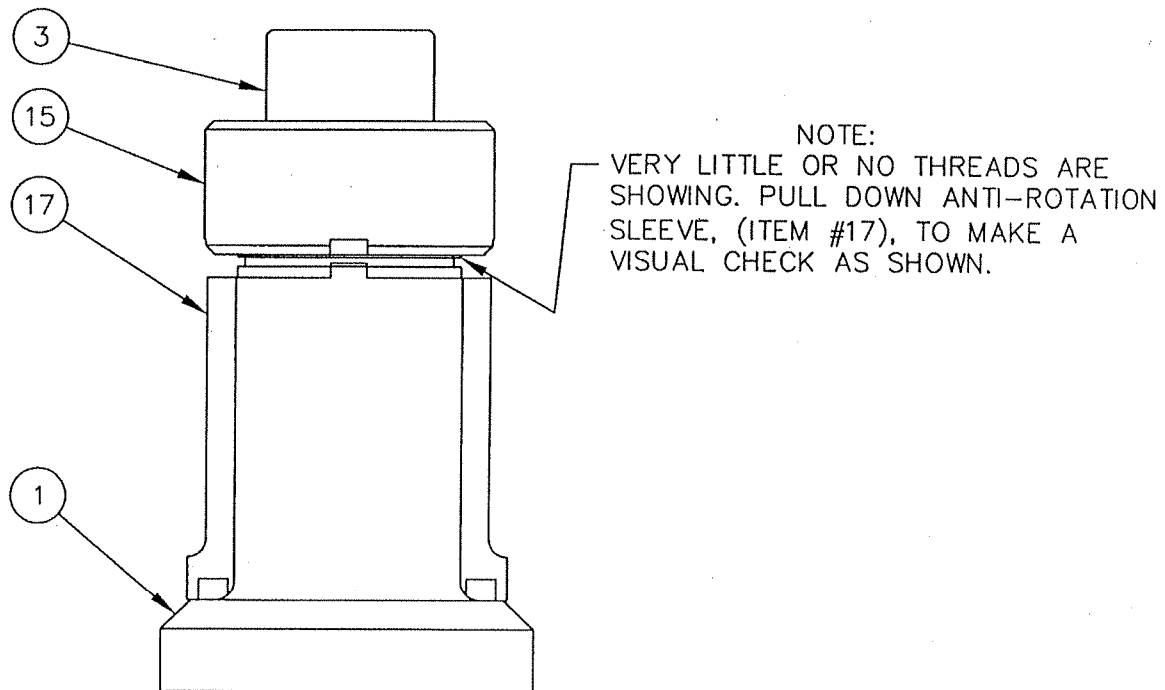


FIGURE 5-12

**WARNING:**

IF FOR SOME REASON THE RETAINER NUT, (#15) IS NOT THREADED FULLY ONTO SWIVEL BODY, (#1) – STOP! DISASSEMBLE AND FIND THE PROBLEM. NEVER OPERATE THE DEVICE UNLESS THE RETAINER NUT, (#15) IS PROPERLY INSTALLED.

## 2. REPLACEMENT OF SEAL BACK-UP RING.

**NOTE:** INDICATION OF WORN BACK-UP RING WILL BE THE EXTRUSION OF THE SEAL OUT OF THE WEEP HOLES IN THE SWIVEL BODY.

- A. FOLLOW DIRECTIONS FOR REPLACEMENT OF HIGH PRESSURE SEAL AND INSTALL A NEW BACK-UP RING.

## 3. REPLACING ROTATING LANCE DRIVE BELT

- A. DISCONNECT AIR TUBING FROM THE FITTINGS.
- B. STAND THE LANCE UPRIGHT AND CLAMP IN A VISE AS SHOWN IN FIGURE 5-13. USING THE SIDE HANDLE, ITEM (#27), UNSCREW THE DISCHARGE BARREL HOUSING, (#18).
- C. RAISE THE DISCHARGE BARREL, (#18) HOUSING TO EXPOSE THE FLAT ON THE SWIVEL SHAFT. WITH ONE WRENCH ON THE SWIVEL SHAFT AND ONE ON THE ROTATING HUB, SEE FIGURE 5-14, UNSCREW THE DISCHARGE BARREL, AND REMOVE THE DISCHARGE BARREL HOUSING, NOZZLE HUB AND SIDE HANDLE AS A UNIT (SEE FIGURE 5-15).
- D. REMOVE SCREWS, (ITEM #30), AND BELT DRIVE COVER, (ITEM #3). SEE FIGURE 5-16.
- E. LOOSEN SCREW, (ITEM #8), SO THAT THE AIR MOTOR, (#14) IS FREE ENOUGH TO PERMIT REMOVAL OF THE ENDLESS TIMING BELT, (#13) SEE FIGURE 5-17.
- F. REMOVE ENDLESS TIMING BELT, (#13) REPLACE WITH NEW BELT AND REASSEMBLE BY REVERSING DIRECTIONS FOR DISASSEMBLY.

## 4. REMOVING OR REPLACING AIR MOTOR (REFER TO EXPLODED DRAWING IN PARTS SECTION FOR PART NUMBERS)

FOLLOW DIRECTIONS A THRU F IN 3. **REPLACING ROTATING LANCE DRIVE BELT** AND CONTINUE WITH THE FOLLOWING STEPS.

- G. REMOVE AIR MOTOR, (ITEM #14), FROM PLATE (ITEM # 2).
- H. REMOVE AIR FITTING, (ITEM #38), AND STREET ELBOW (ITEM #42), AND FLOW CONTROL VALVE (ITEM #36), FROM THE AIR MOTOR, (ITEM #14).

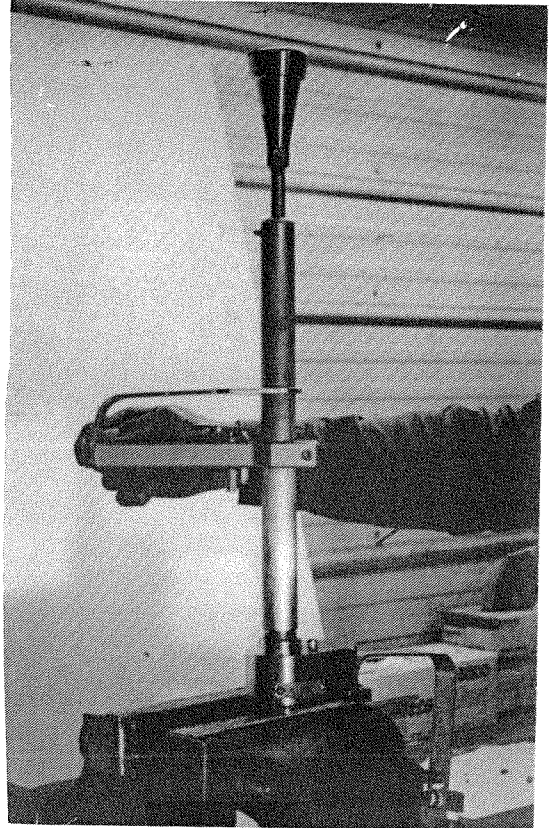


FIGURE 5-13

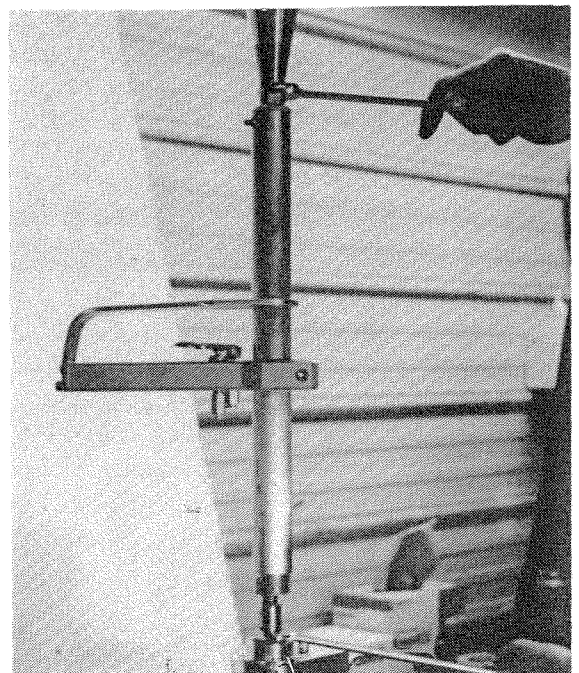


FIGURE 5-14



- I. REMOVE SCREWS, (ITEM #48), AND DRIVER SPROCKET, (ITEM #12).
- J. THE AIR MOTOR, (#14) CAN NOW BE REPLACED OR REPAIRED. FOR REPAIR REFER TO INGERSOLL RAND OPERATION AND MAINTENANCE INFORMATION LOCATED IN THE BACK OF THIS MANUAL.
- K. TO REASSEMBLE, REVERSE DIRECTIONS FOR DISASSEMBLY.

5. **SWIVEL SHAFT REPLACEMENT**  
**NUMBERS REFERRED TO IN A THRU H BELOW ARE FROM THE EXPLODED DRAWING OF THE LANCE IN THE PARTS SECTION.**

- A. DISCONNECT AIR LINES FROM THE TRIGGER, (ITEM #33), BY PUSHING LINE INTO THE FITTING WHILE PULLING ON THE FLANGE OF THE FITTING. WHEN THE FLANGE EXTENDS THE LINE CAN BE PULLED OUT OF THE FITTING.
- B. REMOVE THE ROTATING NOZZLE HUB, (ITEM #20), (THE DISCHARGE BARREL MAY COME OUT WITH THE HUB).
- C. USING THE HANDLE, (ITEM #27), UNSCREW AND RAISE THE BARREL HOUSING TO EXPOSE THE FLATS ON THE DISCHARGE BARREL JUST ABOVE THE BELT COVER.
- D. HOLDING THE SWIVEL SHAFT ON THE FLATS UNSCREW THE DISCHARGE BARREL AS SHOWN IN FIGURE 5-14 AND REMOVE THE DISCHARGE BARREL, BARREL HOUSING, SIDE HANDLE AND NOZZLE AS A UNIT.
- E. REMOVE CAP SCREWS, (ITEM #30), AND BELT DRIVE COVER, (ITEM #3), SEE FIGURE 5-18. LOOSEN SOCKET HEAD SCREW, (ITEM #8), SO THAT AIR MOTOR, (#14) IS FREE ENOUGH TO PERMIT REMOVAL OF THE ENDLESS TIMING BELT, (#13).
- F. REMOVE ENDLESS TIMING BELT, (ITEM #13), RETAINING RING, (#58), DRIVEN SPROCKET, (ITEM #9), AND 605 WOODRUFF KEY. SEE FIGURE 5-19.

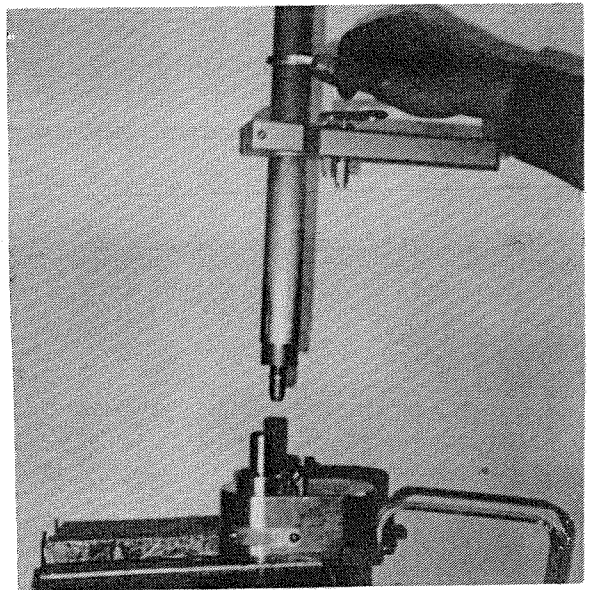


FIGURE 5-15

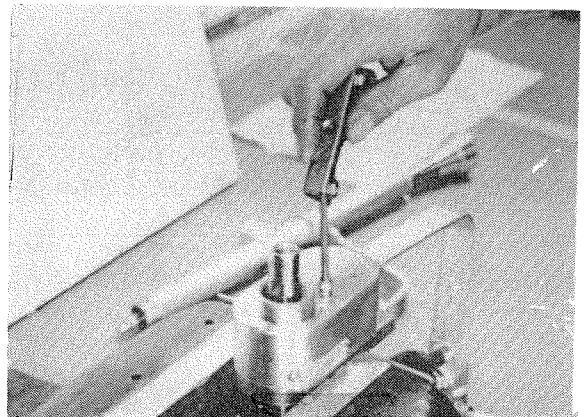


FIGURE 5-16

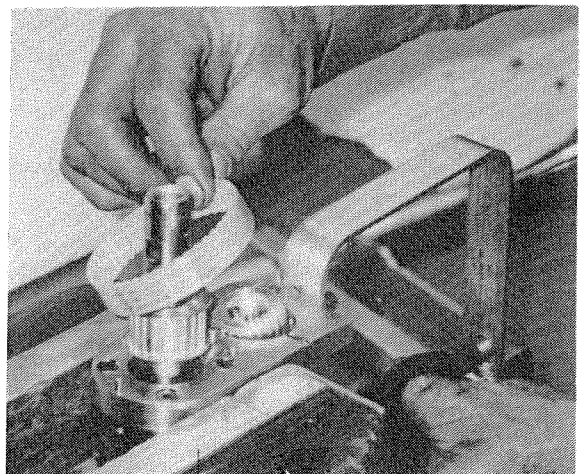


FIGURE 5-17

G. DISCONNECT WATER FITTING TO SWIVEL.

H. REMOVE SCREWS, (ITEM #7), AND REMOVE SWIVEL FROM PLATE, (ITEM #2). SEE FIGURE 5-20.

**ITEM NUMBERS REFERRED TO IN I THRU U BELOW ARE FROM THE EXPLODED DRAWING OF THE SWIVEL IN THE PARTS SECTION 7.**

I. REMOVE SCREWS, (#13), SWIVEL END CAP, (#4), AND GREASE FITTING, (#12). HOLDING SEAL HOUSING ON THE FLATS AND USING CHANNEL LOCKS ON THE NUT RETAINER UNSCREW AND REMOVE. REMOVE THE SEAL HOUSING, SEAL AND BACKUP RING.

J. CLAMP THE SWIVEL UPRIGHT IN A VISE, ON THE SHAFT ABOVE THE THREADED PORTION AS SHOWN IN FIGURE 5-21. PLACE A PIECE OF WOOD OR OTHER NON-METALLIC MATERIAL AGAINST THE SWIVEL BODY, (#1), OUTSIDE OF THE BEARING RACE AND STRIKE WITH A HAMMER AS SHOWN IN FIGURE 5-21.

CONTINUE WORKING AROUND THE CIRCUMFERENCE OF THE SWIVEL BODY, (#1) UNTIL IT IS STRIPPED FROM THE SWIVEL SHAFT, (#2). SEE FIGURE 5-22.

K. THE BALL BEARINGS, (#7 & #8) CAN BE REMOVED FROM THE SWIVEL SHAFT, (#2) BY USING A CHISEL BETWEEN THE SHAFT SHOULDER AND THE INNER BEARING RACE AS SHOWN IN FIGURE 5-23.

L. REMOVE THE SEAL, (#9), BY PLACING THE SWIVEL END CAP, (#4), WITH THE SEAL SIDE DOWN IN A VISE AS SHOWN IN FIGURE 5-24. REACH THROUGH THE TOP WITH A PUNCH AND TOP THE SEAL AROUND THE CIRCUMFERENCES TO REMOVE.

M. TO INSTALL A NEW SEAL, (#10), TURN THE END CAP OVER IN THE VISE AND CLAMP. SET THE NEW SEAL OVER THE COUNTERBORE AND TAP AROUND THE CIRCUMFERENCE USING A WOOD BLOCK AND HAMMER TO SEAT IN THE COUNTERBORE.

N. REMOVE THE SEAL, (#10), BY REACHING IN THE END OF THE BODY WITH A LONG SLENDER PUNCH IN AS SHOWN IN FIGURE 5-25.

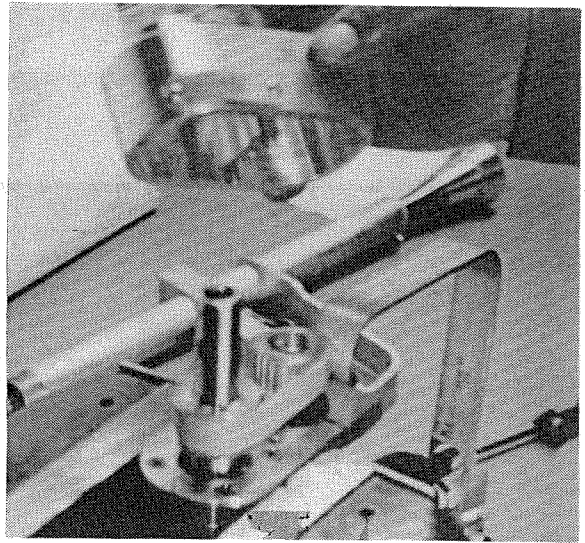


FIGURE 5-18

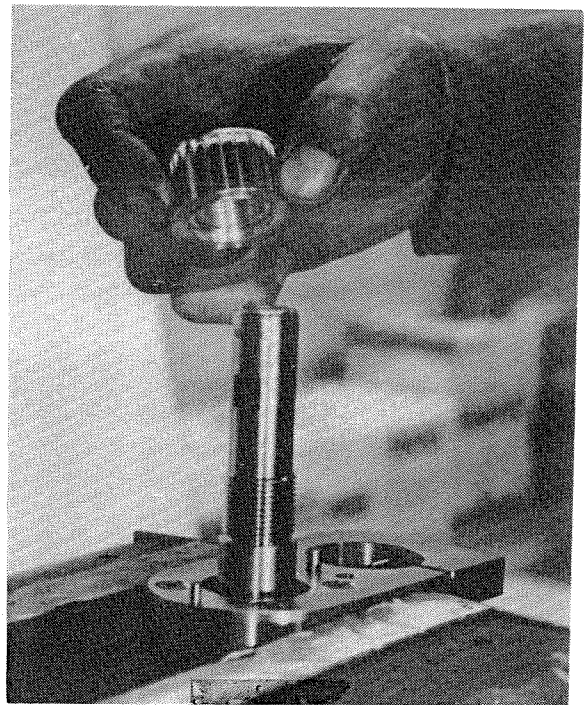


FIGURE 5-19

- O. TO INSTALL A NEW SEAL YOU WILL NEED A ROD A LITTLE SMALLER IN DIAMETER THAN THE SEAL AND LONG ENOUGH TO REACH THE SEAL COUNTERBORE. APPLY SOME GREASE TO THE NEW SEAL AND ON THE END OF THE ROD. PLACE THE SEAL ON THE END OF THE ROD AND SEAT IT IN THE COUNTERBORE, SEE FIGURE 5-26.
- P. INSTALL THE BEARINGS, (#7), AND (#8), ON THE NEW SHAFT. FIGURE 5-27 SHOWS THE BEARING BEING DRIVEN ONTO THE SHAFT USING A HOLLOW SHAFT TO BEAR ON THE INNER BEARING RACE.
- Q. WITH THE SWIVEL SHAFT CLAMPED IN THE VISE ASSEMBLE THE BODY AND SHAFT BY DRIVING THE BODY OVER THE SHAFT AS SHOWN IN FIGURE 5-28.
- R. INSTALL THE GREASE FITTING (#12), AND END CAP, (#4).
- S. TURN THE BODY IN THE VISE SO THAT THE HIGH PRESSURE SEAL END IS UP. INSTALL THE SEAL HOUSING SEAL AND BACKUP RING AS A UNIT. APPLY ANTI-SEIZE COMPOUND ONTO THE RETAINER NUT THREADS AND SCREW ONTO THE BODY AND TIGHTEN TO 25 LB-FT (34 N-m) OF TORQUE.
- T. USING THE GREASE FITTING FILL WITH NLGI No.2 LITHIUM-BASE GREASE.
- U. INSTALL THE SWIVEL ON THE LANCE BY REVERSING THE DIRECTIONS FOR DISASSEMBLY.

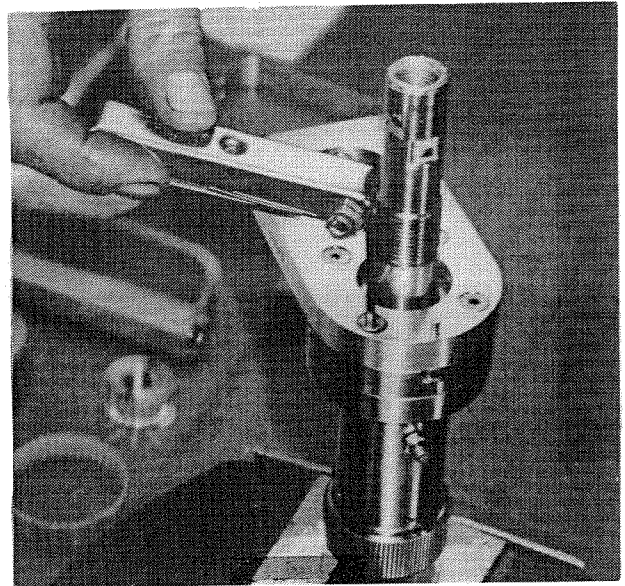


FIGURE 5-20

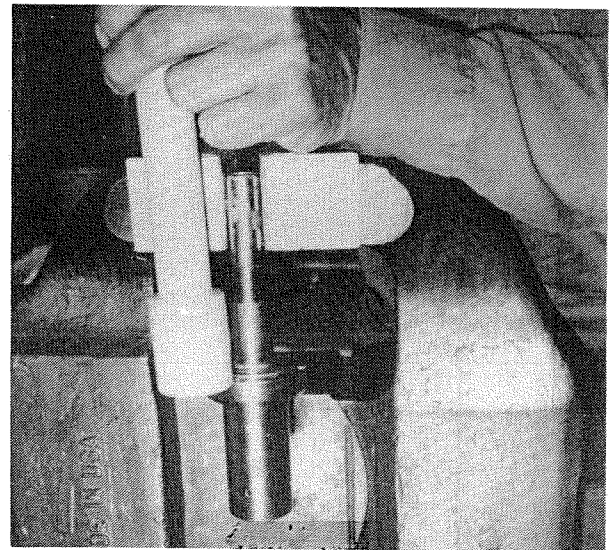


FIGURE 5-21

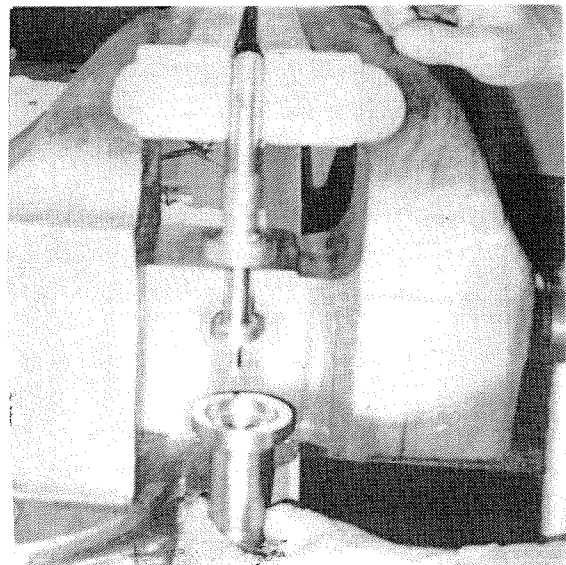


FIGURE 5-22



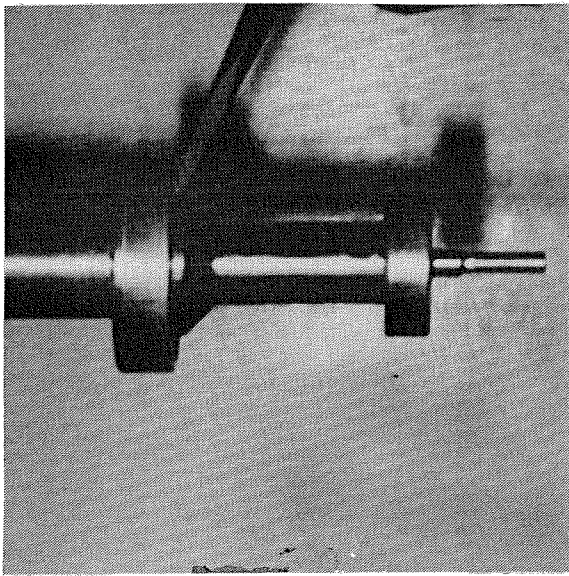


FIGURE 5-23

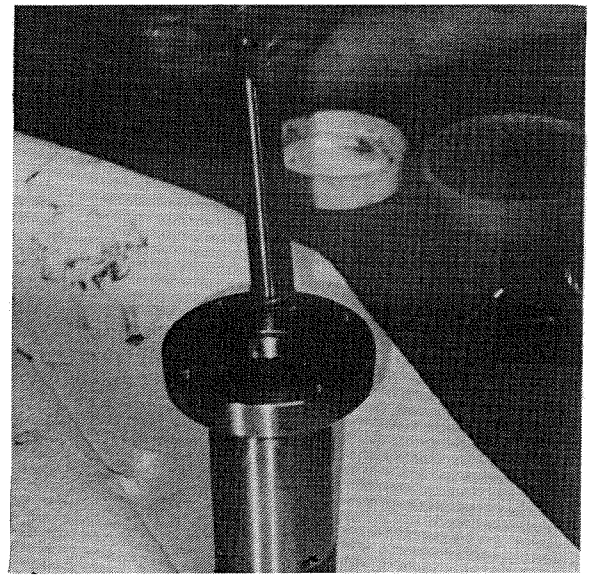


FIGURE 5-26



FIGURE 5-24

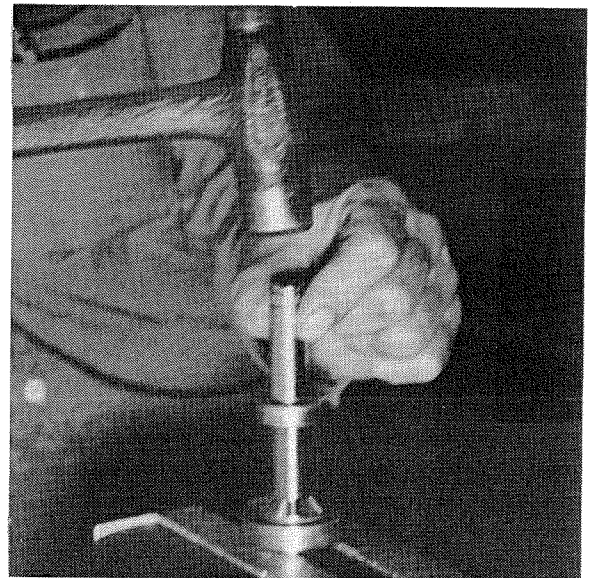


FIGURE 5-27



FIGURE 5-25

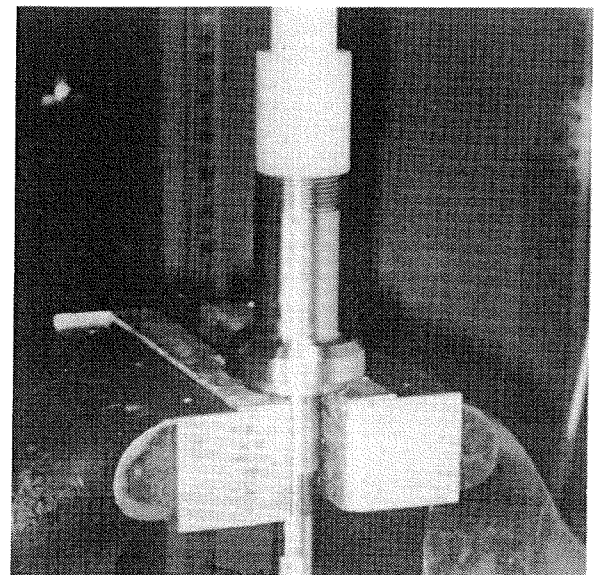
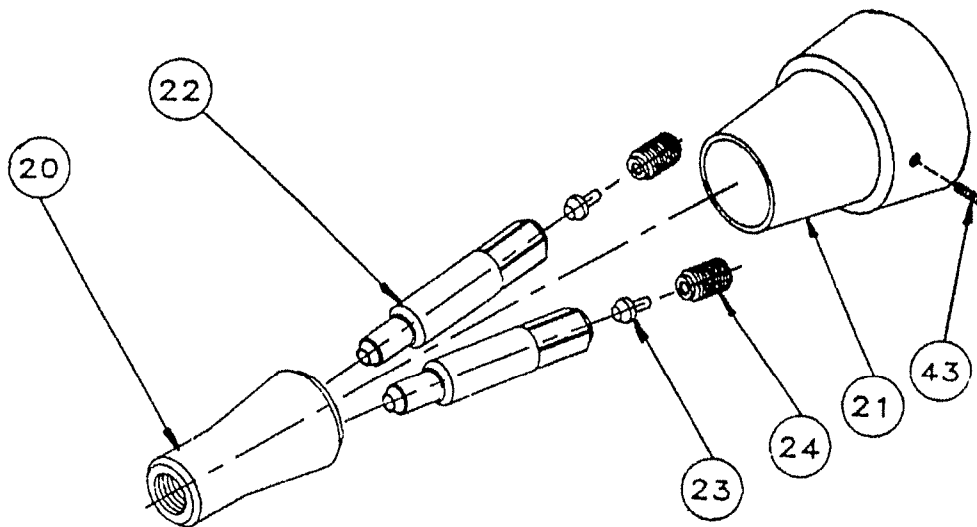


FIGURE 5-28

## **6. REPLACEMENT OF NOZZLES**

THE NOZZLE ORIFICES USED IN THE 40K ROTATING LANCE ARE A SAPPHIRE JEWEL ASSEMBLY, (#23), HELD IN PLACE WITH A RETAINER GLAND. IF THE CLEANING PERFORMANCE OF THE ROTATING NOZZLES STARTS TO DETERIORATE OR IF THE PUMP UNIT HAS TO BE SPEEDED UP TO MAINTAIN THE DESIRED OPERATING PRESSURE, IT IS AN INDICATION THAT THE NOZZLES ARE WORN AND NEED REPLACEMENT.

1. TO CHANGE THE NOZZLE ASSEMBLY, (#23), INSERT A 3/16 ALLEN WRENCH IN THE RETAINER GLAND AND REMOVE THE GLAND, (#24), COMPLETELY. THE NOZZLE ORIFICE ASSEMBLY, (#23), MAY EASILY BE REMOVED AND DISCARDED.
2. PLACE A NEW NOZZLE ORIFICE ASSEMBLY WITH THE CONED END FIRST, INTO THE CAVITY. PUT SOME ANTI-SEIZE COMPOUND ON THE NOZZLE RETAINER GLAND, (#24) THREADS, AND SCREW IT DOWN OVER THE NOZZLE ORIFICE ASSEMBLY. TIGHTEN THE RETAINER GLAND, (#24) TO 20 LB-FT (27.2 N-m) TORQUE.



**II. PREVENTIVE MAINTENANCE SCHEDULE**  
**NCG8400A-3/3L ULTRA CLEAN ROTATING LANCES®**

| NCG8400A-3/3L LANCES                                                                   |  | DAILY     | WEEKLY     | MONTHLY     | 3 MONTHS    | 6 MONTHS    | YEARLY       |
|----------------------------------------------------------------------------------------|--|-----------|------------|-------------|-------------|-------------|--------------|
| PREVENTIVE MAINTENANCE TASK                                                            |  | (8 HOURS) | (40 HOURS) | (160 HOURS) | (250 HOURS) | (500 HOURS) | (1000 HOURS) |
| INSPECT FOR WATER LEAKS                                                                |  | *         |            |             |             |             |              |
| INSPECT FOR ACCUMULATED DIRT AND PRODUCT BUILD-UP                                      |  | *         |            |             |             |             |              |
| FILL GREASE FITTING WITH STANDARD MOLY-GREASE                                          |  | *         |            |             |             |             |              |
| CHECK AIR SOURCE FOR 90 PSI MAXIMUM                                                    |  | *         |            |             |             |             |              |
| CHECK FOR DAMAGED COMPONENTS, LOOSE AIR FITTINGS, WATER FITTINGS, MOUNTING BOLTS, ETC. |  | *         |            |             |             |             |              |
| ADJUST OR CLEAR CLOG FROM EXHAUST PORTS                                                |  | *         | *          |             |             |             |              |
| GREASE AIR MOTOR WITH STANDARD MOLY-GREASE                                             |  |           |            | *           |             |             |              |
| CLEAN OR CLEAR EXHAUST PORTS                                                           |  |           |            | *           |             |             |              |
| FLUSH AIR MOTOR WITH WD-40® OR EQUIVALENT                                              |  |           |            | *           |             | *           |              |
| REPLACE AIR MOTOR BELT                                                                 |  |           |            |             |             | *           |              |
| REPLACE WORN NOZZLES                                                                   |  |           | *          |             |             |             |              |

**PREVENTIVE MAINTENANCE SCHEDULE  
NCG8400A-3/3L ULTRA CLEAN ROTATING LANCES®**

| <b>DS8800A ROTATING SEAL<br/>PREVENTIVE MAINTENANCE TASK</b>                                                 | <b>DAILY<br/>(8 HOURS)</b> | <b>WEEKLY<br/>(40 HOURS)</b> | <b>MONTHLY<br/>(160 HOURS)</b> | <b>3 MONTHS<br/>(250 HOURS)</b> | <b>6 MONTHS<br/>(500 HOURS)</b> | <b>YEARLY<br/>(1000 HOURS)</b> |
|--------------------------------------------------------------------------------------------------------------|----------------------------|------------------------------|--------------------------------|---------------------------------|---------------------------------|--------------------------------|
| INSPECT FOR WATER LEAKS                                                                                      | *                          |                              |                                |                                 |                                 |                                |
| FILL GREASE FITTING WITH STANDARD MOLY-GREASE                                                                | *                          |                              |                                |                                 |                                 |                                |
| CHECK FOR DAMAGED COMPONENTS                                                                                 | *                          |                              |                                |                                 |                                 |                                |
| REPLACE SHAFT SEAL, BS8809 @ 8-12 HOURS AND *BRASS BACK-UP RING                                              |                            |                              |                                |                                 |                                 |                                |
| REPLACE BACK-UP RING, BS8810 @ 24-36 HOURS. IF REPLACING BRASS BACK-UP RING, CLEAN BRASS RESIDUE FROM SHAFT. | *                          |                              |                                |                                 |                                 |                                |
| INSPECT SHAFT, REPLACE IF WORN                                                                               |                            |                              |                                | *                               | *                               | *                              |

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## SECTION 6

### SPECIAL TOOLS

| <u>DESCRIPTION</u>             | <u>PAGE NUMBER</u> |
|--------------------------------|--------------------|
| I. SPECIAL TOOL IDENTIFICATION | 6-2                |

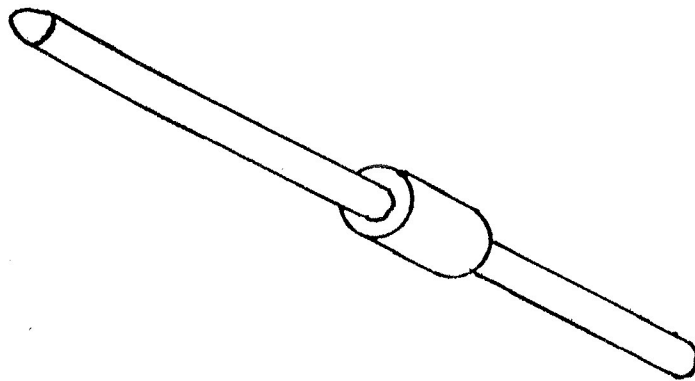


## **I. SPECIAL TOOLS IDENTIFICATION**

THE NCG8400A-3/3L ULTRA-CLEAN® ROTATING LANCES  
REQUIRE THESE SPECIAL TOOLS WHEN  
REPAIRS ARE PERFORMED.

### **CAUTION:**

**USE THE PROPER TOOL FOR THE SPECIFIC JOB. THE USE OF  
THE IMPROPER TOOL WILL RESULT IN COSTLY DAMAGE TO  
THE HIGH PRESSURE WATER JETTING EQUIPMENT.**



SPECIAL TOOL #BM8125

USED FOR REMOVING AND INSTALLING O-RINGS AND SEALS.

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## **SECTION 7**

### **PARTS**

| <b><u>DESCRIPTION</u></b>      | <b><u>PAGE NUMBER</u></b> |
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| I. NCG8400A-3 ROTATING LANCE   | 7-2                       |
| II. NCG8400A-3L ROTATING LANCE | 7-4                       |

# NCG8400A-3 ROTATING LANCE

## PARTS LIST

| ITEM # | PART #          | DESCRIPTION                       | QTY. |
|--------|-----------------|-----------------------------------|------|
| 1      | DS8800A         | ROTATING SEAL ASSEMBLY            | 1 EA |
| 1      | DS8805          | BODY, SWIVEL                      | 1 EA |
| * 2    | DS10566         | SHAFT, SWIVEL                     | 1 EA |
| 3      | CS8807          | HOUSING, SEAL                     | 1 EA |
| 4      | CS10399         | CAP, SWIVEL END                   | 1 EA |
| * 5    | BS8809          | SEAL, SHAFT                       | 1 EA |
| * 6    | BS8810          | RING, BACK-UP                     | 1 EA |
| * 7    | PM10398         | BEARING BALL                      | 1 EA |
| * 8    | PM8812          | BEARING, BALL                     | 1 EA |
| * 9    | PM10378         | SEAL                              | 1 EA |
| * 10   | PM6693          | SEAL                              | 1 EA |
| 12     | PM13063         | FITTING, GREASE                   | 1 EA |
| 13     | 10-32X5/8SHSS   | SCREW                             | 4 EA |
| 14     | 10-24HCLW-SS    | WASHER                            | 4 EA |
| 15     | BS8980          | NUT, RETAINER                     | 1 EA |
| 16     | PM12811         | KEY, WOODRUFF                     | 1 EA |
| 17     | BS13061         | SLEEVE, ANTI-ROTATION             | 1 EA |
| 18     | PM13062         | SPRING, SPIRAWAVE                 | 1 EA |
| 2      | CA8389          | PLATE, AIR MOTOR AND SWIVEL MOUNT | 1 EA |
| 3      | CA8392          | COVER, BELT DRIVE                 | 1 EA |
| 4      | 1/4-20X1-1/2HS  | SCREW, SOCKET HEAD, S.S.          | 2 EA |
| 5      | 3/16X3/4PDSS    | PIN, DOWEL, S.S.                  | 1 EA |
| 6      | 1/8X1/2PDSS     | PIN, DOWEL, S.S.                  | 1 EA |
| 7      | 10-32X7/8SHFSS  | SCREW, SOCKET FLAT HEAD, S.S.     | 4 EA |
| 8      | 10-32X1-1/2SHSS | SCREW, SOCKET HEAD, S.S.          | 1 EA |
| 9      | BM10567         | SPROCKET, DRIVEN, 22 TOOTH        | 1 EA |
| 10     | 1/4-HCLW-SS     | WASHER, LOCK, S.S.                | 2 EA |
| 11     | BA8401          | SHAFT, MOTOR EXTENSION            | 1 EA |
| 12     | BA8671          | SPROCKET, DRIVER                  | 1 EA |
| 13     | PM8635          | BELT, ENDLESS TIMING              | 1 EA |
| 14     | BA8406          | DRILL, PNEUMATIC (AIR MOTOR)      | 1 EA |
| 15     | CA8434          | GUARD, TRIGGER                    | 1 EA |
| 16     | BA8393          | COVER, DRIVE SHAFT                | 1 EA |
| 17     | BA8394-2        | BARREL, ROTATING DISCHARGE        | 1 EA |
| 18     | BA8395-2        | HOUSING, DISCHARGE BARREL         | 1 EA |
| 19     | BA8396          | BEARING, ROTATING BARREL          | 1 EA |
| 20     | CA8397          | HUB, ROTATING NOZZLE              | 1 EA |
| 21     | CA8637          | COVER, NOZZLE PROTECTOR           | 1 EA |
| 22     | BN7507          | HOLDER, NOZZLE ORIFICE            | 2 EA |
| 23     | JB-NOZZLE       | NOZZLE                            | 2 EA |
| 24     | BA3894          | GLAND, NOZZLE RETAINER            | 2 EA |
| 26     | 10-24HCLW-SS    | WASHER, S.S.                      | 1 EA |
| 27     | DL12672         | HANDLE                            | 1 EA |
| 29     | BA8453          | GUARD, SIDE HANDLE                | 1 EA |
| 30     | 1/4-20X2-SHS    | SCREW, CAP, S.S.                  | 2 EA |
| 31     | 1/4-20X1/2SHS   | SCREW, CAP, S.S.                  | 4 EA |
| 32     | BL12674         | BRACKET, TRIGGER                  | 1 EA |
| 33     | BL12673         | TRIGGER                           | 1 EA |
| 34     | 6-32 x 1SHSS    | SCREW, SOCKET HEAD CAP, S.S.      | 1 EA |
| 35     | PM12685         | BOOT, PROTECTIVE                  | 1 EA |
| 36     | PM12942         | VALVE, FLOW CONTROL               | 1 EA |
| 38     | DM2666-14       | FITTING, AIR                      | 1 EA |
| 39     | DM2666-56       | TUBING, AIR                       | 2 FT |
| 42     | PM12963         | ELBOW, STREET                     | 1 EA |
| 43     | 10-32X1/4SS     | SCREW, SET                        | 2 EA |

NCG8400A-3 ROTATING LANCE (CONT'D)

|         |                             |                       |      |
|---------|-----------------------------|-----------------------|------|
| 44      | 8-32X3/8BHSS                | SCREW, S.S.           | 2 EA |
| 45      | PM7758                      | TAG                   | 1 EA |
| 48      | 6-32X1/2SHSS                | SCREW, S.S.           | 2 EA |
| 49      | 6-32 LWS                    | WASHER, LOCK, S.S.    | 2 EA |
| 50      | PM12687                     | VALVE, PNEUMATIC      | 2 EA |
| 51      | 1/4-20 X 3/8 DP SS          | SCREW, SET            | 2 EA |
| 52      | AA-4099                     | O-RING                | 2 EA |
| 53      | 10-24 X 1/2 FHSS            | SCREW, S.S.           | 2 EA |
| 54      | PM7404                      | FITTING, GREASE, S.S. | 1 EA |
| 55      | 5/16 X 3/4 PD SS            | PIN, DOWEL, S.S.      | 1 EA |
| 56      | PM12686                     | ADAPTER, HOSE         | 2 EA |
| 58      | PM8630                      | RETAINING, RING       | 1 EA |
| SHADED: | RECOMMENDED FOR SPARE PARTS |                       |      |

\* ITEMS INCLUDED IN REBUILD KIT #8400A-3 RKBT.

# NCG8400A-3L ROTATING LANCE

## PARTS LIST

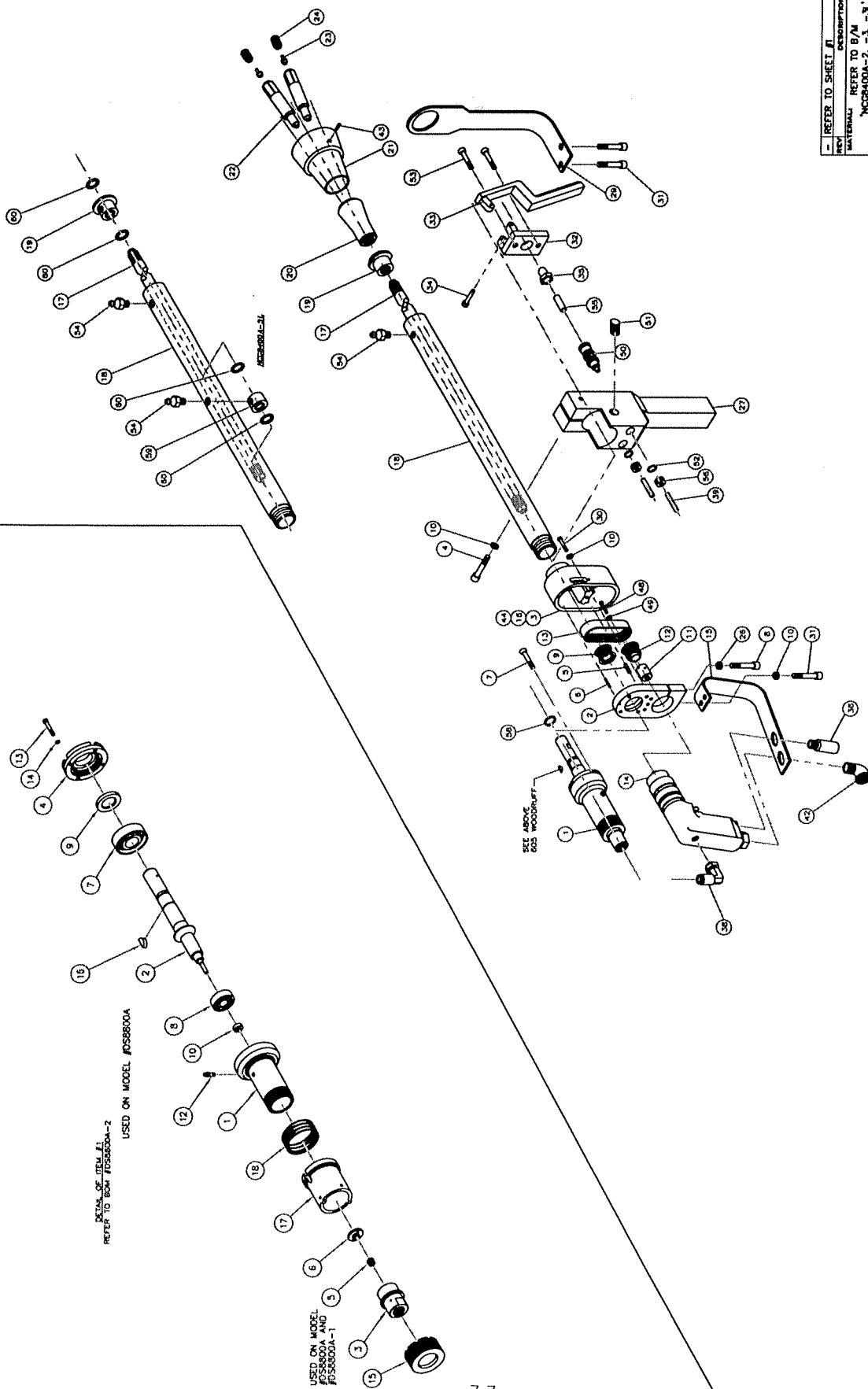
| ITEM #    | PART #                 | DESCRIPTION                              | QTY.        |
|-----------|------------------------|------------------------------------------|-------------|
| <b>1</b>  | <b>DS8800A</b>         | <b>ROTATING SEAL ASSEMBLY</b>            | <b>1 EA</b> |
| 1         | DS8805                 | BODY, SWIVEL                             | 1 EA        |
| * 2       | DS10566                | SHAFT, SWIVEL                            | 1 EA        |
| 3         | CS8807                 | HOUSING, SEAL                            | 1 EA        |
| 4         | CS10399                | CAP, SWIVEL END                          | 1 EA        |
| * 5       | BS8809                 | SEAL, SHAFT                              | 1 EA        |
| * 6       | BS8810                 | RING, BACK-UP                            | 1 EA        |
| * 7       | PM10398                | BEARING BALL                             | 1 EA        |
| * 8       | PM8812                 | BEARING, BALL                            | 1 EA        |
| * 9       | PM10378                | SEAL                                     | 1 EA        |
| * 10      | PM6693                 | SEAL                                     | 1 EA        |
| 12        | PM13063                | FITTING, GREASE                          | 1 EA        |
| 13        | 10-32X5/8SHSS          | SCREW                                    | 4 EA        |
| 14        | 10-24HCLW-SS           | WASHER                                   | 4 EA        |
| 15        | BS8980                 | NUT, RETAINER                            | 1 EA        |
| 16        | PM12811                | KEY, WOODRUFF                            | 1 EA        |
| 17        | BS13061                | SLEEVE, ANTI-ROTATION                    | 1 EA        |
| 18        | PM13062                | SPRING, SPIRAWAVE                        | 1 EA        |
| <b>2</b>  | <b>CA8389</b>          | <b>PLATE, AIR MOTOR AND SWIVEL MOUNT</b> | <b>1 EA</b> |
| <b>3</b>  | <b>CA8392</b>          | <b>COVER, BELT DRIVE</b>                 | <b>1 EA</b> |
| <b>4</b>  | <b>1/4-20X1-1/2HS</b>  | <b>SCREW, SOCKET HEAD, S.S.</b>          | <b>2 EA</b> |
| <b>5</b>  | <b>3/16X3/4PDSS</b>    | <b>PIN, DOWEL, S.S.</b>                  | <b>1 EA</b> |
| <b>6</b>  | <b>1/8X1/2PDSS</b>     | <b>PIN, DOWEL, S.S.</b>                  | <b>1 EA</b> |
| <b>7</b>  | <b>10-32X7/8SHFSS</b>  | <b>SCREW, SOCKET FLAT HEAD, S.S.</b>     | <b>4 EA</b> |
| <b>8</b>  | <b>10-32X1-1/2SHSS</b> | <b>SCREW, SOCKET HEAD, S.S.</b>          | <b>1 EA</b> |
| <b>9</b>  | <b>BM10567</b>         | <b>SPROCKET, DRIVEN, 22 TOOTH</b>        | <b>1 EA</b> |
| <b>10</b> | <b>1/4-HCLW-SS</b>     | <b>WASHER, LOCK, S.S.</b>                | <b>2 EA</b> |
| <b>11</b> | <b>BA8401</b>          | <b>SHAFT, MOTOR EXTENSION</b>            | <b>1 EA</b> |
| <b>12</b> | <b>BA8671</b>          | <b>SPROCKET, DRIVER</b>                  | <b>1 EA</b> |
| <b>13</b> | <b>PM8635</b>          | <b>BELT, ENDLESS TIMING</b>              | <b>1 EA</b> |
| <b>14</b> | <b>BA8406</b>          | <b>DRILL, PNEUMATIC (AIR MOTOR)</b>      | <b>1 EA</b> |
| <b>15</b> | <b>CA8434</b>          | <b>GUARD, TRIGGER</b>                    | <b>1 EA</b> |
| <b>16</b> | <b>BA8393</b>          | <b>COVER, DRIVE SHAFT</b>                | <b>1 EA</b> |
| <b>17</b> | <b>BM17711-1</b>       | <b>BARREL, ROTATING DISCHARGE</b>        | <b>1 EA</b> |
| <b>18</b> | <b>CM17708-1</b>       | <b>HOUSING, DISCHARGE BARREL</b>         | <b>1 EA</b> |
| <b>19</b> | <b>BM17710</b>         | <b>BEARING, ROTATING BARREL</b>          | <b>1 EA</b> |
| <b>20</b> | <b>CA8397</b>          | <b>HUB, ROTATING NOZZLE</b>              | <b>1 EA</b> |
| <b>21</b> | <b>CA8637</b>          | <b>COVER, NOZZLE PROTECTOR</b>           | <b>1 EA</b> |
| <b>22</b> | <b>BN7507</b>          | <b>HOLDER, NOZZLE ORIFICE</b>            | <b>2 EA</b> |
| <b>23</b> | <b>JB-NOZZLE</b>       | <b>NOZZLE</b>                            | <b>2 EA</b> |
| <b>24</b> | <b>BA3894</b>          | <b>GLAND, NOZZLE RETAINER</b>            | <b>2 EA</b> |
| <b>26</b> | <b>10-24HCLW-SS</b>    | <b>WASHER, S.S.</b>                      | <b>1 EA</b> |
| <b>27</b> | <b>DL12672</b>         | <b>HANDLE</b>                            | <b>1 EA</b> |
| <b>29</b> | <b>BA8453</b>          | <b>GUARD, SIDE HANDLE</b>                | <b>1 EA</b> |
| <b>30</b> | <b>1/4-20X2-SHS</b>    | <b>SCREW, CAP, S.S.</b>                  | <b>2 EA</b> |
| <b>31</b> | <b>1/4-20X1/2SHS</b>   | <b>SCREW, CAP, S.S.</b>                  | <b>4 EA</b> |
| <b>32</b> | <b>BL12674</b>         | <b>BRACKET, TRIGGER</b>                  | <b>1 EA</b> |
| <b>33</b> | <b>BL12673</b>         | <b>TRIGGER</b>                           | <b>1 EA</b> |
| <b>34</b> | <b>6-32 x 1SHSS</b>    | <b>SCREW, SOCKET HEAD CAP, S.S.</b>      | <b>1 EA</b> |
| <b>35</b> | <b>PM12685</b>         | <b>BOOT, PROTECTIVE</b>                  | <b>1 EA</b> |
| <b>36</b> | <b>PM12942</b>         | <b>VALVE, FLOW CONTROL</b>               | <b>1 EA</b> |
| <b>38</b> | <b>DM2666-14</b>       | <b>FITTING, AIR</b>                      | <b>1 EA</b> |
| <b>39</b> | <b>DM2666-56</b>       | <b>TUBING, AIR</b>                       | <b>2 FT</b> |
| <b>42</b> | <b>PM12963</b>         | <b>ELBOW, STREET</b>                     | <b>1 EA</b> |
| <b>43</b> | <b>10-32X1/4SS</b>     | <b>SCREW, SET</b>                        | <b>2 EA</b> |

NCG8400A-3L ROTATING LANCE (CONT'D)

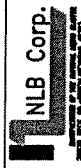
|         |                             |                       |      |
|---------|-----------------------------|-----------------------|------|
| 44      | 8-32X3/8BHSS                | SCREW, S.S.           | 2 EA |
| 45      | PM7758                      | TAG                   | 1 EA |
| 48      | 6-32X1/2SHSS                | SCREW, S.S.           | 2 EA |
| 49      | 6-32 LWS                    | WASHER, LOCK, S.S.    | 2 EA |
| 50      | PM12687                     | VALVE, PNEUMATIC      | 2 EA |
| 51      | 1/4-20 X 3/8 DP SS          | SCREW, SET            | 2 EA |
| 52      | AA-4099                     | O-RING                | 2 EA |
| 53      | 10-24 X 1/2 FHSS            | SCREW, S.S.           | 2 EA |
| 54      | PM7404                      | FITTING, GREASE, S.S. | 1 EA |
| 55      | 5/16 X 3/4 PD SS            | PIN, DOWEL, S.S.      | 1 EA |
| 56      | PM12686                     | ADAPTER, HOSE         | 2 EA |
| 58      | PM8630                      | RETAINING, RING       | 1 EA |
| 59      | BM17709                     | BUSHING, MIDDLE       | 1 EA |
| 60      | PM17713                     | SEAL, OIL             | 1 EA |
| SHADED: | RECOMMENDED FOR SPARE PARTS |                       |      |

\* ITEMS INCLUDED IN REBUILD KIT #8400A-3 RKB.T.





| REV | DESCRIPTION       | DATE | BY |
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DO NOT SCALE DRAWING

INFORMATION FOR THE USER: THIS DRAWING IS THE PROPERTY OF NLB CORP. AND IS NOT TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, WITHOUT THE WRITTEN CONSENT OF NLB CORP.

DATE: 1/17/90  
BY: J. H. HARTON  
CHK: J. H. HARTON  
SCALE: NONE  
SHEET: 2 OF 3

TITLE: LANCE CLEANING  
PROJECT: LANCE CLEANING  
DRAWING NO.: NCC8400A-2, -3, -3L

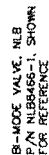
REV: F

DA12700



**BI-MODE TO NCG8400A-3  
HOSE ASSEMBLY (DM14150)**

| ITEM# | PART #        | DESCRIPTION                                                          | QTY.  |
|-------|---------------|----------------------------------------------------------------------|-------|
| 1     | NP40-3/16-35F | HOSE, 3/16" X 35', 40K, 9/16-18 FEMALE SWIVEL END, W/COVER           | 1 EA. |
| 2     | DM6023-242    | ADAPTER, HOSE, 9/16-18 THR FEM. CONE X 3/8 HIGH PRESSURE MALE        | 1 EA. |
| 3     | CM10671       | SHROUD, HOSE ASSEMBLY, ENC3321 UPDATED BY ECN3355                    | 1 EA. |
| 4     | BM12684       | HOSE, AIR, ASSEMBLY, 6MM ID, 3/8" NPTM SWIVEL BONDED W 5/32" ID HOSE | 1 EA. |



HAND LANCE, MLB P/N  
NCG8400A-2, SHOWN  
FOR REFERENCE

NLB Corp.



*Manufacturer of the National Liquid Blaster*

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

## **WARRANTY**

All components manufactured by the seller are warranted to be free from defects in material and workmanship under normal use for 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 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 seller assumes no responsibility for any equipment and 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.

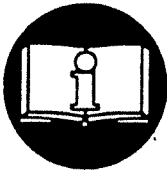
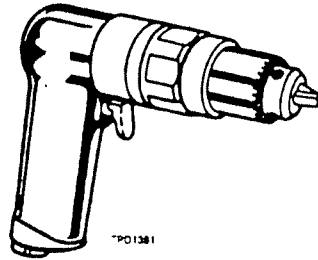
The seller's liability under this warranty is limited to the repair and replacement of defective parts as stated above and the seller is not responsible for any damages, expenses or loss of income resulting from such defects.

# **MANUFACTURERS' LITERATURE**

# OPERATION AND MAINTENANCE MANUAL

## for

### SERIES 6A DRILLS



#### ⚠ WARNING

**IMPORTANT SAFETY INFORMATION ENCLOSED.  
READ THIS MANUAL BEFORE OPERATING TOOL.**

#### **FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.**

- Always operate, inspect and maintain this tool in accordance with American National Standards Institute Safety Code for Portable Air Tools (ANSI B186.1).
- For safety, top performance, and maximum durability of parts, operate this tool at 90 psig (6.2 bar/620 kPa) maximum air pressure at the inlet with 3/8" (10 mm) inside diameter air supply hose.
- Air powered tools can vibrate in use. Vibration, repetitive motions or uncomfortable positions may be harmful to your hands and arms. Stop using any tool if discomfort, tingling feeling or pain occurs. Seek medical advice before resuming use.
- Always turn off the air supply and disconnect the air supply hose before installing, removing or adjusting any accessory on this tool, or before performing any maintenance on this tool.
- Keep hands, loose clothing and long hair away from the rotating end of the tool.
- Anticipate and be alert for sudden changes in motion during start up and operation of any power tool.
- Tool accessory may continue to rotate briefly after throttle is released.
- Do not lubricate tools with flammable or volatile liquids such as kerosene, diesel or jet fuel.
- Do not remove any labels. Replace any damaged label.
- Use accessories recommended by Ingersoll-Rand.

#### **NOTICE**

The use of other than genuine Ingersoll-Rand replacement parts may result in safety hazards, decreased tool performance, and increased maintenance, and may invalidate all warranties.

Ingersoll-Rand is not responsible for customer modification of tools for applications on which Ingersoll-Rand was not consulted.

Repairs should be made only by authorized personnel. Consult your nearest Ingersoll-Rand Authorized Servicenter.

It is the responsibility of the employer to place the information in this manual into the hands of the operator.

Refer All Communications to the Nearest  
Ingersoll-Rand Office or Distributor.

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# **INGERSOLL-RAND®**

## **PROFESSIONAL TOOLS**

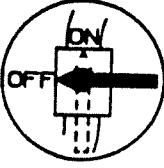
## WARNING LABEL IDENTIFICATION

### WARNING

FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.

|                                                                                   |                                                                                                  |
|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
|  |  <b>WARNING</b> |
|                                                                                   | Always wear eye protection when operating or performing maintenance on this tool.                |

|                                                                                    |                                                                                                    |
|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
|  |  <b>WARNING</b> |
|                                                                                    | Always wear hearing protection when operating this tool.                                           |

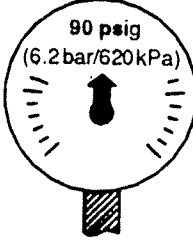
|                                                                                   |                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  |  <b>WARNING</b>                                                                                          |
|                                                                                   | Always turn off the air supply and disconnect the air supply hose before installing, removing or adjusting any accessory on this tool, or before performing any maintenance on this tool. |

|                                                                                    |                                                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  |  <b>WARNING</b>                                                                                                                                                 |
|                                                                                    | Air powered tools can vibrate in use. Vibration, repetitive motions or uncomfortable positions may be harmful to your hands and arms. Stop using any tool if discomfort, tingling feeling or pain occurs. Seek medical advice before resuming use. |

|                                                                                     |                                                                                                    |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
|  |  <b>WARNING</b> |
|                                                                                     | Do not carry the tool by the hose.                                                                 |

|                                                                                      |                                                                                                      |
|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
|  |  <b>WARNING</b> |
|                                                                                      | Do not use damaged, frayed or deteriorated air hoses and fittings.                                   |

|                                                                                     |                                                                                                    |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
|  |  <b>WARNING</b> |
|                                                                                     | Keep body stance balanced and firm. Do not overreach when operating this tool.                     |

|                                                                                      |                                                                                                      |
|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
|  |  <b>WARNING</b> |
|                                                                                      | Operate at 90 psig (6.2 bar/620 kPa) Maximum air pressure.                                           |

## PLACING TOOL IN SERVICE

### LUBRICATION



**Ingersoll-Rand No. 10    Ingersoll-Rand No. 67**

Always use an air line lubricator with this tool.  
We recommend the following Filter-Lubricator-Regulator Unit:

**For USA – No. C11-03-G00**

**For International – No. C16-C3-A29**

**For models with D, H, J, JJ, K or L gearing,** inject approximately 2 to 3 cc of Ingersoll-Rand No. 67 Grease into the Grease Fitting (40) in the Gear Case (39) after each 50 000 cycles or 160 hours of operation, whichever occurs first.

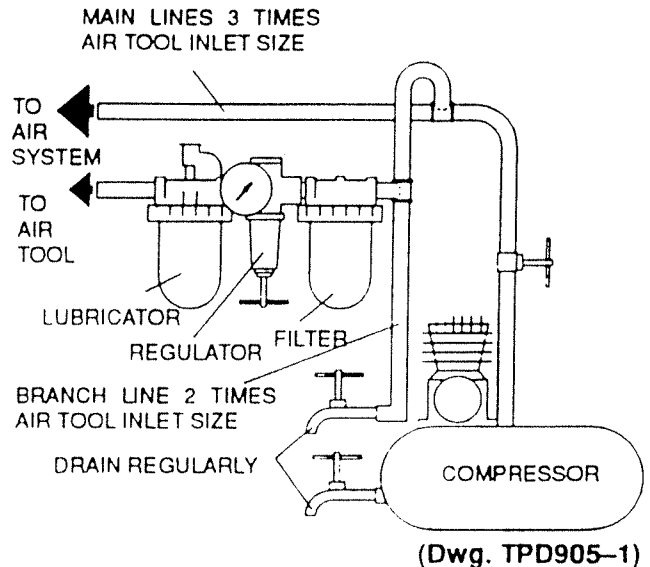
**For models with M, R or S gearing,** inject approximately 3 to 4 cc of Ingersoll-Rand No. 67 Grease into the Grease Fitting (40) in the Gear Case (39) after each 50 000 cycles or 160 hours of operation, whichever occurs first.

### INSTALLATION

#### Air Supply and Connections

Always use clean dry air. Dust, corrosive fumes and/or excessive moisture can ruin the motor of an air tool.

An air line filter can greatly increase the life of an air tool. The filter removes dust and moisture. Low pressure (under 90 psig; 6.2 bar/620 kPa) reduces the speed of all air tools. Low air pressure not only wastes time, but also costs money. High air pressure (over 90 psig; 6.2 bar/620 kPa) raises performance beyond the rated capacity of the tool and could cause injury. Be sure all hoses and fittings are the correct size and are tightly secured.  
See Dwg. TPD905-1 for a typical piping arrangement.



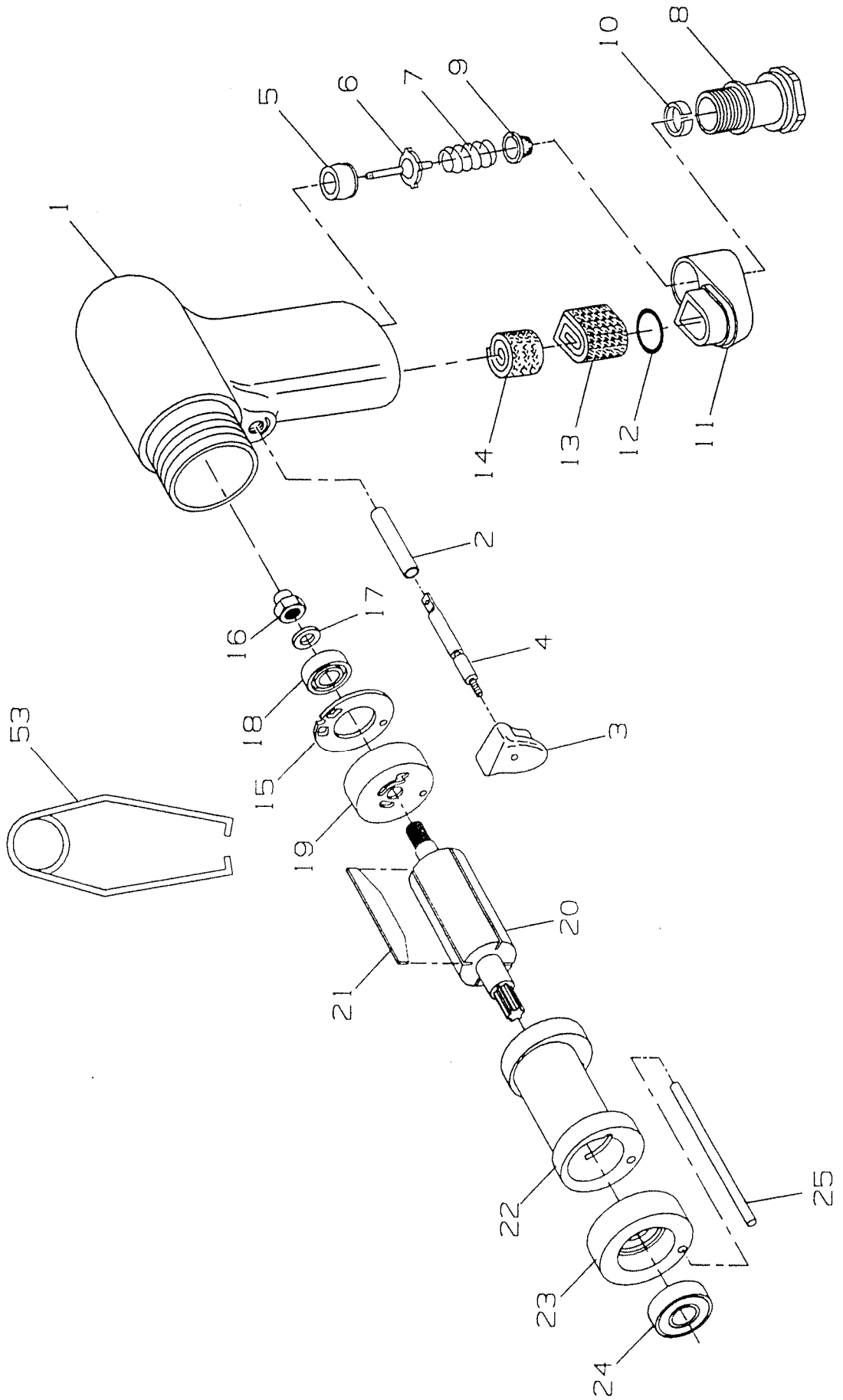
*Series 6A Drills are designed for drilling operations in the aerospace, automotive, appliance, electronic, machining and furniture industries.*

### HOW TO ORDER A DRILL

#### DRILL WITH PISTOL GRIP HANDLE

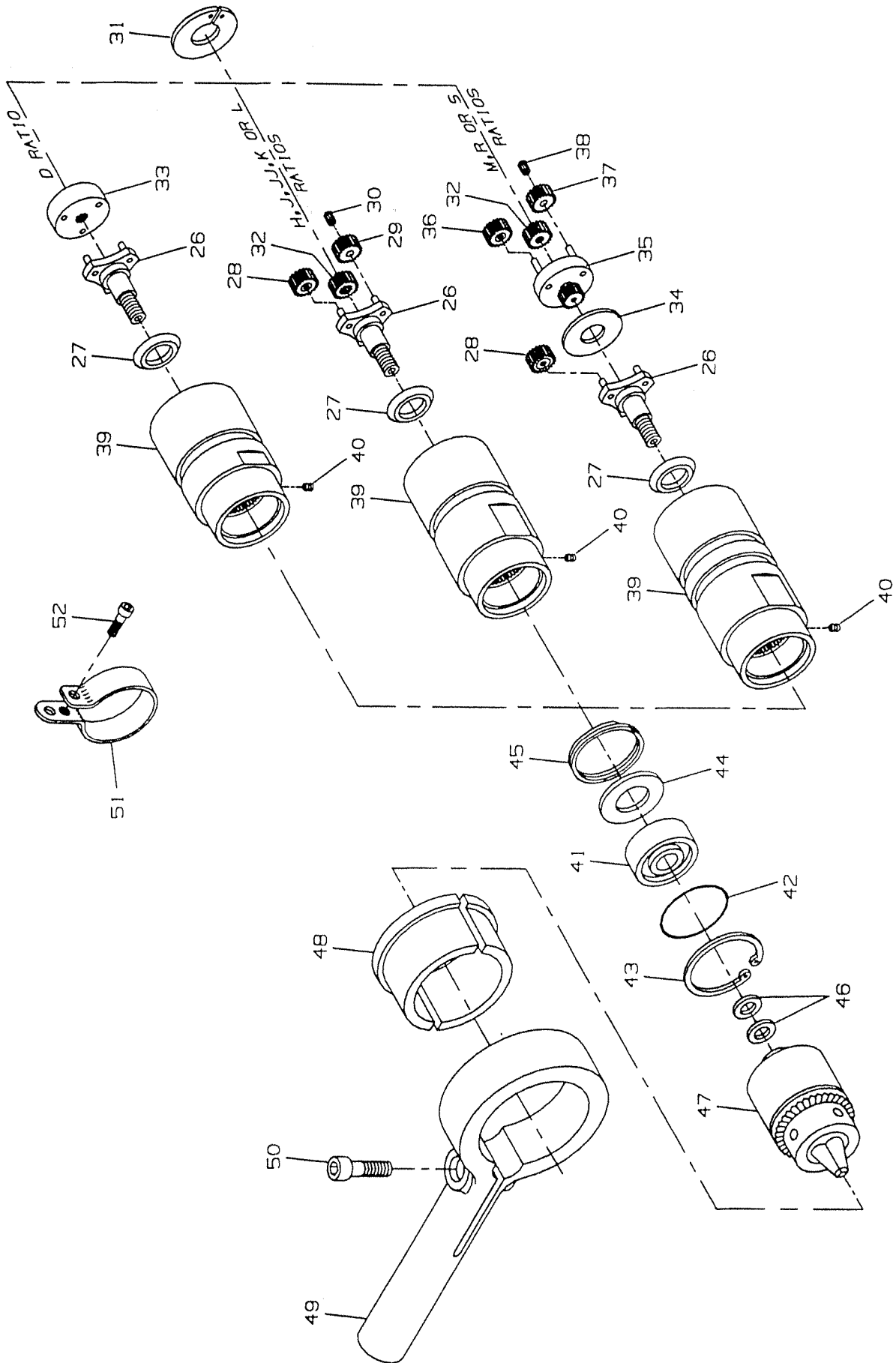
| Model   | Free Speed, rpm | Chuck Capacity |    |
|---------|-----------------|----------------|----|
|         |                 | in             | Nm |
| 6ADST4  | 20 000          | 1/4            | 6  |
| 6AHST4  | 6 000           | 1/4            | 6  |
| 6AJST4  | 5 100           | 1/4            | 6  |
| 6AJJST4 | 3 950           | 1/4            | 6  |
| 6AKST4  | 3 100           | 1/4            | 6  |
| 6ALST4  | 2 150           | 1/4            | 6  |
| 6AMST6  | 1 500           | 3/8            | 10 |
| 6ARST6  | 500             | 3/8            | 10 |
| 6ASST6  | 350             | 3/8            | 10 |

## MOTOR PARTS





## GEAR UNITS



## BA8406 Part Number Cross Reference

[illegible]

## MAINTENANCE SECTION

### WARNING

Always wear eye protection when operating or performing maintenance on this tool.

Always turn off the air supply and disconnect the air supply hose before installing, removing or adjusting any accessory on this tool, or before performing any maintenance on this tool.

### LUBRICATION

Each time a Series 6A Drill is disassembled for repair or replacement of parts, lubricate the tool as follows:

1. Moisten all O-rings with O-ring lubricant.
2. Work approximately 1.5 cc of Ingersoll-Rand No. 67 Grease into the Rear Rotor Bearing (18), Front Rotor Bearing (24) and the Spindle Bearing (41).
3. Work approximately 6 cc to 8 cc of Ingersoll-Rand No. 67 Grease into the D, H, J, JJ, K or L ratio gear train and 10 cc to 12 cc of Ingersoll-Rand No. 67 Grease into the M, R or S ratio gear train. Grease the Planet Gear Bearings (28, 30, 36 and 38), the gear teeth inside the Gear Case (39) and the planet gear shafts on the Spindle (26) and Gear Head (35).

### DISASSEMBLY

#### General Instructions

1. Do not disassemble the tool any further than necessary to replace or repair damaged parts.
2. Whenever grasping a part in a vise, always use leather-covered or copper-covered vise jaws to protect the surface of the part and help prevent distortion. This is particularly true of threaded members and housings.
3. Do not remove any part which is a press fit in or on a subassembly unless the removal of that part is necessary for repairs or replacement.
4. Do not disassemble the tool unless you have a complete set of new gaskets and O-rings for replacement.

#### Disassembly of the Gearing

1. For L, M, R or S ratio, loosen the Pinch Bolt (50) and remove the Dead Handle Assembly (49) and Handle Adapter (48).
2. Remove the Drill Chuck (47) by inserting the Chuck Key in one of the holes in the Chuck and tapping the Key sharply with a hammer.
3. Being careful not to distort the Motor Housing (1), grasp the flats on the Housing in leather-covered or copper-covered vise jaws with the Gear Case (40) facing upward.
4. Using a wrench on the flats of the Gear Case, loosen, but do not remove the Gear Case.

### NOTICE

In the following step, be sure to hold the tool over a workbench so that you will not drop or lose parts.

5. Remove the tool from the vise and, while holding the tool horizontally, carefully unscrew the Gear Case and pull it away from the Motor Housing.
6. Using snap ring pliers, remove the Gear Retainer (31).
7. For D ratio, remove the Drive Plate (33).
8. For H, J, JJ, K or M ratio, the Rotor Pinion (32) may come out with the Gear Case, or it may have remained with the Rotor (20) when the Gear Case was removed. Remove the Rotor Pinion.
9. For R or S ratio, remove the Gear Head Planet Gear Assembly (36), Gear Head (35) and Gear Head Spacer (34).  
For M ratio, remove the Gear Head Planet Gear (37), Gear Head Planet Gear Bearing (38), Gear Head (35) and Gear Head Spacer (34).
10. Remove the Spindle Planet Gear Assembly (28) or Spindle Planet Gear (29).
11. Push the Spindle from the Gear Case.
12. If it is necessary to remove the Spindle Bearing (41) from the front of the Gear Case, use a pair of internal snap ring pliers to remove the Spindle Bearing Retainer (43). Remove the Bearing Seal (42).
13. Do not remove the Spindle Bearing from the Gear Case unless it is absolutely necessary and you have a new bearing for replacement. If you must remove the bearing from the Gear Case, position the Gear Case vertically in an arbor press, internally threaded end facing upward. Using a 3/4" (19 mm) diameter brass rod against the bearing, press the Spindle Bearing from the Gear Case.
14. Tap the front end of the Gear Case on a workbench to remove the Grease Shield (44).
15. Remove the and Seal Support (27) from the Spindle.
16. If the Grease Shield Retainer (45) must be removed, insert a thin blade screwdriver under the tab, and rotary motion, spiral the Retainer out of the groove in the Gear Case.

#### Disassembly of the Motor

1. Grasp the splined end of the Rotor (20) in leather-covered or copper-covered vise jaws and pull the assembled motor from the Motor Housing (1).
2. Remove the Rear End Plate Gasket (15) from the Motor Housing.
3. Using a wrench, unscrew and remove the Rear Rotor Bearing Retaining Nut (16).
4. Remove the Rotor from the vise and remove the Bearing Thrust Washer (17), Rear End Plate (19), Cylinder (22) and Vanes (21).
5. Check the Front Rotor Bearing (24) for damage or roughness. If replacement is necessary, support the Front End Plate (23) between two blocks of wood on the table of an arbor press. Using a flat face punch on the inner ring, tap the Bearing out of the End Plate.

## MAINTENANCE SECTION

6. Check the Rear Rotor Bearing (18) for damage or roughness. If replacement is necessary, use a flat face punch on the inner ring and tap the Bearing out of the End Plate.

### Disassembly of the Pistol Grip Motor Housing

1. Carefully grasp the Motor Housing (1) in leather-covered or copper-covered vise jaws so that the handle is upward.
2. Unscrew and remove the Inlet Bushing Assembly (8).
3. Remove the Muffler Assembly (11) and Muffler O-ring (12) from the Muffler Assembly.
4. Withdraw the Air Strainer Screen (9), Throttle Valve Spring (7) and Throttle Valve (6) from the housing handle.
5. Withdraw the Trigger Assembly (3).
6. Remove the Muffler Element (13).
7. For R or S ratios, remove the Muffler Element (14).

#### NOTICE

In the following step, only remove the Throttle Valve Seat (5) when replacing it or when the Trigger Bushing (2) must be replaced.

8. To remove the Throttle Valve Seat, insert a wire hook through the central hole of the Seat and hooking the underside of the Seat, pull the Seat out of the Motor Housing.
9. Before removing the Trigger Bushing (2), all Seals and components must be removed from the Motor Housing.
  - a. Grasp the Motor Housing in copper-covered vise jaws with the Trigger Bushing upward.

#### CAUTION

In the following step, apply enough heat to warm the Housing, but do not exceed 200°F. Do not apply heat directly to the Skinsulate covering. Take all precautions necessary to avoid being burned during the following procedure.

- b. Using a torch, apply heat to the Motor Housing around the Bushing.
- c. Thread a 10-32 tap into the Bushing and pull the Bushing out of the Housing with the tap.

## ASSEMBLY

### General Instructions

1. Always press on the inner ring of a ball-type bearing when installing the bearing on a shaft.
2. Always press on the outer ring of a ball-type bearing when installing the bearing in a bearing recess.
3. Whenever grasping a tool or part in a vise, always use leather-covered or copper-covered vise jaws. Take extra care with threaded parts and housings.

\* Registered trademark of Loctite Corporation.

4. Always clean every part and wipe every part with a thin film of oil before installation.
5. Apply a film of O-ring lubricant to all O-rings before final assembly.
6. Check every bearing for roughness. If an open bearing must be cleaned, wash it thoroughly in a suitable cleaning solution and dry with a clean cloth. **Sealed or shielded bearings should never be cleaned.** Work grease thoroughly into every open bearing before installation.

### Assembly of the Pistol Grip Motor Housing

1. If the Trigger Bushing (2) was removed, proceed as follows:
  - a. Put a few drops of Loctite®\* No. 601 Sealant on the end of a thin stick and insert the stick into the trigger bushing hole of the Motor Housing. Work the stick so that the Sealant flows against the shoulder inside the Housing.
  - b. Insert the Trigger Bushing into the Motor Housing (1) to a depth approximately one-half the length of the Bushing.
  - c. Put a few drops of Loctite No. 601 Sealant in the counterbore surrounding the outside diameter of the Bushing.
  - d. Rotate the Bushing approximately 180 degrees to make certain the Sealant makes complete contact around the outside of the Bushing.
  - e. Push the Bushing into the Housing until it bottoms against the shoulder inside the Housing.
  - f. Allow the Sealant to cure for eight hours at room temperature.
2. Carefully grasp the Motor Housing in leather-covered or copper-covered vise jaws, inlet end facing upward.
3. If the Throttle Valve Seat (5) was removed, use a flat-faced rod 1/2" (13 mm) in diameter by 3" (76 mm) long to push the Seat into the Motor Housing until it seats.
4. Press the Trigger (3) onto the grooved end of the Trigger Pin so that it is at right angles to the hole in the opposite end of the Pin.
5. Insert the Trigger Assembly into the Trigger Bushing so that the hole in the Trigger Pin aligns dead center with the hole in the Throttle Valve Seat.
6. For R and S ratios, work the Muffler Element (14) into the exhaust cavity in the handle of the Motor Housing.
7. Fold or roll the Muffler Element (13) and work it into the exhaust cavity in the handle of the Motor Housing.
8. Using needle nose pliers to hold the short stem end of the Throttle Valve (6), install the Valve inserting the long stem end through the hole in the Throttle Valve and Trigger Pin.

## MAINTENANCE SECTION

9. Place the Air Strainer Screen (9), closed end first, inside the large end coil of the Throttle Valve Spring (7).
10. Insert the Throttle Valve Spring and Screen, small coil end first, so that the Spring encircles the end of the Throttle Valve.
11. Apply a thin coat of O-ring lubricant to the Muffler O-ring (12) and install the O-ring on the hub of the Muffler (11).
12. Install the Inlet Bushing Spacer (10) in the large hole in the Muffler Assembly (11).
13. Place the Muffler Assembly on the face of the handle so that the hub with the Muffler O-ring extends into the handle.
14. Thread the Air Inlet Bushing (8) into the large hole in the Muffler Assembly. Tighten the Bushing to a minimum of 26 ft-lb (35 Nm) torque.

### Assembly of the Motor

1. If the Rear Rotor Bearing (18) was removed, use a sleeve that contacts the outer ring of the Rear Rotor Bearing and press the Rear Rotor Bearing into the Rear End Plate (19).
2. Place the Rear End Plate, bearing end trailing, on the threaded hub of the Rotor (20). Insert a 0.001" feeler gauge or shim between the face of the Rotor and End Plate. Place the Bearing Thrust Washer (17) on the threaded hub of the Rotor. Thread the Rear Rotor Bearing Retaining Nut (16) onto the hub of the Rotor and tighten it until the feeler gauge has a slight drag during removal. Remove the feeler gauge.

#### NOTICE

**The Rotor must spin freely while holding the End Plate.**

3. Lightly grasp the threaded hub of the Rotor in leather-covered or copper-covered vise jaws with the splined hub upward.
4. Wipe each Vane (21) with a film of light oil and place a Vane in each slot in the Rotor.
5. Looking down the axis of the Rotor and Cylinder (39), position the Cylinder over the Rotor with the cylinder dowel hole at twelve o'clock, the notch in cylinder face at ten o'clock and the two slots in the side of the Cylinder at two o'clock. Place the Cylinder down over the Rotor and Vanes and against the Rear End Plate.
6. Push the Front Rotor Bearing (24) into the recess in the Front End Plate (23).

#### NOTICE

**Before pressing the Bearing onto the rotor shaft in the next step, align the cylinder dowel hole in the Rear End Plate, Cylinder and Front End Plate. After pressing the Bearing onto the shaft, lightly**

**rap the end of the splined hub with a plastic hammer to relax the load on the Bearing. The Rotor must rotate in the Bearing without drag.**

7. Remove the assembled Rotor from the vise and using a sleeve that contacts the inner ring of the Front Rotor Bearing, press the Bearing, flat side of the Front End Plate first, onto the rotor shaft.
8. Position the Rear End Plate Gasket (15) in the bottom of the motor housing bore so that the dowel hole and air inlet port in the Gasket align with the dowel hole and air inlet in the housing bore face.
9. Using an assembly dowel 3/32" in diameter by 10" long (2.3 mm x 254 mm), align the dowel holes in the Front End Plate, Cylinder and Rear End Plate. Insert the assembly rod through the aligned holes so that about 3" (76 mm) of the rod extends beyond the Rear End Plate. Insert the extension into the dowel hole at the bottom of the housing bore, and slide the motor into the Motor Housing until it seats.
10. Withdraw the assembly dowel and insert the Cylinder Dowel (25) until the Cylinder Dowel is slightly below the surface of the Front End Plate.

### Assembly of the Gearing

1. Stand the Gear Case (39), end with the flats upward, on a workbench.
2. If the Shield Retainer (45) was removed, install it in the second groove below the front face of the Gear Case.
3. Place the Grease Shield (44) in the Gear Case so that it butts against the Shield Retainer.
4. Using a sleeve that contacts the outer ring of the Bearing, press the Spindle Bearing (41) into the Gear Case until it butts against the Grease Shield. Install the Spindle Bearing Seal (42).
5. Using snap ring pliers, install the Spindle Bearing Retainer (43) against the Bearing Seal and into the groove in front of the Spindle Bearing.
6. Turn the Gear Case over so that the internal threaded end faces upward.
7. Install the Seal Support (27), large end first, over the hub of the Spindle (26).
8. Slide the Spindle into the Gear Case, threaded end first, until the Seal Support contacts the inner ring of the Spindle Bearing.
9. **For D ratio**, align the three holes in the Drive Plate (33) with the spindle pins and install the Drive Plate on the pins of the Spindle.
10. **For H Ratio**, push the Spindle Planet Gear Bearings (30) into the Spindle Planet Gears (29). Grease the assembled Spindle Planet Gears and Bearings and install them on the pins of the Spindle.
11. **For J, JJ, K, L, M, R or S ratio**, grease the bearings and gears of the Spindle Planet Gear Assemblies (28) and install them on the pins of the Spindle.

## MAINTENANCE SECTION

12. For **M, R or S ratio**, install the Gear Head Spacer (34) in the Gear Case against the Spindle Planet Gears.
13. For **M, R or S ratio**, grease the splined hub of the Gear Head (35) and insert it into the Gear Case. The splined hub must pass through the Gear Head Spacer and mesh with the teeth of the Spindle Planet Gears.
14. For **M ratio**, push the Gear Head Planet Gear Bearings (38) into the Gear Head Planet Gears (37). Grease the assembled Gear Head Planet Gears and Bearings and install them on the pins of the Gear Head.
15. For **R or S ratio**, grease the bearings and gears of the Gear Head Planet Gear Assemblies (36) and install them on the pins of the Gear Head.
16. For **H or J ratio**, grease the Rotor Pinion (32) and install it in the center of the Spindle Planet Gears. Make certain the teeth of the Pinion and Planet Gears mesh.  
For **M ratio**, grease the Rotor Pinion (32) and install it in the center of the Gear Head Planet Gears. Make certain the teeth of the Pinion and Planet Gears mesh.
17. Using snap ring pliers, install the Gear Retainer (31) in the shallow internal groove in the Gear Case behind the Drive Plate, Spindle Planet Gears or Gear Head Planet Gears.
18. Thread the assembled Gear Case onto the assembled Motor Housing until it is hand tight. Make certain the gear teeth on the Spindle mesh with the gear teeth of the Rotor Pinion, Gear Head Planet Gears or Spindle Planet Gears.
19. Tighten the Gear Case between 30 and 35 ft-lb (41 and 47 Nm) torque.
20. For **D, H, J, JJ, K or L ratio**, install one Drill Chuck Spacer (46) onto the drill spindle.  
For **M, R or S ratio**, install two Drill Chuck Spacers (46) onto the drill spindle.
21. Thread the Drill Chuck (47) onto the drill spindle and tighten.
22. For **L, M, R or S ratio**, install the Dead Handle Adapter (48) and Dead Handle Assembly (49) onto the front end of the Gear Case. Tighten the Pinch Bolt (50) between 10 and 20 in. lb (1.4 and 2.3 Nm) torque.

### NOTICE

After hand tightening the Gear Case, run the motor at free speed on low air pressure while final tightening the Gear Case. Listen while tightening to make certain the gears mesh properly.

## TROUBLESHOOTING GUIDE

| Trouble              | Probable Cause                                                 | Solution                                                                                                                                                                                                                                                              |
|----------------------|----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Loss of Power        | Low air pressure                                               | Check air supply. For top performance, the air pressure must be 90 psig (6.2 bar/620 kPa).                                                                                                                                                                            |
|                      | Plugged Air Strainer Screen or Inlet Screen                    | Clean the Air Strainer or Screen in a clean, suitable cleaning solution. If the Screen cannot be cleaned, replace it.                                                                                                                                                 |
|                      | Clogged Muffler or Exhaust Silencer                            | Clean the Muffler Element in a clean, suitable cleaning solution. If it cannot be cleaned, replace it.                                                                                                                                                                |
|                      | Worn or broken Vanes                                           | Replace a <b>complete</b> set of Vanes.                                                                                                                                                                                                                               |
|                      | Damaged Rear End Plate Gasket                                  | Install a new Rear End Plate Gasket.                                                                                                                                                                                                                                  |
|                      | Worn or broken Cylinder                                        | Replace the Cylinder if it is cracked or if the bore appears wavy or scored.                                                                                                                                                                                          |
|                      | Improper lubrication or dirt build-up                          | Clean the Motor Unit parts and lubricate them as instructed.                                                                                                                                                                                                          |
| Leaky Throttle Valve | Worn Throttle Valve and/or Throttle Valve Seat                 | Install a new Throttle Valve and/or Throttle Valve Seat.                                                                                                                                                                                                              |
|                      | Dirt accumulation on Throttle Valve and/or Throttle Valve Seat | Pour about 3 cc of a clean, suitable cleaning solution into the air inlet and operate the tool for about 30 seconds. <b>Immediately</b> , pour 3 cc of the recommended oil into the air inlet and operate the tool for 30 seconds to lubricate all the cleaned parts. |
| Gear Case gets hot   | Excessive grease                                               | Clean and inspect Gear Case and gearing parts and lubricate as instructed.                                                                                                                                                                                            |
|                      | Worn or damaged parts                                          | Clean and inspect the Gear Case and Gearing. Replace worn or broken components.                                                                                                                                                                                       |

### NOTICE

**SAVE THESE INSTRUCTIONS. DO NOT DESTROY.**