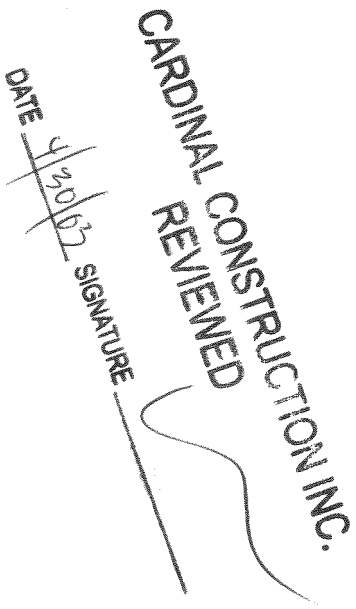
TROJAN TECHNOLOGIES INC.
UV4000LF™ OPERATION AND MAINTENANCE MANUAL
MILLIDGEVILLE, NB.

SERIAL NUMBER
410945

Trojan



Patent Numbers are:
5,006,244
4,872,980
4,482,809
1,163,086
1,327,877
2,174,989
Other Patents Pending

This manual is intended to be used by the owner to understand and operate the System UV4000™. Drawings and descriptions of the system parts are included, along with explanations of how the system works and what affects its performance.

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LOCAL REPRESENTATIVE
ATLANTIC PURIFICATION SYSTEMS LTD.
10 Ferguson Road
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Dartmouth, NS. B2Y 3Z5, CANADA
TEL: (902) 469-2806
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WARNING:

IN ORDER TO PREVENT SERIOUS BURNS, NEVER RUN UV LAMPS IN OPEN AIR OR EXPOSE ONE'S SELF TO UV LIGHT.

UV4000™ LOW FLOW DISINFECTION SYSTEM OPERATION AND MAINTENANCE MANUAL

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SYSTEM UV4000™ LOW FLOW OPERATION AND MAINTENANCE MANUAL

SECTION 1.0

Warnings and Precautions

Section 1.0 WARNINGS AND PRECAUTIONS

1. Exposure to ultraviolet light can cause serious burns to the eyes and skin. Turn off power supply to module lamps before servicing any UV lamps or modules.

2. Always wear protective clothing with proper eye glasses when working around or near operating lamps.

3. Never look directly into the reaction chamber when lamps are on.

4. Water level safety controls have been provided to shut down the lamps in the reaction chamber insert if there is insufficient water to cover the lamp sleeves. This is a safety system designed to prevent the operator from exposure to harmful UV light and to prevent damage to the lamps.

Note: Do not change, reset, disable or by-pass the water level settings on the inlet or outlet water sensor probes.

5. UV lamps must not be energized unless the lamp sleeves are fully submerged in water. Dry lamps will melt down causing dangerous UV exposure and equipment damage.

6. The power distribution centers have more than one power feed. All electric service power must be shut off before working inside the power distribution center.

7. Only qualified personnel must be allowed access inside the power distribution center and system control center.

8. Do not spray water in or around the power distribution center when lids are open.

9. The wiper system functions as a complete unit and must not be disassembled or modified unless authorized by Trojan personnel.

10. Always wear protective clothing and full eye protection when draining or filling acid in the wiper collars.

11. Acid could spill from the wiper collars during sleeve removal, therefore, always drain acid first and flush with clean water.

12. See safety precautions listed under Section 5.7 when removing a module for maintenance.

Shell Canada Limited

Material Safety Data Sheet

Effective Date: 2001-01-08
Supersedes: 2000-05-19

THIS PRODUCT IS NOT A WHMIS CONTROLLED SUBSTANCE.

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT:	**TELLUS* T 15**
SYNONYMS:	LOW TEMPERATURE HYDRAULIC OIL
PRODUCT USE:	Hydraulic Fluid
MSDS Number:	407-154

MANUFACTURER
Shell Canada Limited
P.O. Box 100, Station M
400-4th Ave. S.W.
Calgary, AB Canada
T2P 2H5

TELEPHONE NUMBERS	
Shell Emergency Number	1-800-661-7378
CANUTEC 24 HOUR EMERGENCY NUMBER	613-996-6666
For general information:	1-800-661-1600
For MSDS information:	403-691-3982
(From 7:30 to 4:30 Mountain Time)	403-691-2220

This MSDS was prepared by the Toxicology and Material Safety Section of Shell Canada Limited.

*An asterisk in the product name designates a trade-mark(s) of Shell Canada Limited, used under license by Shell Canada Products.

2. COMPOSITION/INFORMATION ON INGREDIENTS

Component Name	CAS Number	% Range	WHMIS Controlled	CBI Claim No. CBI Date

THIS PRODUCT IS NOT A WHMIS CONTROLLED SUBSTANCE.
See Section 8 for Occupational Exposure Guidelines.

3. HAZARDS IDENTIFICATION

Physical Description: Liquid Lightly Coloured Hydrocarbon Odour

Routes of Exposure: Exposure will most likely occur through skin contact or from inhalation of mechanically or thermally generated oil mists.

Hazards:

Inhalation of oil mist or vapours from hot oil may cause irritation of the upper respiratory tract.

For further information on health effects, see Section 11.

4. FIRST AID

Eyes	Flush eyes with water for at least 15 minutes while holding eyelids open. If irritation occurs and persists, obtain medical attention.
Skin	Wipe excess from skin. Wash contaminated skin with mild soap and water for 15 minutes.
Ingestion	Do not induce vomiting. Obtain medical attention immediately.
Inhalation	Remove victim from further exposure. Additional first aid treatment is not ordinarily required.
Notes to Physician	In general, lubricating oils have low oral toxicity. High pressure injection under the skin may have serious consequences and may require urgent treatment.

5. FIRE FIGHTING MEASURES

Extinguishing Media	Dry Chemical Carbon Dioxide Foam Water Fog
Firefighting Instructions	Water or foam may cause frothing. Do not use a direct stream of water as it may spread fire. Containers exposed to intense heat may rupture. Use water to cool fire exposed containers. Water may be used to flush spills away from exposure. Do not enter confined fire space without adequate protective clothing and an approved positive pressure self-contained breathing apparatus.
Hazardous Combustion Products	Carbon monoxide, carbon dioxide and dense smoke are produced on combustion.

6. ACCIDENTAL RELEASE MEASURES

Eliminate all ignition sources. Isolate hazard area and restrict access. Wear appropriate breathing apparatus (if applicable) and protective clothing. Stop leak only if safe to do so. Dike and contain land spills; contain water spills by booming. For large spills remove by mechanical means and place in containers. Absorb residue or small spills with absorbent material and remove to non-leaking containers for disposal. Flush area with water to remove trace residue. Dispose of recovered material as noted under Disposal Considerations. Notify appropriate environmental agency(ies).

7. HANDLING AND STORAGE

Handling:	Avoid excessive heat, formation of oil mist, breathing of vapours and mist of hot oil and prolonged or repeated contact with skin. Launder contaminated clothing prior to reuse. Properly dispose of contaminated leather articles, including shoes, that cannot be decontaminated. Use good personal hygiene.
Storage:	Store in a cool, dry, well ventilated area, away from heat and ignition sources.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

THE FOLLOWING INFORMATION, WHILE APPROPRIATE FOR THIS PRODUCT, IS GENERAL IN NATURE. THE SELECTION OF PERSONAL PROTECTIVE EQUIPMENT WILL VARY DEPENDING ON

THE CONDITIONS OF USE.

Occupational Exposure Limits (2000) :	Oil mist (mineral): 5 mg/m3 (TLV/TWA) ACGIH 10 mg/m3 (TLV/STEL) ACGIH
Mechanical Ventilation:	To maintain levels below workplace exposure limits mechanical ventilation recommended. Local ventilation is recommended if oil mist is present or if exposure limit is exceeded. Make up air should always be supplied to balance air exhausted (either generally or locally).

PERSONAL PROTECTIVE EQUIPMENT:

Eye Protection:	Chemical safety goggles and/or full face shield to protect eyes and face, if product is handled such that it could be splashed into eyes.
Skin Protection:	Oil impervious gloves (nitrile, neoprene or PVC) should be worn at all times when handling this product. Impervious clothing (apron, coveralls) should also be worn in confined workspaces or where the risk of skin exposure is much higher.
Respiratory Protection:	If exposure exceeds occupational exposure limits, use an appropriate NIOSH-approved respirator. Depending on airborne concentrations, use either a NIOSH-approved dust/mist respirator or a NIOSH-approved supplied-air respirator. Under conditions of high heat, use a NIOSH-approved chemical cartridge respirator with organic vapour cartridges in combination with a dust/mist pre-filter.

9. PHYSICAL DATA

Physical State:	Liquid
Appearance:	Lightly Coloured
Odour:	Hydrocarbon Odour
Odour Threshold:	Not available
Freezing/Pour Point:	Pour Point <-51 degrees C
Boiling Point:	>315 degrees C
Density:	841.5 kg/m3 @ 15 degrees C
Vapour Density (Air = 1):	Not available
Vapour Pressure:	<0.1 mm Hg @ 20 degrees C
Specific Gravity (Water = 1):	0.000
pH:	Not applicable
Flash Point:	Method Cleveland Open Cup = 116 degrees C
Lower Explosion Limit:	Not available
Upper Explosion Limit:	Not available
Autoignition Temperature:	Not available
Viscosity:	14.25 - 15.75 cSt @ 40 degrees C
Evaporation Rate (n-BuAc = 1):	Not available
Partition Coefficient (K_{ow}):	Not available
Water Solubility:	Insoluble
Other Solvents:	Hydrocarbon Solvents

10. STABILITY AND REACTIVITY

Chemically Stable:	Yes
Hazardous Polymerization:	No

Sensitive to Mechanical Impact:	No
Sensitive to Static Discharge:	No
Incompatible Materials:	Avoid strong oxidizing agents.
Conditions of Reactivity:	Avoid excessive heat, formation of vapours or mists.

11. TOXICOLOGICAL INFORMATION

Ingredient (or Product if not specified) **Toxicological Data**

Routes of Exposure:	Exposure will most likely occur through skin contact or from inhalation of mechanically or thermally generated oil mists.
Formulation:	No data is specifically available for this product and therefore this toxicological information is based on data available for the ingredients.
Irritancy:	This product is not a primary skin irritant after exposure of short duration, is not a skin sensitizer and is not irritating to the eyes.
Chronic Effects:	Prolonged or repeated contact may cause various forms of dermatitis including folliculitis and oil acne. Long term intensive exposure to oil mist may cause benign lung fibrosis.

12. ECOLOGICAL INFORMATION

Environmental Effects	Do not allow product or runoff from fire control to enter storm or sanitary sewers, lakes, rivers, streams, or public waterways. Block off drains and ditches. Provincial regulations require and federal regulations may require that environmental and/or other agencies be notified of a spill incident. Spill area must be cleaned and restored to original condition or to the satisfaction of authorities.
Biodegradability	Not readily biodegradable.

13. DISPOSAL CONSIDERATIONS

Waste management priorities (depending on volumes and concentration of waste) are: 1. recycle (reprocess), 2. energy recovery (cement kilns, thermal power generation), 3. incineration, 4. disposal at a licenced waste disposal facility. Do not attempt to combust waste on-site. Incinerate at a licenced waste disposal site with approval of environmental authority. Landfill absorbed material in a government approved site.

14. TRANSPORTATION INFORMATION

Canadian Road and Rail Shipping Classification:
This product is not regulated under the Canadian Transportation of Dangerous Goods Regulations for transport by road and rail.

15. REGULATORY INFORMATION

This product has been classified in accordance with the hazard criteria of the *Controlled Products Regulations* (CPR) and the MSDS contains all the information required by the CPR.

DSL/NDSL Status:	THIS PRODUCT IS NOT A WHMIS CONTROLLED SUBSTANCE. This product, or all components, are listed on the Domestic Substances List, as required under the Canadian Environmental Protection Act. This product and/or all components are listed on the U.S. EPA TSCA Inventory.
Other Regulatory Status:	Provincial criteria are likely and should be requested when notifying provincial authorities. No Canadian federal standard; however, for general discharge guidance, federal installations limited to 15 mg/L for total oil and grease.

16. ADDITIONAL INFORMATION

Revisions:	This revision reflects the change of name from Shell Canada Products Limited to Shell Canada Products. This MSDS has been reviewed and updated.

ECOLAB

Ecolab Inc.

Ecolab Center
St. Paul, Minnesota 55102

12021 MATERIAL SAFETY DATA SHEET
MEDICAL EMERGENCIES ONLY (24 Hour Service): 1-800-328-0026
Medical Calls from Outside of the USA: 1-651-222-5352
INSTITUTIONAL DIVISION Ecolab Inc.
Ecolab Center St. Paul MN 55102
Product Information: 1-800-352-5326 Issue Date: March 29, 2001

1.0 IDENTIFICATION /

1.1 Product Name: LIME-A-WAY 10.2P
1.2 Product Type: Liquid High Acid Cleaner/Delimer
1.3 Hazard Rating: Health: 3 Fire: 0 Reactivity: 0

Substances Subject to SARA 313 Reporting Are Indicated by "#"

2.0 HAZARDOUS COMPONENTS /

	CAS No.	%	(mg/m3) PEL	TWA
2.1 Phosphoric acid	7664-38-2	32	1	1*
			*ACGIH STEL = 3	
2.2 Nonionic surfactant	confidential	1-5	No	No

STEL = ACGIH short term exp. limit (15 min) PEL = OSHA 8 hr ave in air
TWA = ACGIH 8 hr average C = ceiling limit in air, do not exceed

3.0 PHYSICAL DATA /

3.1 Appearance: Clear green liquid; mild organic odor
3.2 Solubility in Water: Mixes with water in all proportions
3.3 pH: 1.0 - 1.5 (100%); 2.0 - 3.0 (1%)
3.4 Initial Boiling Point: > 212 deg F
3.5 Specific Gravity: 1.205 @ 68 deg F

4.0 FIRE AND EXPLOSION DATA /

4.1 Special Fire Hazards: None
4.2 Fire Fighting Methods: Product does not support combustion.

5.0 REACTIVITY DATA /

5.1 Stability: Stable under normal conditions of use and handling.
5.2 Conditions to Avoid: Mix only with water. Reacts with metals; reacts vigorously with alkaline chemicals. Do not mix with chlorinated detergents or sanitizers - will cause hazardous vapors.

6.0 SPILL OR LEAK PROCEDURES / USE PROPER PROTECTIVE EQUIPMENT

6.1 Cleanup: Dike or dam large spills. Pump to containers or soak up on inert absorbent. Flush residue or small spills to sanitary sewer.
6.2 Waste Disposal: Consult state/local authorities for limits on chemical waste disposal. Unused product is RCRA Corrosive (D002).

7.0 HEALTH HAZARD DATA / DANGER

7.1 Effects of Overexposure to Concentrate:
Eyes: CAUSES CHEMICAL BURNS. May cause blindness.
Skin: CAUSES CHEMICAL BURNS.
If Swallowed: HARMFUL. Causes chemical burns of mouth, throat and stomach.
If Inhaled: Vapors or mist cause irritation, including a burning taste, sneezing, coughing and difficulty breathing. People with asthma or other lung problems may be more affected.

8.0 FIRST AID /

8.1 Eyes: Flush at once with cool running water. Remove contact lenses and continue flushing for 15 minutes, holding eyelids apart so as to rinse entire eye. CALL A PHYSICIAN IMMEDIATELY.
8.2 Skin: Immediately flush skin with plenty of cool running water for at least 15 minutes while removing contaminated clothing and shoes. Discard or wash before reuse.
8.3 If Swallowed: Rinse mouth at once; then drink 1 or 2 large glasses of water. DO NOT induce vomiting. NEVER give anything by mouth to an unconscious person.
8.4 If Inhaled: Immediately move to fresh air.

IMMEDIATELY CALL THE MEDICAL EMERGENCY NUMBER, 1-800-328-0026,
A POISON CONTROL CENTER, OR A PHYSICIAN

9.0 PROTECTIVE MEASURES /

9.1 FOR CONCENTRATE:
Eyes: Wear chemical splash goggles. For continued or severe exposure wear a face shield over the goggles.
Skin: Wear any industrial rubber gloves, other protective equipment as necessary to prevent skin contact.
Respiratory: Avoid breathing mists or vapors of this product.
Note: Access to emergency eye wash and shower is recommended.

10.0 ADDITIONAL INFORMATION /

10.1 Purpose of 3/29/2001 issue: Remove SARA 313 for phosphoric acid. Replaces January 14, 2000 issue.

KEEP OUT OF REACH OF CHILDREN

The above information is believed to be correct with respect to the formula used to manufacture the product. As data, standards and regulations change, and conditions of use and handling are beyond our control, NO WARRANTY, EXPRESS OR IMPLIED, IS MADE AS TO THE COMPLETENESS OR CONTINUING ACCURACY OF THIS INFORMATION.

SECTION 1.2 MAINTENANCE SUMMARY FORM

1. MAINTENANCE REQUIREMENTS

a) UV MODULES

Maintenance Operation Comments	Frequency	Solution (If Applicable)
Replace Ultraviolet Lamps, see Section 5.7 of manual.	5000 HOURS prorated @ 60% Power Level	---
Recharge cleaning solution in wiper assemblies, see Section 5.8 of manual.	When PH of solution is lower than 3	Limeaway (10% phosphoric acid solution)

b) MODULE REMOVE MECHANISM

Maintenance Operation Comments	Frequency	Lubricant (If Applicable)
Lubricate stainless steel cable.	Monthly	General purpose grease
Inspect cable for fraying. Inspect lifting hook for stress.	Monthly	---

c) HYDRAULIC SYSTEMS CENTRE

Maintenance Operation Comments	Frequency	Fluid
Check fluid levels in cooling system reservoir. See Section 6.3 for details.	Monthly	50/50 mixture propylene glycol and water
Check fluid levels in hydraulic reservoir. See Section 6.4 for details.	Monthly	Tellus 15

d) **ONLINE TRANSMISSION UNIT**

Maintenance Operation Comments	Frequency	Solution (If Applicable)
Flush system with cleaning agent. See Section 3.5 for details.	Monthly	20 ml bleach/20 litres water
Replace Desiccant Tray. See Section 3.5 for details.	Check tray weekly. Replace when colour pink.	---
Clean quartz cuvette. See Section 3.5 for details.	Monthly	Mild liquid detergent 5ml / 4 litres water

e) **INTENSITY PROBE**

Maintenance Operation Comments	Frequency	Solution
Clean quartz window of probe body. See Section 4.3 for details.	Weekly	Limeaway (10% phosphoric acid solution)

2. **RECOMMENDED SPARE PARTS FOR INVENTORY**

Part No.	Description	Unit	Quantity
441039	UV Lamp Assembly	ea	10
441033	Quartz Sleeve Assembly	ea	10
903374	Electronic Ballast	ea	10
445007	Wiper Seal	ea	10
442644	Hydraulic Cylinder	ea	1
442077	Hydraulic Cylinder Boot	ea	1

For a complete Replaceable Parts List see Section 10.0 of this manual.

SYSTEM UV4000™ LOW FLOW OPERATION AND MAINTENANCE MANUAL

SECTION 2.0

Introduction

Section 2.0 INTRODUCTION

The Trojan System UV4000LF™ uses ultraviolet light to disinfect waste water and process water. Its simple effective design makes it suitable for many large scale applications in water treatment. Unlike chemical disinfection, UV does not require the handling of dangerous substances and adds no toxic compounds to the effluent. Gravity flow through an open channel eliminates the pumps and pressure vessels associated with most other UV systems. The modular design of the System UV4000LF™ makes it versatile and permits easy access to the equipment.

What is Ultraviolet (UV) Light?

UV light is defined as electromagnetic radiation having a wavelength less than that of visible light (400 nm) and greater than that of X-Rays (100 nm). The unit of wavelength used is a nanometre (nm) equal to 10^{-9} meters. The optimum UV wavelength for germicidal effect is 265 nm, which is found only in small amounts in solar radiation because energy at these wavelengths is absorbed by the atmosphere.

The primary source of UV energy in current technology is a special short wave arc lamp (like the ones supplied with your system). The primary reason for its use is that a significant amount of its UV energy output is near the wavelength of 265 nm. The radiation is generated by striking an electric arc through a metallic compound vapour; discharge of the energy generated by excitation of the metallic molecules results in the emission of the UV light.

Disinfection vs. Sterilization

Sterilization implies the total elimination of pathogens or disease carrying microorganisms. In contrast, disinfection is a reduction in the concentration of pathogens to non-infectious levels.

How Does UV Light Disinfect?

UV light with a wavelength of 265 nm causes a rearrangement in the genetic code of microorganisms, preventing them from reproducing.

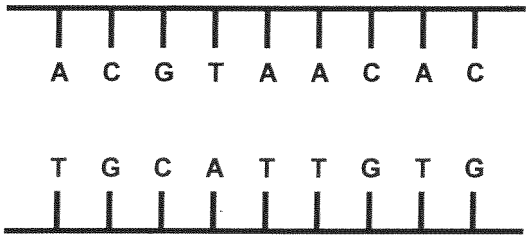
Microorganisms are single-celled organisms and these in turn are made out of molecules. Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are chain-like macromolecules that function in the storage and transfer of a cell's genetic information (type and quantity of enzyme production). The DNA molecule is considered to be the principal target of UV radiation energy and the primary component where significant biological damage occurs.

The DNA is a long polymer comprised of a double helix chain of simple monomeric units (molecules) called nucleotides. There are four different DNA nucleotides differing only in their base component and represented by the letter A, G, C & T.

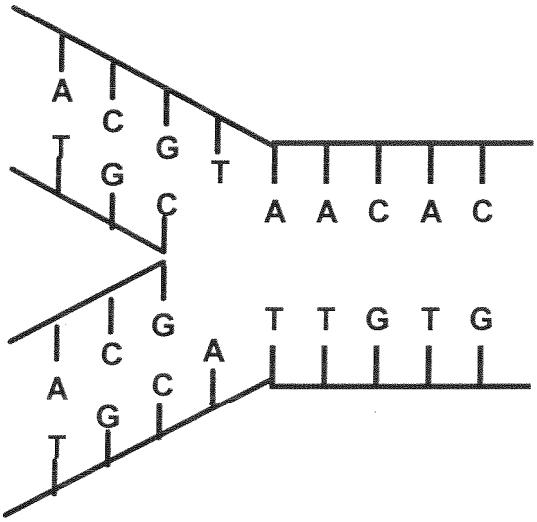
BASE COMPONENT	DNA NUCLEOTIDES	
PURINE	A (ADENINE)	G (GUANINE)
PYRIMIDINE	T (THYMINE)	C (CYTOSINE)

The order of these nucleotides constitutes the genetic information of the cell. In the two strands, G is always opposite C and T is opposite A; if damage occurs in one strand the adjacent strand can serve as a template to reverse the damage or to reconstruct the damaged segment. During cell division, duplicate DNA strands are prepared through splitting of the original DNA strand and building a complementary strand to each of the parental strands.

Hypothetical DNA Double Strand



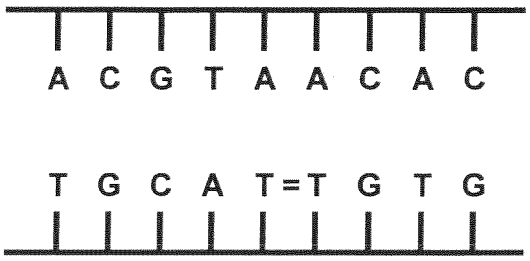
Replicating DNA



At this point, the concepts of dimer and dimerization should be introduced. Dimerization occurs when two adjacent molecules form new bonds such that a double molecule (or dimer) is formed.

The photochemical changes induced by UV radiation on the DNA of an organism have been thoroughly studied. Although several mechanisms exist, the most dominant is the dimerization of two pyrimidine molecules. The UV induced dimer between two adjacent pyrimidines has been demonstrated for all combinations. However, the thymine dimer is formed with the greatest efficiency. This is shown on the Figure below.

Dimerization of Thymine Nucleotides



There are two adjacent thymine monomers on one of the strands; during exposure to UV light, new bonds are formed between the two such that a double Thymine molecule or dimer is formed. Formation of many dimers along a DNA strand makes replication very difficult.

FACTORS AFFECTING UV DISINFECTION

Ultraviolet light kills bacteria and viruses by destroying their genetic material. The performance of a UV system to disinfect water is expressed in terms of reduction of bacteria, or "kill". Each system is designed to reduce bacteria counts to a certain allowable level, which depends on the requirements of the specific application. The dose of UV light available to kill bacteria is measured in microwatt-seconds/cm^2, which is equivalent to the product of the light intensity and the duration of exposure, or retention time. Any factor that affects light intensity or retention time will affect performance.

Dose = Intensity (μW/cm^2) x Retention Time (sec)

The Trojan System UV4000^{TM} is designed to deliver a dose that takes into account lamp aging.

	Factors Affecting Performance		
DOSE =	INTENSITY	X	RETENTION TIME
	Water Quality • UV Transmission • Suspended Solids • Level of Dissolved organics • Total Hardness Lamp Condition • Sleeve Cleanliness • Aging Treatment Process		Flow Rate Reactor Design

UV Transmission:

UV transmission is defined as the percentage of UV light at 254 nm not absorbed after passing through 1 cm of effluent sample. Transmission depends on dissolved and suspended matter in the water. Reduced transmission lowers the intensity of the light in the liquid, thus requiring longer exposure time in order to deliver the proper UV dose. The visual clarity of a water sample is not always a good indicator of its UV transmission since water that is clear to visible light may absorb invisible ultraviolet wavelengths.

Suspended Solids (SS):

Suspended solids consist of any filterable particles present in the water, and are measured in parts per million (ppm) or mg/l. They lower UV transmission by scattering and absorbing the light. They can also reduce kill by encapsulating bacteria and protecting them from exposure to the UV light. If a wastewater contains high levels of SS, a higher UV dose is required.

Typically, the level of SS varies within the range of 5.0 to 30.0 mg/l

Level of Dissolved Organics:

Specific organic compounds in a wastewater stream will absorb energy which is emitted in the germicidal wavelength region of the spectrum.

Total Hardness:

The presence of high levels of inorganic magnesium or calcium carbonates in a wastewater stream may contribute to coating of the quartz sleeve.

Sleeve Cleanliness:

To ensure maximum performance from the unit, it is essential that the quartz sleeves be kept clean. If coating is allowed to build up on the sleeves, the amount of the UV light transmitted to the water will be reduced.

Treatment Process:

The Biological (secondary) treatment process has a bearing on the performance of the UV system. Different treatment processes produce effluents with different UV transmittance characteristics and different observed cleaning frequency patterns.

Flow Rate:

The flow rate through the UV system will determine the retention time, which in turn determines the delivered UV dose at a given UV light intensity.

Reactor Design:

The hydraulic characteristics of a reactor can strongly influence disinfection efficiency.

SYSTEM UV4000™ LOW FLOW OPERATION AND MAINTENANCE MANUAL

SECTION 3.0

UV4000™ System Control Center

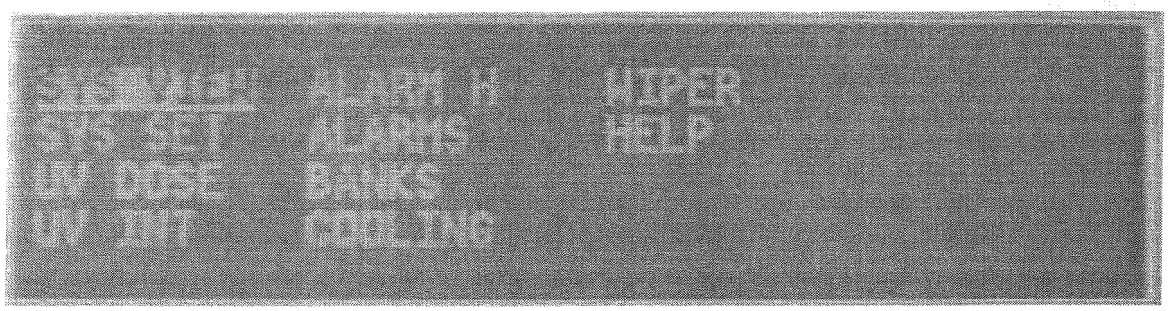
Section 3.1 LOW FLOW USER INTERFACE LAYOUT

CURSOR KEYPAD

NUMERIC KEYPAD

Section 3.2 LOW FLOW USER INTERFACE SCREENS

Section 3.2.1 Main Menu



Picture 1: Main Menu Screen – Low Flow Controller.

The main menu consists of all the screen goto selectors. The navigator can enter any screen by using the arrow keys on the cursor keypad to position the cursor over the desired screen and then by pressing the enter key on the cursor keypad.

Note: The cursor, located on the SYS VIEW menu goto selector, appears in reverse video in the above picture.

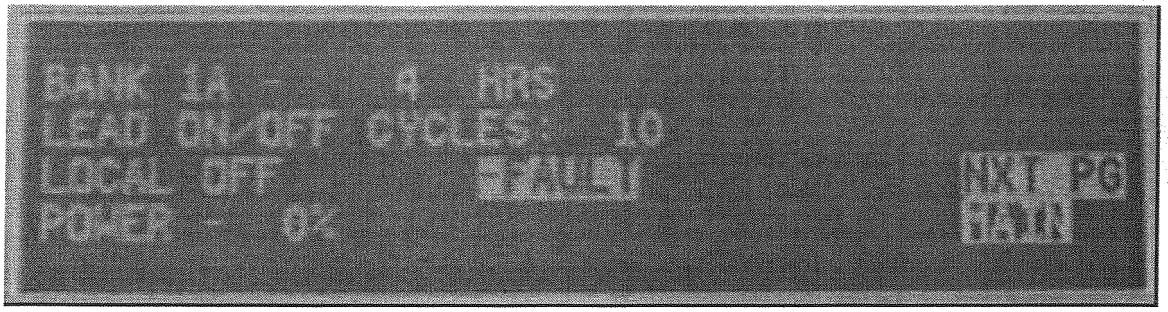
Each screen and all sub-pages have a main menu goto selector on them. Once access has been gained to any of the screens or sub-pages, the operator can return to the main menu screen by selecting its goto selector and accepting the entry.

The main menu screen allows access to the following screens:

1 - System View **(SYS VIEW)**
2 - System Settings **(SYS SET)**
3 - UV Dose **(UV DOSE)**
4 - UV Intensities **(UV INT)**
5 - Alarm History **(ALARM H)**
6 - Alarm Status **(ALARMS)**
7 - Bank Control **(BANKS)**
8 - Cooling Control **(COOLING)**
9 - Wiper Control **(WIPER)**
10 - Help **(HELP)**

The following sections describe the control and monitoring functions of the screens and their sub-pages in detail.

Section 3.2.2 System View



Picture 2: System View (overview) Screen – Page 1.

Access to the system view screens is gained from the main menu screen (see section 3.2.1)

The first and second pages of the system view screen provide the viewer with a quick overview of the current operating parameters of UV banks 1A and 1B .

The operator is provided with the following information relating to bank 1A on page 1 (refer to picture 2 above), and bank 1B on page 2 (refer to picture 3 below), of the system view screen:

- Total bank accumulated runtime indicator. Once a bank is placed in either the manual on (hand) or automatic on modes of operation this value will increment by one for every hour of operation. This value will increase throughout the entire lifespan of the system. Page 1 currently displays a total accumulated runtime for bank 1A as 4 hours (hrs). **Note:** Not to be confused with total lamp accumulated runtime of a bank.

- Bank lead and lag wear cycle status indicator. Indicates if the bank selected is either the lead or the lag bank in the system. The automatic dose pacing system will cycle the banks to ensure equal lamp life usage, or wear. This cycling will occur when both banks are placed in the automatic mode of operation and the bank cycle timer has expired and the current lead bank runtime hours are greater than the current lag bank runtime hours. The lead/lag wear cycle time period is dictated by the value entered for the bank cycle timer (see system settings screens). The operator may also change the current lead bank selection manually (see system setting screens). Page 1 currently displays bank 1A as the lead bank in the system.

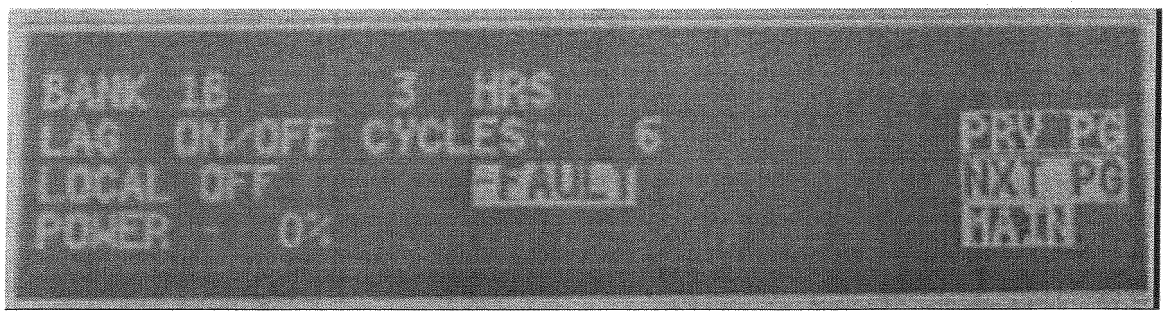
- Bank cycle indicator. Displays the number of on/off power cycles for the selected bank. Page 1 currently displays bank 1A as having accumulated 10 on/off power cycles.

- Bank operational mode indicator. Displays the bank's current operational mode; local on, local off, remote hand, remote off, remote auto on or remote auto off. The operator has control over a bank's operational mode via the bank control screens and bank operational mode selector switches. Page 1 currently displays bank 1A as being in the local off mode of operation.

- Bank fault status indicator. The fault status indicator, located next to the bank operational mode indicator, will appear when a bank related fault is active. A bank fault is active once a condition is present and uninterrupted for its entire alarm delay period. Page 1 currently displays bank 1A as being faulted.

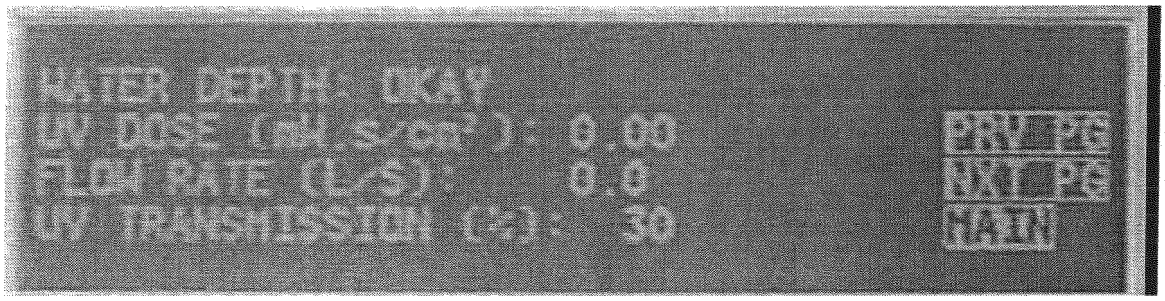
- Bank power level indicator. Displays the percent power level that a bank's lamps and ballasts are operating at (all modes of operation). Only one power level is achieved for all of the lamps and ballasts in a bank. Page 1 currently displays the lamps and ballasts for bank 1A as operating at a power level of 0%.

- Page 1 of the system view screen is also equipped with two goto screen selectors, main menu **(MAIN)** and next page **(NXT PG)**. The operator can return to the main menu screen or move on to page 2 of the system view screens by using the arrow keys on the cursor keypad to position the cursor over the desired goto screen selector then by pressing the enter key on the cursor keypad.



Picture 3: System View (overview) Screen – Page 2.

Page 2 of the system view screen also includes a previous page **(PRV PG)** goto screen selector. The operator can move to page 3 of the system view screens by choosing the next page **(NXT PG)** goto selector.



Picture 4: System View (overview) Screen – Page 2.

Page 3 of the system view screen allows the operator to maneuver on to page 4 or back to either page 2 or the main menu screen. Refer to above paragraphs on goto screen selectors.

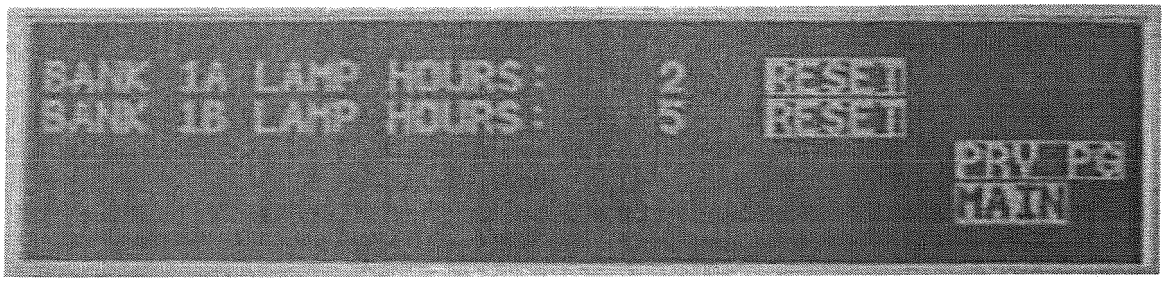
The operator is provided with the following information relating to the UV disinfection system on page 3 of the system view screen:

- Effluent channel water depth indicator. Displays the channel water depth status; "okay", "low" or "high" (displays high if option was included with system). When a low or high (optional) water level condition is present and uninterrupted for the entire alarm delay time period, the status indicator will then change to reflect the incurred condition. Page 3 currently displays the channel effluent water depth as "okay".

- Average system UV dose indicator. Displays the average theoretical delivered UV dose output of all banks currently in operation. **Note:** A bank is not considered to be in operation until the bank lamp warm up delay timer has expired, normally set for four minutes. When a bank is not in operation, off or warming up, it will be excluded from the average delivered UV dose output calculation and indication. Page 3 currently displays the average delivered UV dose of the system as zero.

- Effluent system flow rate indicator. Displays the current effluent flow rate of the system in litres per second. The low flow controller is equipped with a 4-20mA DC input for sensing of the system effluent flow. The low flow controller then scales the flow signal based on the 20mA DC upper limit of the plant flow meter and displays it accordingly. The 20mA upper limit is adjustable via the system setting screens (see section 3.2.3). Page 3 currently displays the effluent flow rate of the system as zero.

- Effluent UV transmission indicator. Displays the current effluent UV transmission of the system. This value is scaled from thirty to one hundred percent. The operator must select the UV transmission source of input, on-line or keypad (refer to section 3.2.4). When keypad is selected, the entered UV transmission value will be displayed here and used in the automatic dose pacing routine. The low flow controller is also equipped with a 4-20mA DC input for sensing of the system UV transmission value. When on-line is selected the low flow controller will monitor the signal, scale it, update its status on the display, and use it to automatically dose pace the system. Page 3 currently displays the system effluent UV transmission as thirty percent.



Picture 5: System View (overview) Screen – Page 4.

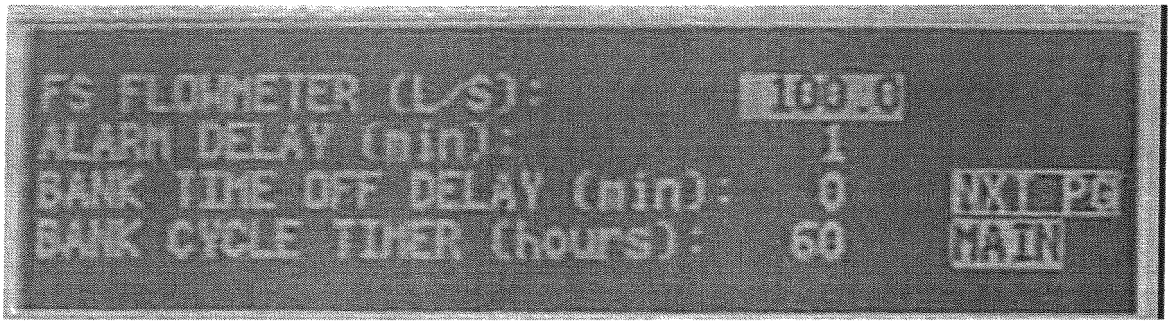
Page 4 of the system view screen allows the operator to maneuver back to page 3 or to the main menu screen via the goto screen selectors.

This screen displays the bank 1A and bank 1B total accumulated lamp runtime, in hours. Page 4 (picture 5 above), currently displays bank 1B lamp runtime as 5 hours. Once a bank is placed in either the local on, remote hand or automatic on modes of operation this value will increment by one for every hour of operation. This value will increase until it reaches 5000 hours. At this time, the lamps in the bank must be changed in order to guaranty proper disinfection.

- Once the bank has been completely re-lamped, the operator must reset the bank total accumulated lamp runtime to zero. This is accomplished by using the cursor keypad and selecting the bank lamp runtime reset selector. Once the appropriate selector has been chosen, pressing the enter key on the numeric keypad twice will reset the bank lamp runtime hours. **Note:** Not to be confused with total bank accumulated runtime.

Provisions have been incorporated to avoid erroneous re-settings of a bank's lamp runtime hours. This is why the operator must press the enter key twice. The first time the operator presses the enter key, with the **RESET** selector highlighted, the indicator will display **ACK** (acknowledge). If the operator wishes to reset the lamp runtime hours then pressing the indicator one more time acknowledges their entry and resets the bank's lamp runtime to zero and changes the indicator back to display **RESET**. Selecting either the previous page or main menu screen goto selector and accepting either entry prior to acknowledging a lamp runtime reset, cancels the lamp hours runtime reset.

Section 3.2.3 System Settings



Picture 6: System Settings Screen – Page 1.

Access to the system settings screens is gained from the main menu screen (see section 3.2.1).

- **FS FLOWMETER**. The operator enters the system flow signal upper 20mA limit. This value corresponds to the 20mA setting of the flow signal hardwired to the low flow controller and used to dose pace the system in the automatic mode of operation.

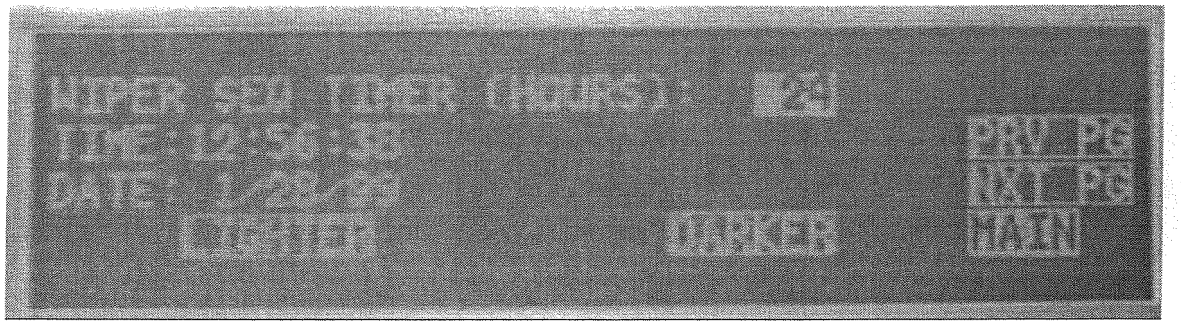
- **ALARM DELAY**. The value entered here is used to adjust the user defined alarm delay timer's preset value. The lower limit is fixed at 1 minute and the upper limit is fixed at 99 minutes. The operator must therefore enter a value from 1 to 99. The recommended setting for the user defined alarm delay period is 30 minutes.

- **BANK TIME OFF DELAY**. The value entered here is used to adjust the user defined bank time off (shutdown) delay timer's preset value. The bank time off delay is used to avoid numerous lamp and ballast on/off cycles. When a bank is in the automatic mode of operation and no longer required to be in operation for the entire bank time off delay time period then it de-energizes. The lower limit is fixed at 30 minutes and the upper limit is fixed at 540 minutes. The recommended setting is 60 minutes.

- **BANK CYCLE TIMER**. The value entered here is used to adjust the user defined bank wear cycle timer's preset value. The bank cycle timer is used to ensure equal runtime wear on the system's lamps and ballasts. The lag bank will be brought into operation and the lead bank will time off when both are placed in the automatic mode of operation, the lag bank lamp runtime hours are less than the lead bank and the bank cycle timer has elapsed. The lower limit is fixed at 1 hour and the upper limit is fixed at 500 hours. The recommended setting is 168 hours.

The operator can enter the setpoints described above by using the numeric keys on the numeric keypad. Once the desired value has been entered pressing on the numeric keypad enter key will accept it.

Page 1 of the system settings screen is also equipped with two goto screen selectors, main menu **(MAIN)** and next page **(NXT PG)**. The operator can return to the main menu screen or move on to page 2 of the system settings screens by using the arrow keys on the cursor keypad to position the cursor over the desired goto screen selector then by pressing the enter key on the cursor keypad.



Picture 7: System Settings Screen – Page 2.

Page 2 (see picture 7 above), of the system settings screen allows the operator to configure the following user adjustable settings:

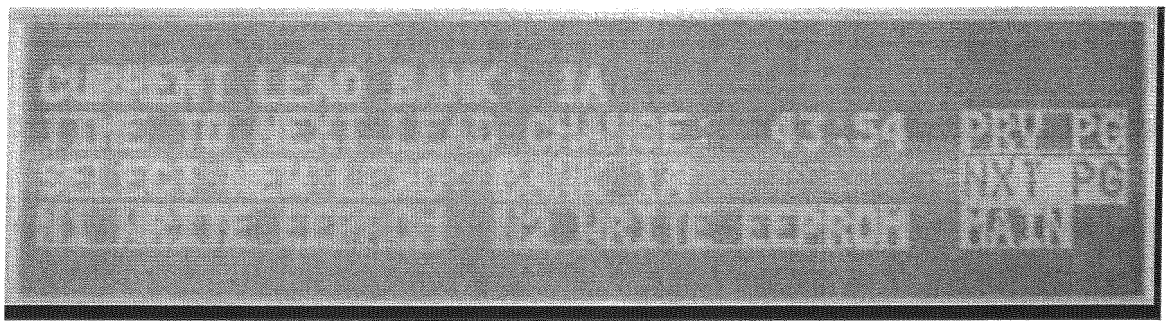
- **WIPER SEQ TIMER**. The value entered here is used to adjust the user defined wiper cleaning sequence timer's preset value. Whenever this time period elapses and a bank wiper system is in the automatic mode of operation, its lamp sleeves will be wiped (cleaned). The lower limit is fixed at 1 hour and the upper limit is fixed at 500 hours. The recommended setting is 4 hours.

- **TIME**. The operator configures the system time clock by entering this value.

- **DATE**. The operator configures the system date by entering this value. The system date must be manually adjusted for daylight savings time.

Page 2 of the system settings screen allows the operator to adjust the contrast of the LCD display. The operator can adjust the contrast by using the arrow keys on the cursor keypad to position the cursor over the desired contrast selector, lighter or darker, and then pressing the enter key to change the contrast.

Page 2 of the system settings screen allows the operator to maneuver back to page 1, on to page 3 or to the main menu screen via the goto screen selectors.



Picture 8: System Settings Screen – Page 3.

Page 3 (see picture 8 above), of the system settings screen allows the operator to maneuver on to page 4 or back to either page 2 or to the main menu screen via the goto screen selectors.

The operator is provided with the following information relating to the UV disinfection system on page 3 of the system settings screen:

- Lead bank indicator. Displays the current lead bank of the system, bank 1A or bank 1B.

- Lead bank cycle timer indicator. Displays how much time remains before the controller will cycle the lead and lag banks of the system for equal wear. The setting for this time period was previously selected by the operator on page 1 of the system settings screen (see bank cycle timer). **Note:** The controller will only automatically cycle the banks if the current lag bank's (bank being cycled to), total accumulated lamp runtime hours are less than the current lead bank's (bank being cycled from), total accumulated lamp runtime hours. If the current lead bank's lamp runtime hours are less than the current lag bank's, the timer will reset and the cycle will begin anew.

Page 3, of the system settings screen, allows the operator to select and change the current lead bank of the system. To manually select the current lead bank, the operator uses the arrow keys on the cursor keypad to position the cursor over the SELECT NEW LEAD bank selector and then presses the enter key to cycle the bank selection. **Note:** Banks in automatic mode that are no longer required will time off upon a manual or automatic wear cycle change prior to de-energizing.

Page 3 of the system settings screen also allows the operator to initiate an EEPROM write to either of the bank communication board maps. To initiate a write to one of the communication board memory map, the operator uses the arrow keys on the cursor keypad to position the selector cursor over the desired node's EEPROM write selector and then presses then enter key on the cursor keypad.

Picture 9: System Settings Screen – Page 4.

Page 4 (see picture 9 above), of the system settings screen allows the operator configure the following user adjustable settings:

- **LOW FLOW ALARM SETPT**. The value entered here is used to adjust the user defined low flow alarm setpoint. Whenever the effluent flow rate drops below this value and remains there for the entire low flow alarm delay period, a low flow alarm will become active.

  LOW FLOW ALARM DELAY. The value entered here is used to adjust the user defined low flow delay timer's preset value. The recommended setting for the user defined low flow alarm delay period is 10 minutes.

- **RECIRC PUMP OFF DELAY (if applicable).** The value entered here is used to adjust the user defined recirculation pump time off (shutdown) delay timer's preset value. The recirculation pump time off delay period is used to avoid numerous pump on/off cycles. When the flow returns above the low flow alarm setpoint and the pump is no longer required to be in operation it will shutdown. It will also shut down once the pump off delay timer period expires. The recommended setting is 10 minutes.

Section 3.2.4 UV Dose

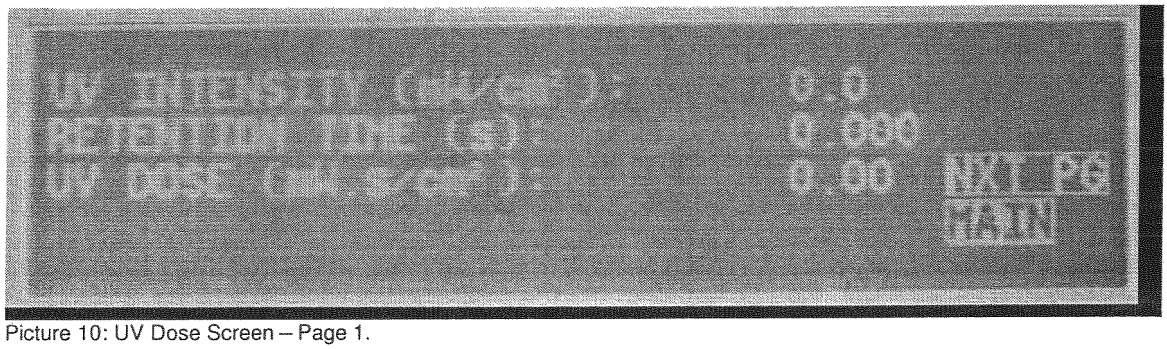
Access to the system view screens is gained from the main menu screen (see section 3.2.1).

The operator is provided with the following information relating to the UV disinfection system on page 1, refer to picture 10 below, of the UV dose screen:

- Average system UV intensity indicator. Displays the average theoretical delivered UV intensity output of all banks currently in operation. **Note:** A bank is not considered to be in operation until its bank lamp warm up delay timer has expired, normally set for four minutes. When a bank is not in operation, off or warming up, it will be excluded from the average delivered UV intensity output calculation and indication. Page 1 currently displays the average delivered UV intensity of the system as zero $mW \cdot s/cm^2$.

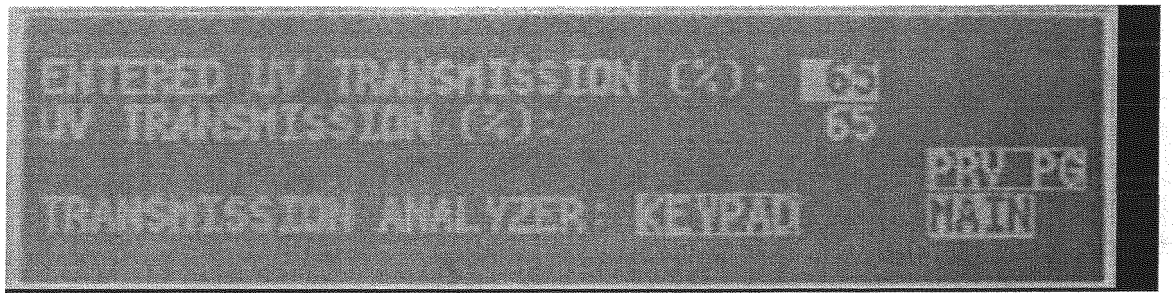
- System retention time indicator. Displays the retention time of the UV system with respect to the effluent. The retention time of the UV system is representative of the amount of time that the effluent is exposed to the UV disinfection process. Page 1 currently displays a retention time of zero seconds.

- Average system UV dose indicator. Displays the average theoretical applied (delivered or calculated) UV dose output of all banks currently in operation. The applied UV dose is calculated with respect to the UV transmission of the system, the operating power levels of the banks, the retention time of the system and the linear reduction due to lamp aging. **Note:** A bank is not considered to be in operation until its bank lamp warm up delay timer has expired, normally set for four minutes. When a bank is not in operation, off or warming up, it will be excluded from the average applied UV dose output calculation and indication. Page 1 currently displays the average applied UV dose of the system as zero.



Picture 10: UV Dose Screen – Page 1.

Page 1 of the UV dose screen is also equipped with two goto screen selectors, main menu **(MAIN)** and next page **(NXT PG)**. The operator can return to the main menu screen or move on to page 2 of the UV dose screens by using the arrow keys on the cursor keypad to position the cursor over the desired goto screen selector then by pressing the enter key on the cursor keypad.



Picture 11: UV Dose Screen – Page 2.

The operator is provided with the following information relating to the UV disinfection system on page 2, see picture 11 above, of the UV dose screen:

- Effluent UV transmission indicator. Displays the current effluent UV transmission of the system. This value is scaled from thirty to one hundred percent. The operator must select the UV transmission source of input, on-line or keypad (refer to section 3.2.4). When keypad is selected, the entered UV transmission value will be displayed here and used in the automatic dose pacing routine. The low flow controller is also equipped with a 4-20mA DC input for sensing of the system's UV transmission value. When on-line is selected the low flow controller will monitor the signal, scale it, update it's status on the display, and use it to automatically dose pace the system. Page 2 currently displays the system effluent UV transmission as 65 percent.

Page 2 of the UV dose screen allows the operator to configure the following user adjustable setpoint:

- Entered UV transmission: when keypad is selected, the transmission value entered here will be used in the automatic dose pacing routine. Page 2 currently displays the entered UV transmission as 65 percent.

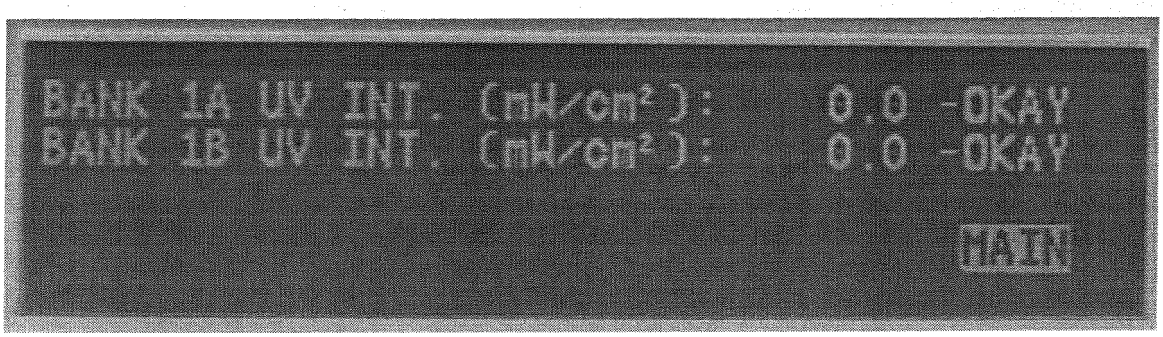
Page 2 of the UV dose screen allows the operator to select the UV transmission source of input, online or keypad. To select the transmission source of input, the operator uses the arrow keys on the cursor keypad to position the cursor over the transmission analyzer selector and then presses the enter key. The currently selected source of input, keypad or online, is displayed in the transmission analyzer selector's text box. Page 2 currently displays the UV transmission source of input as keypad.

Page 2 of the UV dose screen allows the operator to maneuver back to page 1 or to the main menu screen via the goto screen selectors.

Section 3.2.5 UV Intensities

Access to the UV intensity screen is gained from the main menu screen (see section 3.2.1).

The UV intensity screen (see picture 12 below), allows the operator to maneuver back to the main menu screen via its goto screen selector.



Picture 12: UV Intensity Screen.

The operator is provided with the following information relating to the UV disinfection system on the UV intensity screen:

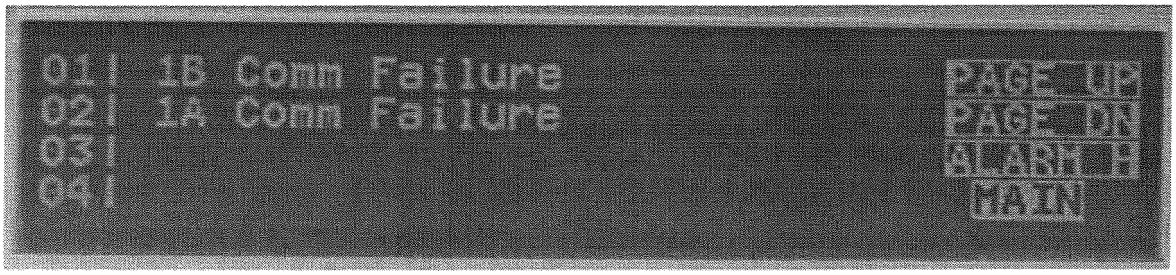
- Received (measured) UV intensity indicator. Displays the measured UV probe intensity as a numeric value in mW/cm^2. Page 1 currently displays bank 1A UV intensity as zero.

- Bank UV intensity fault status indicator. The UV fault status indicator, located next to the measured UV intensity indicator, will display fault when a low UV intensity fault condition for a bank is active. When no fault is active, the status indicator will display OKAY. Page 1 currently displays bank 1A UV status as okay.

Section 3.2.6 Alarm Status

Access to the alarm status screen is gained from the main menu screen or the alarm history screen (see section 3.2.1).

The alarm status screen (see picture 13 below), provides the operator with an overview of the current active UV system alarms. The 68 most recent UV alarms are displayed on the alarm status screen. Once an alarm condition is rectified and no longer active, it will be removed from the alarm status screen. **Note:** It is highly recommended to resolve each alarm as it appears to ensure optimum performance of the UV system.



Picture 13: Alarm Status Screen.

The alarm status screen is also equipped with four goto screen selectors, main menu **(MAIN),** page up **(PAGE UP),** page down **(PAGE DN)** and alarm history **(ALARM H).** The operator can return to the main menu screen, page up or down through the active alarms, or move on to the alarm history screen using the arrow keys on the cursor keypad to position the cursor over the desired goto screen selector then pressing the enter key on the cursor keypad.

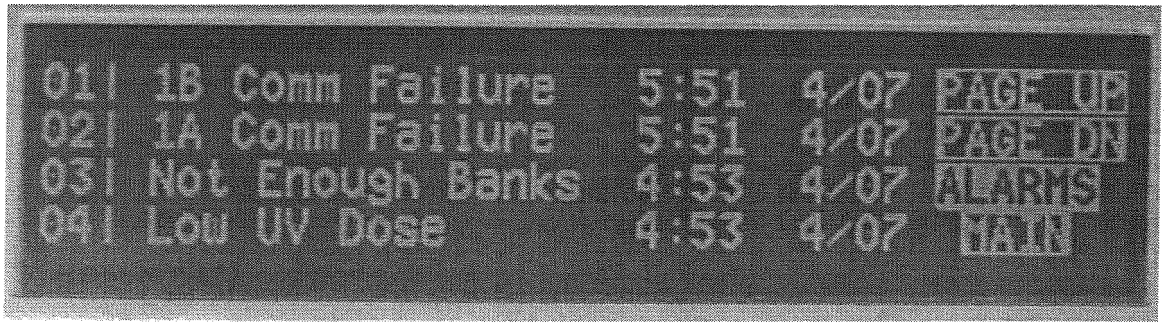
The following alarms will be displayed on the alarm status screen when active:

- Communication Fault
- Low UV Intensity Fault
- Lamp Fault
- Ballast Fault
- Module Fault
- Low UV Dose Fault
- Not Enough Banks Fault
- Low Water Fault
- High Water Fault (optional)
- UV Transmission Analyzer Fault
- Flow meter Fault
- High Coolant Pressure
- Low Coolant Pressure
- Low Wiper Pressure
- High Wiper Pressure
- Wiper Not in Remote
- Bank Not in Remote
- Low Flow Fault
- Node Power on Reset

Section 3.2.7 Alarm History

Access to the alarm history screen is gained from the main menu screen or the alarm status screen (see section 3.2.1).

The alarm history screen provides the operator with an archived history of the UV system alarms. The last 68 UV alarms are archived and displayed on the alarm history screen. Each alarm is time and date stamped indicating when it occurred. The system time and date clocks are adjustable via the system setting screens (see section 3.2.3).



Picture 14: Alarm History Screen.

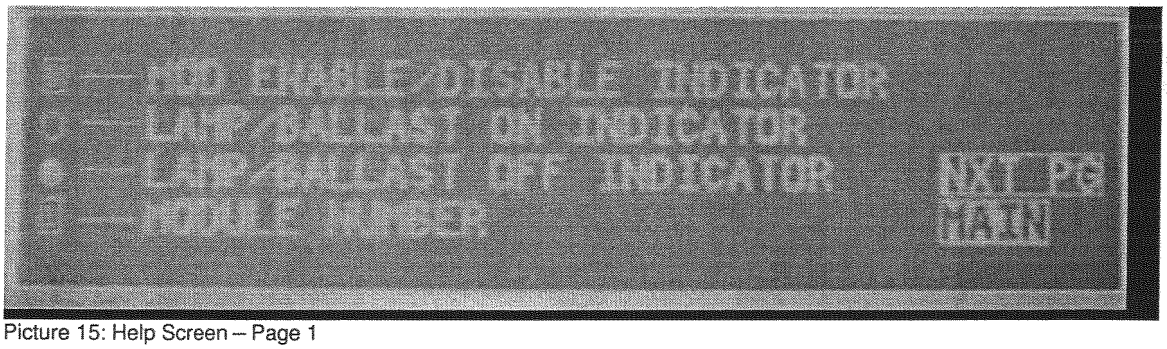
The alarm history screen (see picture 14 above), is also equipped with four goto screen selectors, main menu **(MAIN),** page up **(PAGE UP),** page down **(PAGE DN)** and alarm status **(ALARM S)**. The operator can return to the main menu screen, page up or down through the archived alarms, or move on to the alarm status screen using the arrow keys on the cursor keypad to position the cursor over the desired goto screen selector then pressing the enter key on the cursor keypad.

The following alarm conditions will be displayed on the alarm history screen when active:

- Communication Fault
- Low UV Intensity Fault
- Lamp Fault
- Ballast Fault
- Module Fault
- Low UV Dose Fault
- Not Enough Banks Fault
- Low Water Fault
- High Water Fault (optional)
- UV Transmission Analyzer Fault
- Flow meter Fault
- High Coolant Pressure
- Low Coolant Pressure
- Low Wiper Pressure
- High Wiper Pressure
- Wiper Not in Remote
- Bank Not in Remote
- Low Flow Fault
- Node Power on Reset

Section 3.2.8 Help

Access to the help screens is gained from the main menu screen (see section 3.2.1).



Picture 15: Help Screen – Page 1

The operator is provided with the following information relating to the module graphic indicator of the bank control screen on page 1 (refer to picture 15 above):

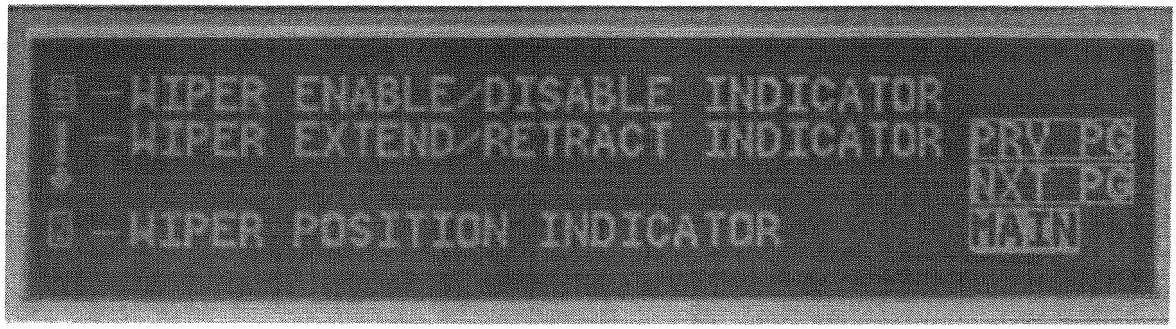
- Module enable/disable indicator. Displays the enable/disable state of a bank module. When a "D" appears inside the text box, the module has been disabled from the bank operational modes. When an "E" appears inside the text box, the module has been enabled. To enable or disable a module from operation in the bank control screen, the operator uses the arrow keys on the cursor keypad to position the cursor over the enable/disable indicator and then presses the enter key toggling the module state.

- Lamp/ballast on indicator. When a module lamp or ballast is on it will appear as a hollow oval circle on the bank control screen.

- Lamp/ballast off indicator. When a module lamp or ballast is off it will appear as a solid oval circle on the bank control screen.

- Module number indicator. Displays the module location inside the UV reactor with reference to the selected bank.

Page 1 of the help screen is also equipped with two goto screen selectors, main menu **(MAIN)** and next page **(NXT PG)**. The operator can return to the main menu screen or move on to page 2 of the help screens using the arrow keys on the cursor keypad to position the cursor over the desired goto screen selector then pressing the enter key on the cursor keypad.



Picture 16: Help Screen – Page 2

Page 2 (see picture 16 above), of the help screen provides the operator with the following information relating to the module wiper graphic indicator of the wiper control screen.

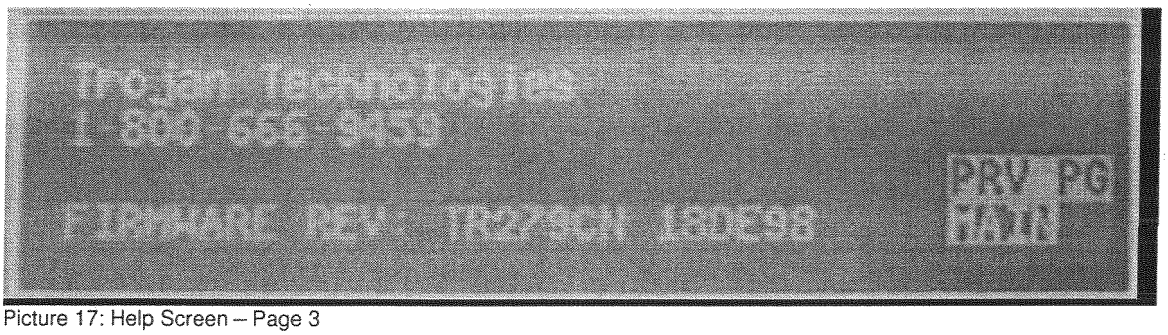
- Wiper enable/disable indicator. Displays the enable/disable state of a module wiper. When a "D" appears inside the text box, the module wiper has been disabled from the bank wiper operational modes. When an "E" appears inside the text box, the module has been enabled. To enable or disable a module from operation, the operator uses the arrow keys on the cursor keypad to position the cursor over the enable/disable indicator and then presses the enter key toggling the module state.

- Wiper extend/retract indicator. When module lamps are being cleaned (wiped), the indicator will fully extend for the entire extension and retraction time periods.

- Wiper position indicator. Displays the module where the wiper is located.

Page 2 of the help screen also includes a previous page **(PRV PG)** goto screen selector. The operator can move to page 3 of the help screens by choosing the next page **(NXT PG)** goto selector.

Page 3 (see picture 17 below), provides the operator with the Trojan Technologies Inc. service center phone number and the program's firmware revision level. The operator can maneuver back to page 2 or to the main menu screen via the goto screen selectors.

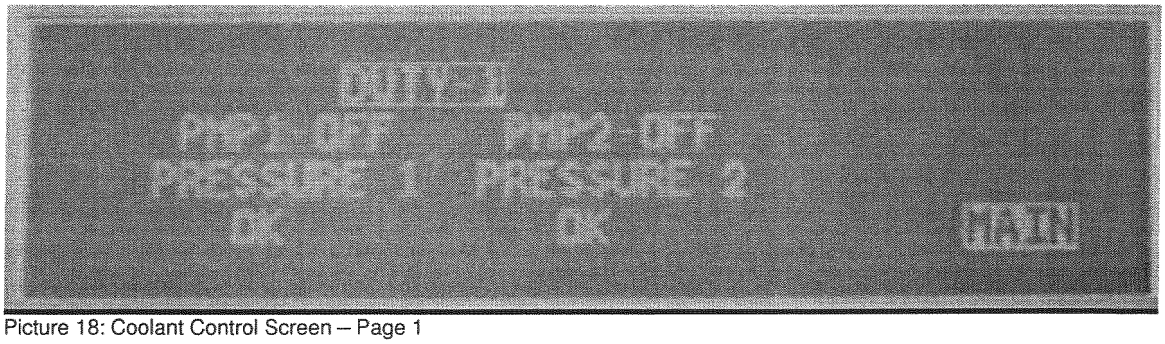


Picture 17: Help Screen – Page 3

Section 3.2.9 Coolant Control

Access to the coolant control screens is gained from the main menu screen (see section 3.2.1).

The coolant control screen allows the operator to maneuver back to the main menu screen via its goto screen selector.



Picture 18: Coolant Control Screen – Page 1

Page 1 (see picture 18 above), of the coolant control screen provides the operator with the following status information relating to the UV lamp/ballast cooling system:

- Coolant pump status indicators. Displays the operational status of the cooling system pumps; on or off. There are two coolant pump status indicators, one for pump 1 (pmp-1) and one for pump 2 (pmp-2). Page 1 currently displays pump 1 operational status as off.

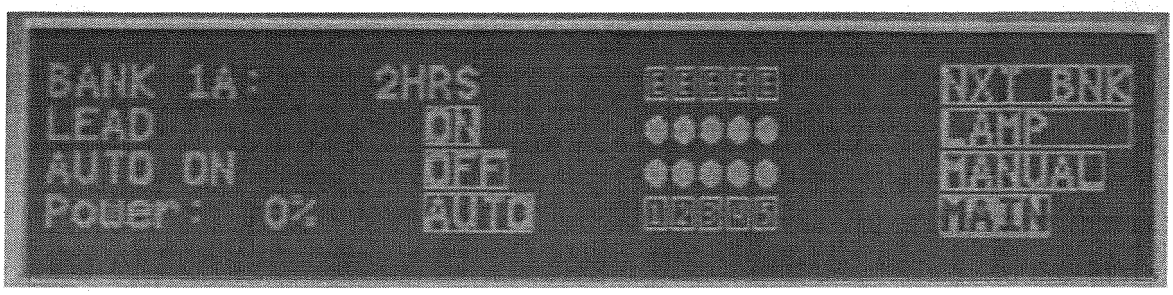
- Coolant pressure indicator. Displays the cooling system fluid pressure status; ok, low or high. When a low or high coolant fluid pressure is present and uninterrupted for its entire alarm delay period, the status indicator will change to reflect the incurred condition. There are two coolant pump pressure indicators, one for pump 1 and one for pump 2. Page 1 currently displays the system fluid pressure for pump 1 as ok.

The operator can select which pump, pump 1 or pump 2, is the cooling system duty operation pump. To select the duty pump, the operator uses the arrow keys on the cursor keypad to position the cursor over the duty pump selector and then presses the enter key to cycle the pump selection. The currently selected duty pump, duty-1 or duty-2, is displayed in the coolant pump duty selector text box. Page 1 currently displays coolant pump 2, duty-2, as the duty pump.

All of the cooling system alarms are latched once active. When a cooling system alarm condition is rectified, the active alarm condition will be unlatched and reset whenever the duty pump selector is toggle from duty-1 to duty-2 or duty-2 to duty-1.

Section 3.2.10 Bank Control

Access to the bank control screens is gained from the main menu screen (see section 3.2.1).



Picture 19: Bank Control Screen – Page 1

The operator is provided with the following information relating to bank 1A on page 1 (refer to picture 19 above), and bank 1B on page 2 of the bank control screens:

- Total bank accumulated runtime indicator. Once a bank is placed in either the manual on or automatic on modes of operation this value will increment by one for every hour of operation. This value will increase throughout the entire lifespan of the system. Page 1 currently displays a total accumulated runtime for bank 1A as 2 hours (hrs). **Note:** Not to be confused with total lamp accumulated runtime of a bank.

- Bank lead and lag wear cycle status indicator. Indicates if the bank selected is either the lead or the lag bank in the system. The automatic dose pacing system will cycle the banks to ensure equal lamp life usage, or wear. This cycling will occur when both banks are placed in the automatic mode of operation and the bank cycle timer has expired and the current lead bank runtime hours are greater than the current lag bank runtime hours. The lead/lag wear cycle time period is dictated by the value entered for the bank cycle timer (see section 3.2.3). The operator may also change the current lead bank selection manually (see system setting screens). Page 1 currently displays bank 1A as the lead bank in the system.

- Bank operational mode indicator. Displays the bank current operational mode; local off, local on, remote off, remote hand, remote auto on or remote auto off. The operator has control over a bank operational mode via the bank control screens. Page 1 currently displays bank 1A as being in the auto on mode of operation.

- Bank fault status indicator. The fault status indicator, located next to the bank operational mode indicator, will appear when a bank related fault is active. A bank fault is active once a condition is present and uninterrupted for its entire alarm delay period. Page 1 currently displays bank 1A as not being faulted.

- Bank power level indicator. Displays the percent power level that bank lamps and ballasts are operating at for all modes of operation. Only one power level is achieved for all of the lamps and ballasts in a bank. Page 1 currently displays the lamps and ballasts for bank 1A as operating at a power level of 0.

- Module enable/disable indicator. Displays the enable/disable state of a bank module. When a "D" appears inside the text box, the module has been disabled from the bank operational modes. When an "E" appears inside the text box, the module has been enabled.

- Lamp/ballast on/off indicator. When the lamp/ballast display selector is set to lamp and a module lamp is on it appears as a hollow oval circle. When the lamp/ballast display selector is set to ballast and a module ballast is on it appears as a hollow oval circle. When a module lamp or ballast is off and the appropriate lamp/ballast display state has been selected, it will appear as a solid oval circle.

- Module number indicator. Displays the module location inside the UV reactor with reference to the selected bank, bank 1A or bank 1B.

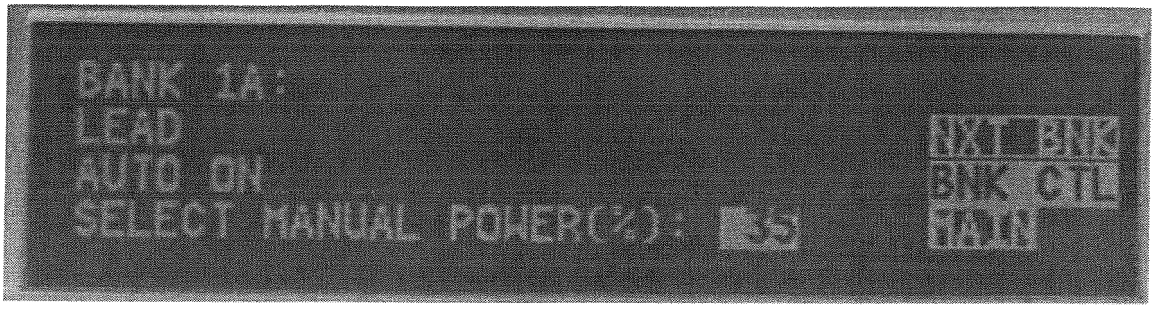
The operator can perform the following control actions with respect to bank 1A on page 1 and bank 1B on page 2 of the bank control screen:

- Bank operational mode selectors. Using the arrow keys the operator can select the desired operational mode of each bank whenever the bank's 3 position selector switch has been placed in the remote position; remote hand (manual on), remote off or remote auto. When remote auto mode is selected each bank's operational power level will be predetermined by the controller's automatic dose pacing power staging routine. When on is selected the bank's operational power level will be determined by the value selected in the manual power settings screen, page 3 of bank control screen. **Note:** Banks always energize at 100% power level for the entire lamp warm up time period *irrespective of the selected power level.*

- Module enable/disable selectors. To enable or disable a module from operation, the operator uses the arrow keys on the cursor keypad to position the cursor over the enable/disable indicator and then presses the enter key on the cursor keypad. When the enter key is press the module enable or disable state will toggle. When a module has been disabled it will be excluded from the bank operational modes. When a module has been enabled it will be included.

- Lamp/ballast selectors. When the operator chooses the lamp selector state, all of the module graphic information will be representative of the bank's lamps. When the operator chooses the ballast selector state, all of the module graphic information is representative of the bank's ballasts.

The bank control screen is also equipped with three goto screen selectors, main menu **(MAIN),** next bank **(NXT BNK)** and manual **(MANUAL).** The operator can return to the main menu screen, select the other bank, or go to the bank manual power setting screen using the arrow keys on the cursor keypad to position the cursor over the desired goto screen selector then pressing the enter key on the cursor keypad.



Picture 20: Bank Control (manual power setting) Screen - Page 3

Page 3 (see picture 20 above), of the bank control screen allows the operator to select a bank's manual operating power level. The operator enters the manual power level setting by using the numeric keys on the numeric keypad. Once the desired value has been entered the operator presses on the keypad enter key and the value is accepted.

The manual power setting screen, page 3 of bank control screen, provides the operator with the following bank related information:

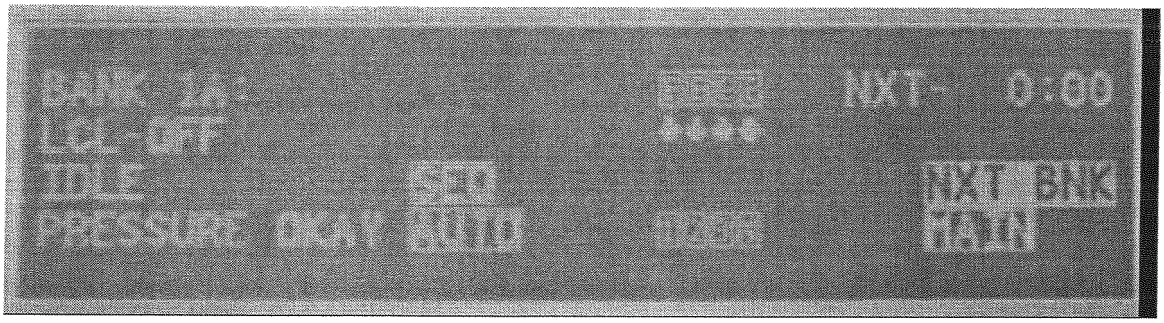
- Bank lead and lag wear cycle status indicator. Indicates if the bank selected is either the lead or the lag bank in the system.

- Bank operational mode indicator. Displays the bank's current operational mode; manual on, off, auto on or auto off.

Page 3 of the bank control screen includes a main menu **(MAIN)** goto selector, next bank **(NXT BNK)** and a bank control **(BNK CTL)** goto screen selector. The operator can return to page 2 of the bank control screen by choosing the bank control goto selector, move on to the other bank's manual power setting screen by choosing the next bank goto selector, or return to the main menu by choosing its goto screen selector.

Section 3.2.11 Wiper Control

Access to the wiper control screens is gained from the main menu screen (see section 3.2.1).



Picture 21: Wiper Control Screen – Page 1

The operator is provided with the following information relating to bank 1A on page 1 (refer to picture 21 above), and bank 1B on page 2 of the system view screen:

- Wiper system operational mode indicator. Displays the bank current wiper system operational mode; local on, local off or remote auto. The operator has control over bank wiper system operational mode via the wiper control selectors switches and the wiper control screen. Page 1 currently displays bank 1A's wiper system as being in the local off mode of operation.

- Wiper collars status indicator. Displays the status of module wiper collars. When a module is being cleaned, its wiper collars will be extended and then retracted over the lamp's quartz sleeve. The wiper collar status indicator will change to display "extending" when the collar is extending and will change to display "retracting" when the collar is retracting. When no modules are being cleaned the status indicator displays idle. Page 1 currently displays bank 1A's wiper collars as being idle.

- Wiper pressure indicator. Displays the hydraulic wiper system fluid pressure status; ok, low, or high. When a low wiper fluid pressure or a high wiper fluid pressure condition is present and uninterrupted for its entire alarm delay period, the status indicator will change to reflect the incurred condition. Page 1 currently displays bank 1A's wiper system fluid pressure as okay.

- Wiper sequence indicator. Displays the time left to the next automatic wipe sequence. Once this time period expires, all of the enabled modules for a given bank will be cleaned one at a time when in automatic mode of operation. The wiper sequence timer is adjustable in the system settings screens (see section 3.2.3). Page 1 currently displays bank 1A's time to next automatic wipe sequence as 0:00.

- Wiper enable/disable indicator. Displays the enable/disable state of module wipers. When a "D" appears inside the text box, the module wiper has been disabled from the bank wiper operational modes. When an "E" appears inside the text box, the module has been enabled.

- Wiper extend/retract indicator. When module lamps are being cleaned (wiped), the indicator will fully extend for the entire extension and retraction time periods.

- Wiper position indicator. Displays the module where the wiper is located inside the UV reactor.

The operator can perform the following control actions with respect to bank 1A on page 1 and bank 1B on page 2 of the wiper control screen:

- Wiper system operational mode selectors. Using the arrow keys the operator can initiate a remote manual wipe sequence. When remote mode is selected via the 3 position selector switches and the operator selects sequence (SEQ) the bank lamps will be cycled through a cleaning sequence. The controller will initiate a remote manual wipe sequence cleaning bank lamps each time the **SEQ** selector is selected.

- Wiper enable/disable selectors. To enable or disable a module wiper collars from operation, the operator uses the arrow keys on the cursor keypad to position the cursor over the enable/disable indicator and then presses the enter key toggling the module wiper state. When a module has been disabled it will be excluded from a bank's manual or automatic wipe sequence. **Note:** Wipers must be enabled or disabled prior to a wipe sequence being initiated.

Section 3.3 UV4000LF™ SYSTEM POWER-UP

The UV4000LF™ system has one electric service supply:

This electric service must be turned on at the local disconnect panel in order for the UV system to function fully.

WARNING:
ALL ELECTRICAL SERVICE SUPPLIES MUST BE SHUT OFF BEFORE ENTERING THE POWER DISTRIBUTION PANEL.

System Controller Power Up

a. Ensure that the main circuit breaker and distribution circuit breakers are ON.
b. Verify that there are no fault lights on the processor.
c. Verify that system parameters are set to the desired state via the operator interface.

UV Lamp Module Power Up

a. Ensure that the Bank 1A and Bank 1B selector switches (located on the power distribution center) along with the wiper selector switches are in the remote position.

b. Using the UV system's operator interface, perform the following sequence:

- If the Main Menu is not currently being displayed, press [MAIN MENU] on the keypad.
- Press [BANK CONTROL SCREEN] to access Bank Status.
- Ensure that all Bank 1A modules are enabled (ENABLE AND NEXT MOD)
- Press [AUTO] to put Bank 1A lamps in Automatic mode.
- Press [NEXT BANK] to access Bank 1B lamps.
- Ensure that all Bank 1B modules are enabled.
- Press [AUTO] to set Bank 1B lamps to Auto.
- Press [MAIN MENU] to return to Main Menu.

Note: The UV system Bank and Wiper modes should be set to Auto unless system maintenance is being performed.

Regularly monitor the operator interface display.

Section 3.4 CONTROLLER MAINTENANCE

The processor has a battery which should be changed annually. Refer to the manufacturers' product manuals for information about this procedure and further maintenance requirements.

The control cabinet should be inspected regularly. Check that the following conditions are met.

- Wire duct covers are in place.
- All wiring is secured.
- All mounting hardware is secure.
- Periodic wire insulation tests may detect potential faults.

NOTE:
IF COMMUNICATION IS LOST FROM THE SYSTEM CONTROLLER PANEL THE BANKS CAN BE OPERATED MANUALLY BY PLACING THE BANK SELECTOR SWITCH LOCATED ON THE POWER DISTRIBUTION PANEL TO THE "ON" POSITION.

TROUBLESHOOTING GUIDE

Problem	Possible Causes And Recommendations
No lights on the processor or I/O modules.	- Main power is OFF. - CB tripped. - Power supply fuse may be blown.
UV Lamps not responding when requested.	- Both banks are OFF or no modules are enabled; check setup.

REFER TO MANUFACTURERS' DOCUMENTATION FOR FURTHER INFORMATION AND TROUBLESHOOTING ASSISTANCE WITH THE CONTROLLER MODULES.

SYSTEM UV4000™ LOW FLOW OPERATION AND MAINTENANCE MANUAL

SECTION 4.0

UV4000™ Control Logic and Monitoring

4.0 CONTROLS PHILOSOPHY – Millidgeville, NB

Layout Drawing # DR410945S01
SC/PDC DRAWING # 929206

4.1.0 Control System Overview

The basis for system control is a microprocessor based controller, which continuously monitors and controls the UV system's functions. Custom electronics, pressure switches and a water level sensor provide the controller with the necessary indications of system parameters.

The operator interface is a custom keypad. Complete control and monitoring of the entire Trojan UV4000^{TM}LF is accomplished through this interface.

CAUTION: *Any changes made to the program can and will affect the process being controlled. Do not attempt to make any changes to this program unless you are intimately familiar with the process.*

4.2.0 Operational Description

An automatic flow paced control system shall be provided by Trojan Technologies, Inc. The control system shall be fully capable of allowing lamps to be operated to maintain sufficient UV dose in regards to a flow on/off condition while conserving power. Commands to turn UV banks on and off shall be retentive, such that operating banks will remain on, and non-energized banks will remain off, in the event of a controller failure, and following restoration of power after a power failure. Other features shall be provided as specified herein.

A total of one (1) flow channel is provided. The flow channel contains two (2) UV banks. Each bank consists of 5x2 lamp modules. Each bank is controlled from a communications board, which controls and monitors the UV bank. This communications board is located within the System Control and Power Distribution Centre. All communications to and from the PDC's originate from the controller via an RS485 serial link. All lamp, ballast and bank status signals are transferred to the controller via this serial link. In total there are 82 bytes of data transferred in a communication string from each UV bank.

A 4-20 mA flow signal shall be transmitted to the controller from the plant effluent flow meter. The flow channel is rated a peak flow of 25000m^3/day at the design effluent UV transmittance.

The automatic flow pacing system will operate as described in this control philosophy.

4.3.0 General Requirements

In the event of a disruption of power to the controller, the battery backup shall retain the control program in memory.

Hydraulic capacity of any channel will not be exceeded regardless of the dose delivery capability of that channel.

Timers shall be accurate to 0.1 minutes or 0.1 hours.

All setpoints will be field adjustable unless otherwise specified herein.

To avoid nuisance alarms, all user alarms will have an adjustable time delay from 1 to 99 minutes.

4.4.0 Module Control

Each module is controlled individually through a soft on/off control integral to the lamp ballast.

When switched on, lamps are initially energized to the high power setting for a warm-up period regardless of mode (i.e. either hand or auto). After the warm-up period has expired, the lamps are automatically switched to the requested power level. The "lamp warm-up" timer (normally 9 minutes) dictates this time period. Lamp warm-up delay timer has a fixed pre-set, and is not user adjustable.

Once a module has been switched off through either hand or automatic mode, it will not re-energize until a "module restart" timer has expired.

When power is restored after an electrical service interruption, modules that were previously on will not re-energize until the module restart timer expires. Module restart timer has a fixed pre-set at 7 minutes and is not user adjustable.

4.5.0 Lamp Control and Monitoring

Power settings are variable from 30 to 100 percent per bank in both auto mode and hand mode.

For power settings, each bank will respond to a 4-bit power level signal, which will instruct the lamp ballast to adjust to the correct power level as determined by the controller.

Each lamp is controlled directly from the lamp ballast, which is fully modulated between 53 to 100 percent per bank in auto mode and from 30 to 100 percent in hand mode.

Specially designed current sensing circuits detect lamp on/off status. The status of each individual lamp is displayed via the Bank Control screen at the Operator Interface. Faulted lamps are indicated by specific address.

4.6.0 ActiClean™ Cleaning System - Control and Monitoring

Modules are cleaned one at a time. A complete wipe sequence to clean all modules may be initiated either manually or automatically via the Wiper Control screen at the operator interface.

In automatic mode, the interval between wiping sequences is determined by the "wiper sequence" timer, which is pre-set at 4 hours and adjustable from 1 to 999 hours.

Each module wiper is controlled by an individual solenoid. At the start of wiper extension, the solenoid is energized and a "wiper stroke" timer is initiated. The wiper stroke timer is pre-set at 20 seconds, and is not user adjustable.

When the wiper stroke timer expires, the solenoid is de-energized and the "wiper stroke" timer is then re-initiated.

When the wiper stroke timer expires, the next module wiper is extended.

The automatic wiper sequence is disabled for flows greater than 90 percent of peak channel hydraulic capacity (adjustable).

4.7.0 Cooling System

Two coolant pumps are supplied. Each coolant pump supply is fed from the SC/PDC's main 480VAC supply.

Coolant pumps may be selected for Duty or Standby mode via the Coolant Control screen.

In Duty mode, the pump will operate continuously. If a low or high-pressure condition exits the controller will automatically cycle to the Standby pump.

If a low or high pressure condition develops with the Standby pump it will remain in operation and the Duty pump will also be brought into operation.

The duty pump will rotate on a timed basis (initially set to 168 hours) to allow equal wear on both pumps.

4.8.0 UV Intensity

One UV intensity sensor is provided for each bank. The signal is amplified to 4-20mA and integrated into the serial communications string to the controller. Range 0 - 300mW/cm^2.

Intensity is displayed on the Operator Interface in percent or engineering units; if engineering units are selected, either the calculated intensity or the actual value from the UV intensity probes can be displayed.

4.9.0 Water Level

Low water level is monitored via a downstream level probe. Discrete contacts from this sensor will be brought directly into the UV system communication boards to signal the low water alarm conditions.

Energized UV lamps will be de-energize 15 seconds after a low water level condition is detected. A low water level condition will cause an alarm to be output.

Note: Low water level condition prevents lamps from being energized and outputs an alarm.

4.10.0 Bank Control - Local/Remote

A three-position selector switch, one per bank, is provided at each SC/PDC for on/off/remote control of the UV equipment.

Placing a bank's selector switch in either the "On" or "Off" position manually overrides all remote controller control.

When the selector switch is placed in the "On" position all of the modules in the selected bank will energize (if previously de-energize), providing there is no low water level condition in the channel and if the bank's module lamps are positioned inside the reactor insert.

When the selector switch is placed in the "Off" position all of the modules in the selected bank will de-energize (if previously energized).

When the selector switch is placed in the "Remote" position the bank will respond to remote controller, refer to sections 11.0, 12.0.

4.11.0 Bank Control - Manual Operation through the Controller

Individual banks will energize when placed in "Hand" mode of operation at the operator interface, if the bank(s) on/off/remote three-position selector switch has been switched to the remote position.

Individual bank power levels may be set manually from 30 to 100 percent, or off via the Bank Control screen at the operator interface.

4.12.0 Bank Control - Dose Pacing

Dose pacing will be applied to banks in "auto" mode only.

In Auto mode and under normal operating conditions, at least one bank shall always stay on-line, regardless of the total effluent flow signal. The lead bank will initially energize at 100% power level. Once the "bank warm up delay" timer expires, the lead bank will stage down to its required power level.

As the delivered dose requirements continue to increase, by either an increase in flow, or an increase in lamp hours, both the lead and lag banks power levels will continue to increase up to the required maximum. When the lead and lag banks power levels reach maximum power and the system requires an increase in UV output, this will result in a " Not Enough Banks Available" alarm to be generated once the alarm delay timer expires.

When the calculated UV dose increases above the value that no longer requires the lag bank to be on-line, a bank (30 min) time off timer will begin timing. Once the bank time off period elapses, the bank will de-energize.

To prevent frequent bank cycling a "bank time off" timer dictates the amount of time required before an increase in dose affects bank power levels and ramps the bank(s) down. Pre-set at 30 minutes this timer is adjustable from 15 to 540 minutes.

Equipment power levels will be controlled so that the minimum power setting and the minimum number of banks are selected to provide an adequate dose.

The following power level percentages will indicate the possible utilization of the UV4000™. These power levels will deliver the required design dose, based on the flow, age of lamps, and the effluent being at the design UV transmittance.

Equipment On	Power Level
Lead Bank	Starts at 100%, stages down to 30%.
Lead Bank	Ramps up to required maximum
Lag Bank	Starts at 100%, stages down to required power level
Lead Bank	Stages down to required power level

Lead & Lag Bank	Alternately stage up to required power levels, one stage at a time, to 100% or until the channel hydraulic maximum is reached
Lead Bank	Starts at 100%, stages down to 30%
Lead Bank	Ramps up to required maximum

The PLC will use the flow and entered UV Transmission value to calculate the theoretical dose for all possible setpoints. These calculations then form the basis for automatic dose pacing.

4.13.0 UV Controller Communications

The UV Controller is the heart of the UV4000™ control system and must communicate with the Operator Interface (OI) and the bank's communication boards.

The UV Controller will communicate to the bank's communication board via an integral RS485 port. The controller will poll each banks communication board in sequence to continually update the status of the modules and lamps. All the status information from one Bank will be contained in one message string. The message string will be decoded by the Controller and checked for errors prior to making the status information available to the Operator Interface. Commands to control all aspects of the UV Bank will be issued by the UV Controller through the RS485 serial link.

Located in the SC/PDC is an auto answer modem. This hardware will permit offsite Trojan Service personnel to monitor system performance and assist in diagnosing failures if a dedicated telephone line is provided.

4.14.0 Alarms

All alarms generated by the UV SC/PDC will be logged and displayed on the Operator Interface. Each alarm will be time and date stamped when it occurs.

Description	No. of Alarms
Lamp Failure	10
Ballast Failure	10
Bank Low UV Intensity	2
Bank Communication Failure	2
High Coolant Pressure	2
Low Coolant Pressure	2
High Wiper Pressure	1
Low Wiper Pressure	1
Wipers Not In Remote	2
Bank Not In Auto	2
Low Water Level	1

Low Flow	1
Flowmeter Fault	1
Low UV Dose	1
Low UV Transmission	1
Multiple Lamp/Ballast Fault	1
Not Enough Banks	1

4.15.0 Operator Interface

The operator can monitor and control the entire system via the screen. A screen and a keypad will be available for system control and monitoring. The information available to the operator will be presented in the following screens:

Bank Control	System Overview	Wiper Control
Alarm Status	Dose Pacing	
System Settings	Alarm History	
Coolant Control	Help Screen	

4.16.0 Input Requirements

Analog Inputs

INPUT NO.	DESCRIPTION	RANGE	CONTROL TYPE
1	FLOW SIGNAL	25000m^3/day	Analog 4-20mA

4.17.0 Output Requirements

Discrete Outputs

OUTPUT NO.	DESCRIPTION	RANGE	CONTROL TYPE
5	BANK 1A ON/OFF STATUS	------	DISCRETE DRY CONTACT
6	BANK 1B ON/OFF STATUS	------	DISCRETE DRY CONTACT
7	COMMON MINOR ALARM	------	DISCRETE DRY CONTACT

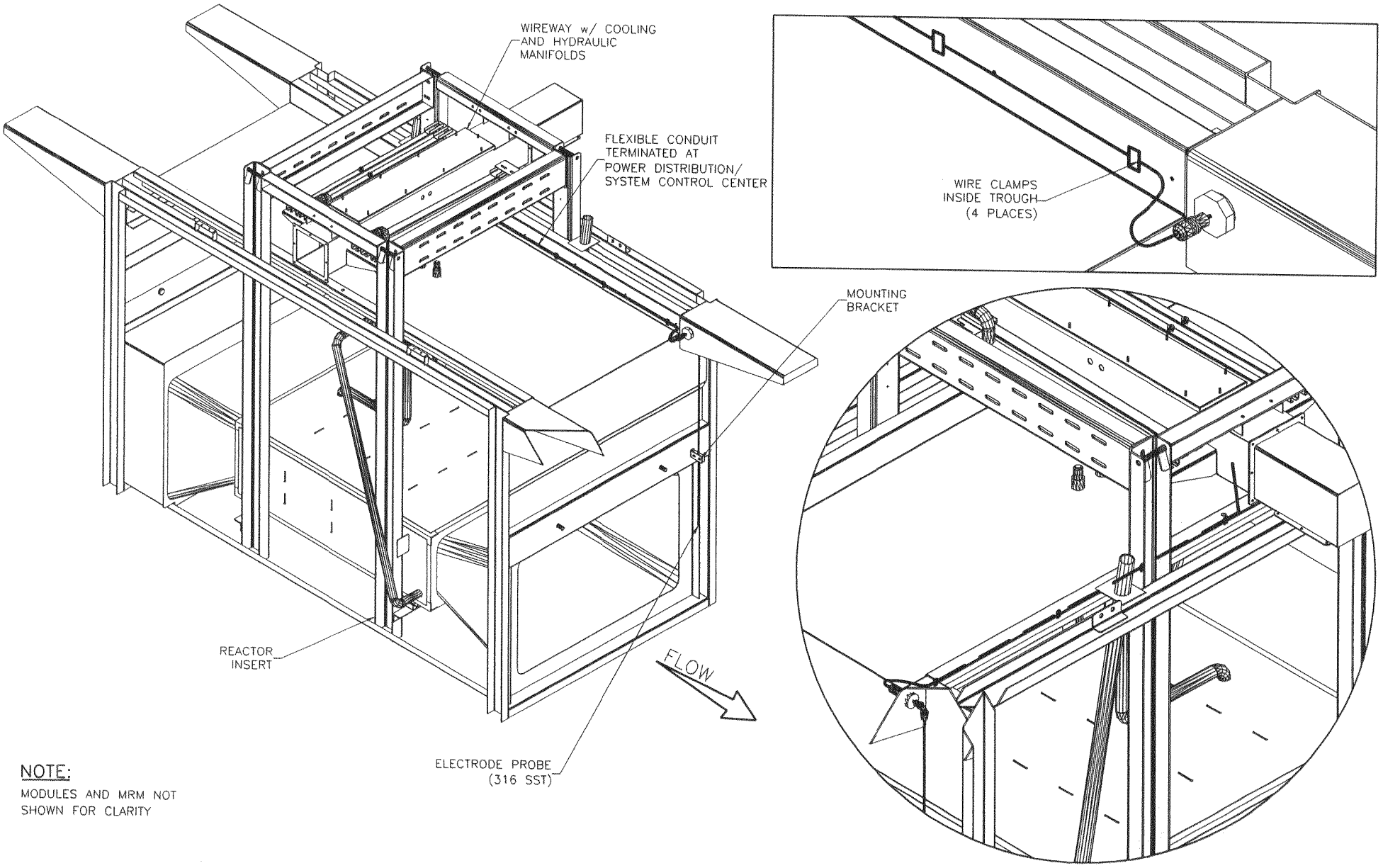
8	COMMON MAJOR ALARM	------	DISCRETE DRY CONTACT

Section 4.2 WATER LEVEL SENSOR

Water level through the reaction chamber insert is monitored by a water level sensor located on the upstream side of the channel insert. Upon a preset low water level condition the UV lamps will denergize and remain off until the proper water level is present. At the same time an alarm will be outputted to the system control center. Upon a preset high water level condition only an alarm will be outputted the UV banks will not denergize.

Do not disable or by-pass the sensor probe water level settings.

WARNING:
THE UV LAMPS MUST NOT BE ENERGIZED UNLESS THE LAMP SLEEVES ARE FULLY SUBMERGED. DRY LAMPS WILL MELT DOWN WITH DANGEROUS UV EXPOSURE AND DAMAGE EQUIPMENT.



NOTE:
MODULES AND MRM NOT SHOWN FOR CLARITY

Trojan Technologies Inc.

DESCRIPTION: STD, UV4LF TYPICAL LEVEL SENSOR LOCATION

DRAWN BY : JAW	DATE : 00JL14
CHECKED BY : DAC	DATE : 00JL14
APPROVED BY : SDK	DATE : 00JL14
SCALE (11x17) : NTS	LOG NUMBER : N/A

STANDARD DRAWING NO. 4M00224
REFERENCE NO. N/A
DWG NO. D01
REV. A

Section 4.3 UV4000™ ULTRAVIOLET SENSOR

Trojan's UV4000LF™ system continuously monitors ultraviolet intensity inside the reaction chamber through two UV probes. One probe gives a representative sample of UV intensity from Bank 1A's lamps, while the other probe gives an indication of UV intensity from Bank 1B. These probes provide 4-20mA signals which are processed by the operator screens and displayed through the appropriate screens of the operator interface.

Internal calibration of the UV probes should only be carried out by qualified personnel.

Maintenance of the UV probes is limited to the periodic cleaning of the quartz window found at the bottom of the stainless steel probe body. Frequency is dependent upon effluent quality.

In order to clean a UV probe's quartz window, the probe body must first be removed from the reaction chamber insert as follows:

Removal and Cleaning of UV Probe

1. Turn off the appropriate bank of UV lamps via the operator interface. (e.g. if removing Bank A probe, turn off Bank A lamps). This will prevent harmful exposure to UV light when the probe is removed.

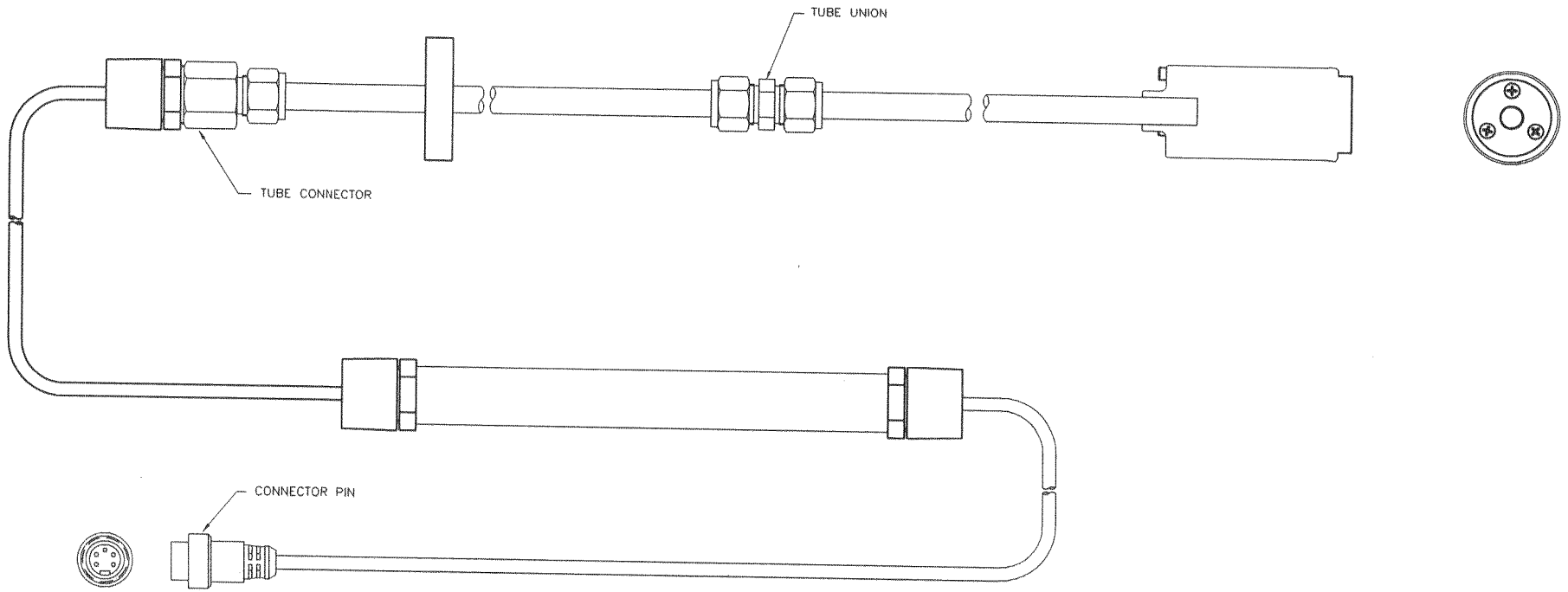
2. Disconnect the low voltage UV probe connector.

3. Lift the probe body from the reaction chamber.

4. Place a heavy cloth or other protective cover over the open probe port as a further safeguard against UV radiation from the reaction chamber.

5. Clean quartz window carefully with Lime-A-Way acid solution. Use gloves and eye protection when working with Lime-A-Way.

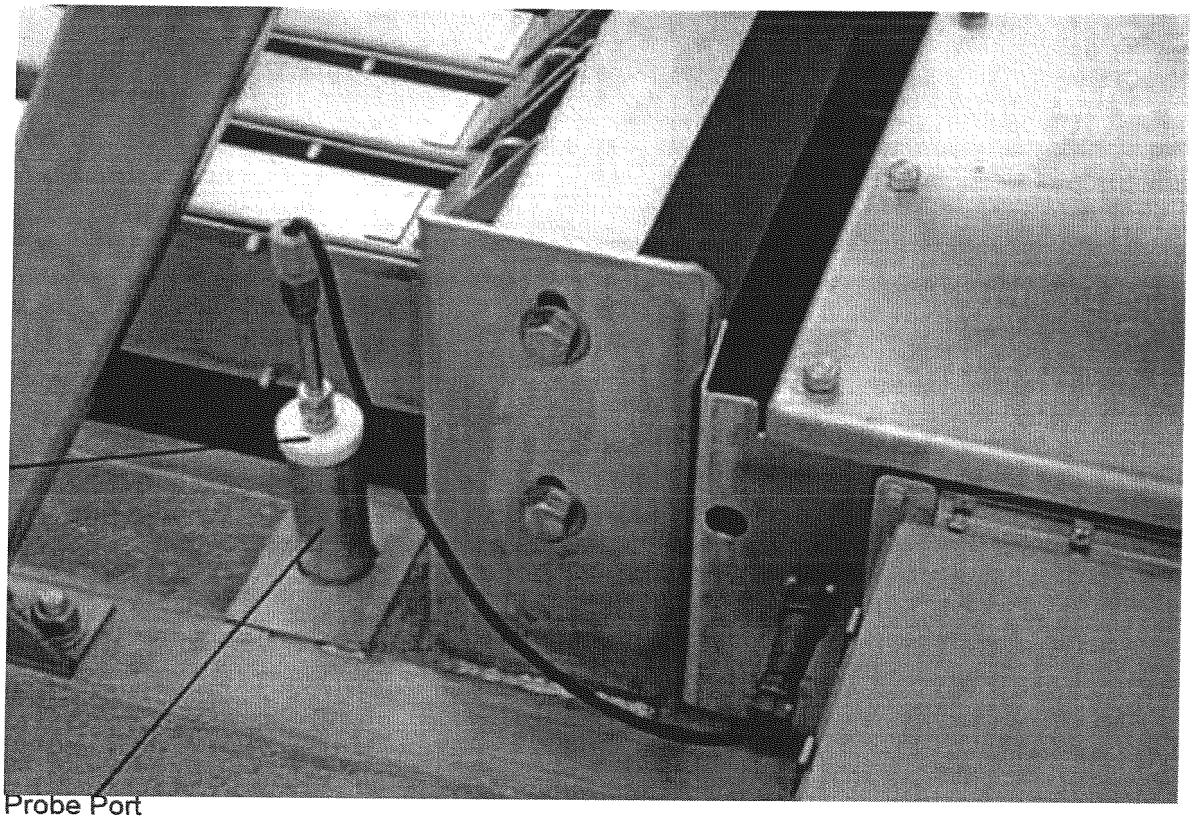
6. When re-installing, be sure that the probe is fully seated in the bottom of the probe port and that the delrin cap is fully engaged at the top of the probe port.



Trojan Technologies Inc.

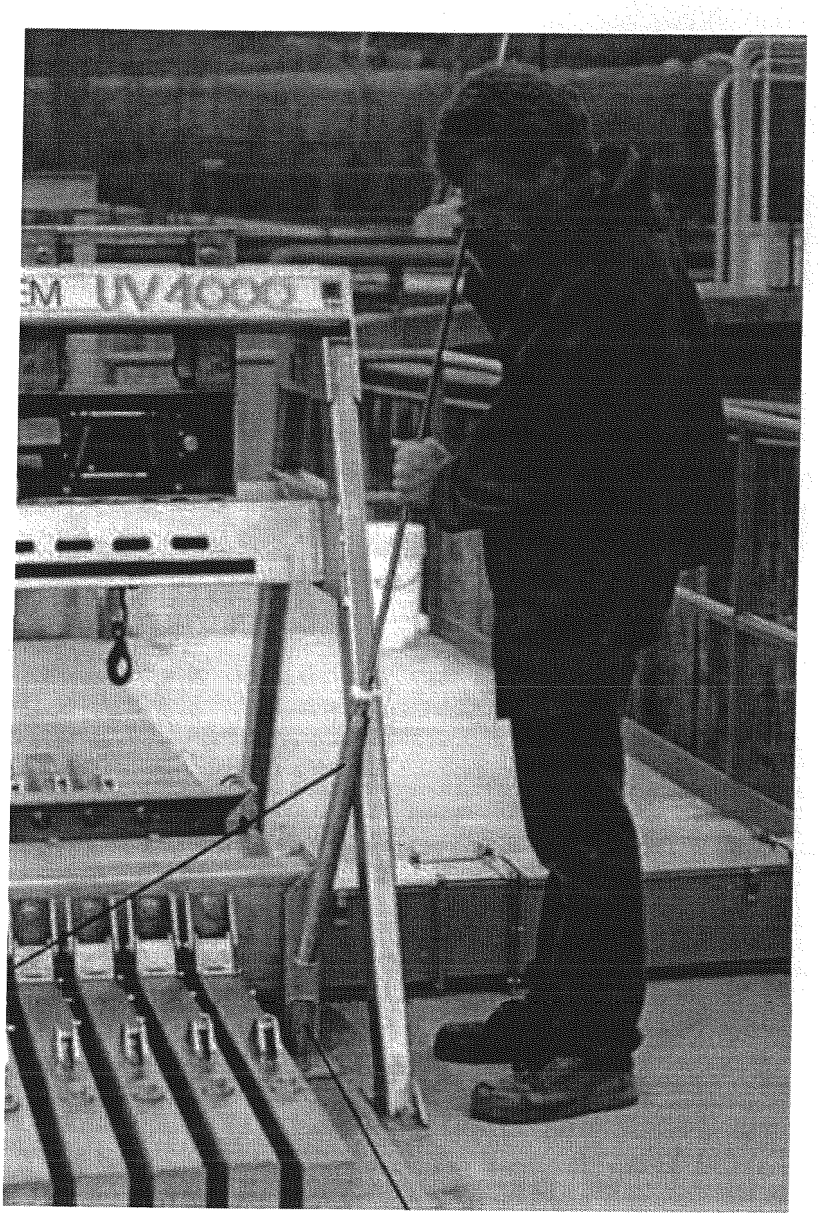
DESCRIPTION: STD, UV4E/LF PROBE ASSEMBLY		QUOTE NO. 4M0191
DRAWN BY : SAK	DATE : 01MY16	PROJECT NO. N/A
CHECKED BY : JAW	DATE : 01JN19	
APPROVED BY : SDK	DATE : 01JN19	DWG NO. D01 / REV. B
SCALE (8½x11) : NOT TO SCALE	LOG NUMBER : 99-3303	

Delrin cap

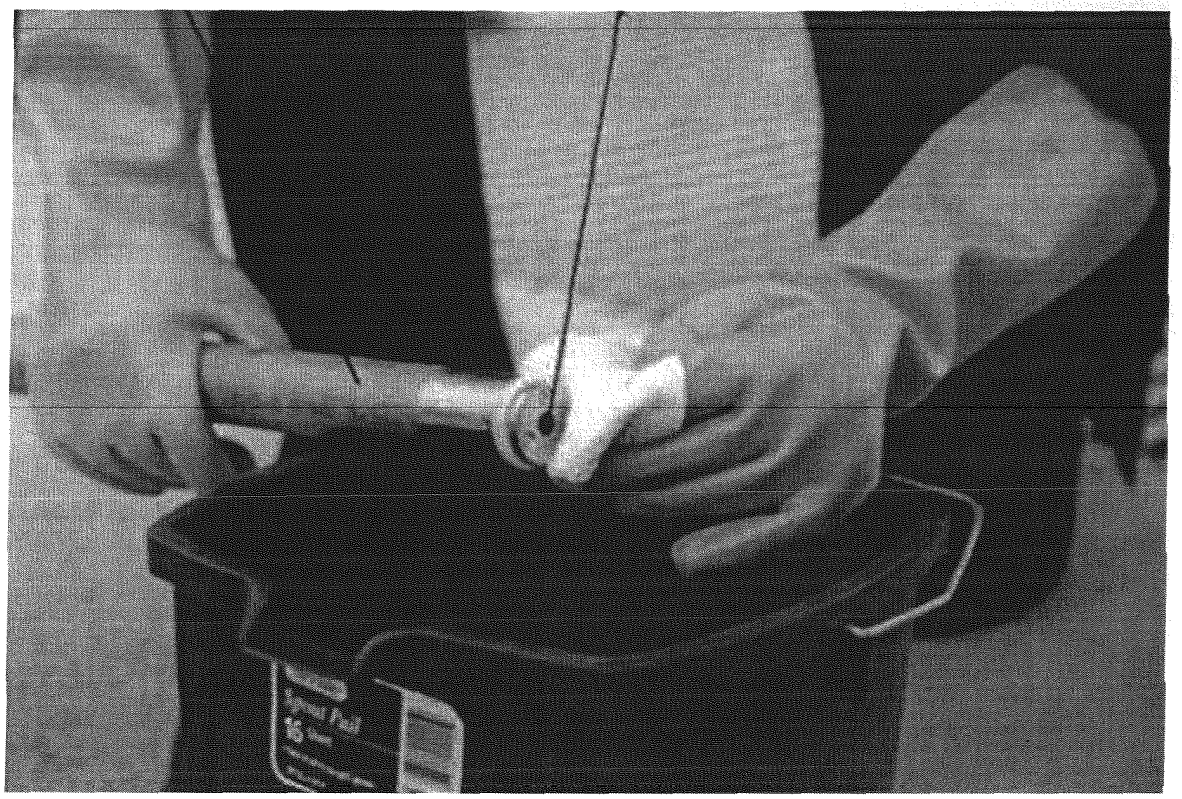


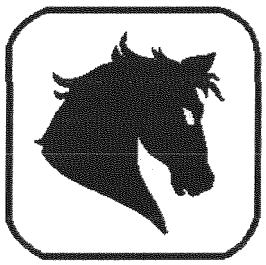
Probe Port

Probe body



Probe body Quartz Window





Trojan

SYSTEM UV4000™ LOW FLOW OPERATION AND MAINTENANCE MANUAL

SECTION 5.0

UV4000™ Module

Section 5.0 UV4000LF™ MODULE

The UV4000LF™ system utilizes a module lamp arrangement. Refer to the following drawings for details of module. The number and configuration of the lamps is determined based on the effluent quality, flow rate, and the specified level of disinfection. The UV lamps are oriented horizontally and parallel to the effluent flow.

UV lamps are enclosed in quartz sleeves , one end has a test tube bottom the opposing end is attached to a 316 stainless steel module frame. The open end is sealed by means of a sleeve securing nut which compresses an o-ring. Each lamp is isolated from all other lamps to prevent moisture from entering the module frame and are rated for continuous submergence.

The lamps are powered by electronic ballasts. The ballasts along with the monitoring system are housed in an enclosure atop the UV module frame. Power is distributed to each ballast through a terminal block connection. The electrical service is via a multiconductor cable connected to the Power Distribution Center. The ballast are kept at operating temperature by a closed looped cooling system.

A keyed interlock bar will be installed across the top of the modules preventing the lifting of the modules while still energized.

Section 5.1 LAMP

The UV lamps are a medium pressure, mercury vapour, hot cathode instant start design. They are designed to produce zero levels of ozone. Lamps are constructed to withstand shock, vibration and are designed with materials which are resistant to UV.

The UV lamps are warranted for 5000 hours on a pro rated basis at an average power level of 60%. The frequency of lamp replacement will depend on factors such as:

- temperature of reaction chamber liquid;
- power level for lamps;
- frequent switching of lamps ON and OFF.

The replacement lamp assembly part number is **441050.**

Section 5.2 QUARTZ SLEEVE

Trojan's UV4000LF™ system utilizes clear fused quartz cylindrical sleeves, domed at one end, to enclose the UV lamps. Bonded to the open end of the quartz sleeve is an integral sleeve holder with male threads for ease of lamp/sleeve replacement. Sleeves are constructed from Type 214 quartz with the properties of 89% transmission.

The sleeves protect the lamps from damage and in conjunction with sealing o-rings, they provide water tight containers.

To prevent any water from entering and contacting the lamps, it is very important to use the proper size sealing o-rings and to firmly tighten the sleeve securing nut when replacing lamps.

The replacement sleeve assembly part number is **441054.**

Section 5.3 ELECTRONIC BALLAST

The UV4000LF™ system utilizes an electronic ballast to energize the germicidal lamps. The ballasts are located within the "suitcase enclosure" at the top of the module. Power is fed to each ballast via a single phase service from a distribution block. Each ballast powers one corresponding lamp.
The replacement ballast pare number is **903374**.

Section 5.4 COOLING SYSTEM

The UV4000LF™ electronic ballast module utilizes a closed loop system to prevent the overheating of the module ballast. A pump is located in the hydraulic systems center which circulates propylene glycol through the coolant extrusion of the module. The extrusion acts as a heatsink as the ballasts are attached mechanically to the extrusion.

Section 5.5 AUTOMATIC CLEANING SYSTEM

Trojan's UV4000LF™ system incorporates an automatic lamp cleaning feature designed to operate periodically without need for system shut-down or loss of disinfection.

Each module is fitted with specialized hydraulic cylinders and a 2 way solenoid control valve which move the wiper collar-assembly in alternate linear motion over the length of the sleeves. Cleaning is then achieved mechanically by the scraping action of the wiper-seals, and chemically by action of the acid cleaning solution contained in the wiper collars.

The hydraulic wiper cylinders are powered from the hydraulic pump located within the hydraulic systems center. Refer to Section 6.4 for further details of the hydraulic supply.

When in the remote mode the cleaning system is controlled by the SCC processor which implements the cleaning cycle by controlling one module at a time in sequence, then repeating the cycle at regular time intervals as pre-selected by the operator. Variable wiping frequency ensures that sleeves can be kept clean regardless of fouling rate. Sequencer ensures that only one module is cleaned at a time. Disinfection continues during cleaning process.

The wiper system can be controlled manually from the Operator Interface of the Control Center. The return and extend positions are used primarily for performing maintenance on the module when in the raised position.

Once a wiper is called to operate the two way solenoid valve will open and distribute fluid through a manifold system to the cylinders via nylon piping within the module frame. Clear piping is used to deliver fluid for the extend motion and the red piping delivers the fluid for the retracting motion of the wiper.

Section 5.6 MODULE REMOVAL

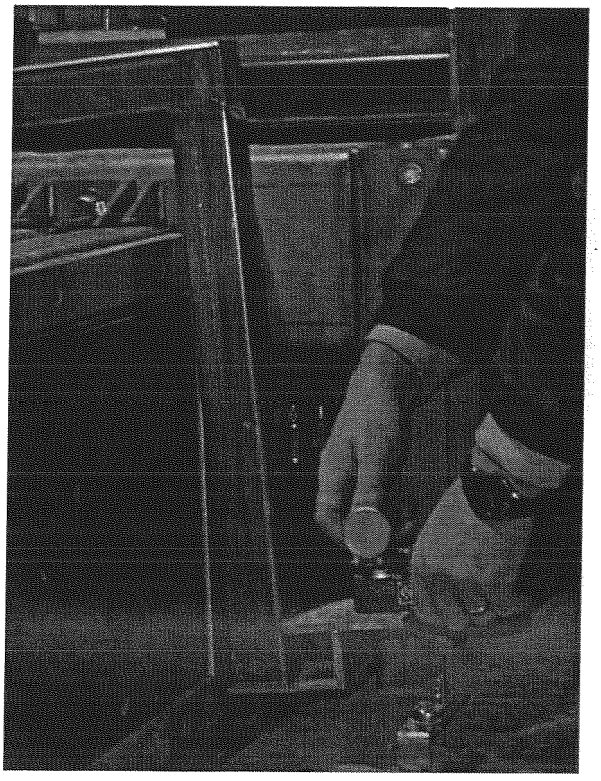
The following is a series of photographs which illustrate the step-by-step procedure for removing a UV module in preparation for any type of module maintenance.

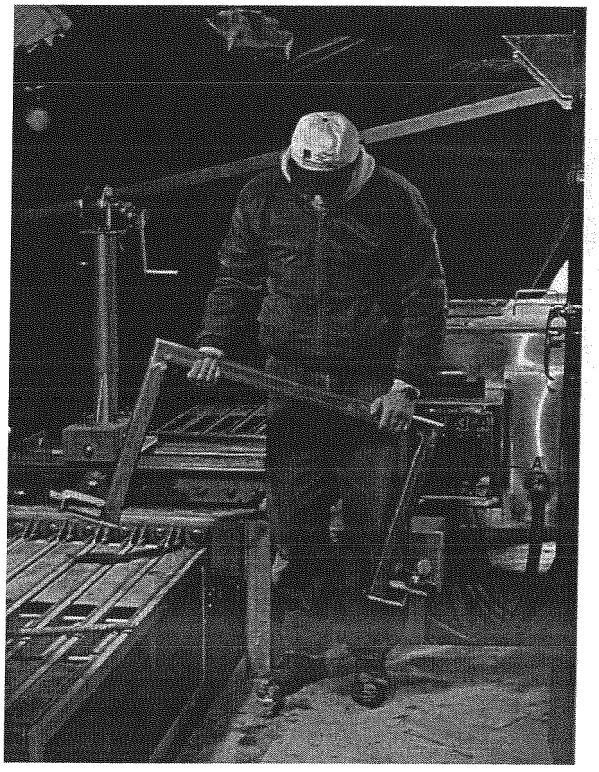
1. Turn off power at the System Control Centre (SCC) for the applicable bank and remove the key from the interlock.

2. Remove the locking bar over the bank using the same key.

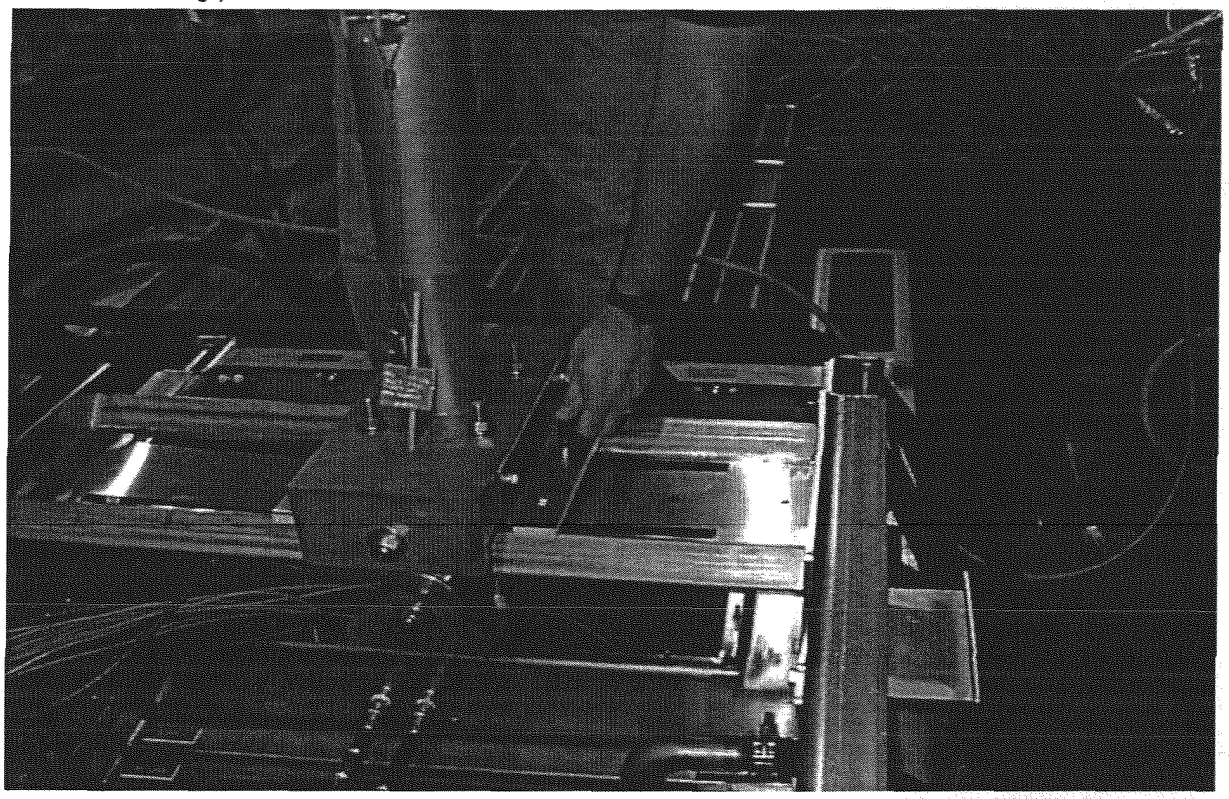
   Note: As a safety feature the key that powers the bank located at the SC/PDC can only be removed when it is in the 'OFF' position. The same key is also used for the lockout bar. Similarily, this key can only be removed from the lockout bar when the all modules in the bank are in place (within the channel) and the lockout bar is in the locked position across all modules. Therefore, a bank that is being serviced cannot be powered up.

3. Remove the applicable number of grating sections to allow clearance for the modules to swing.





4. Slide the module removal mechanism (MRM) over the applicable module and secure in place using the locking pin.



5. Attach the stainless steel rope and lift the applicable module out of the reactor using the manual winch on the MRM. Never lift a module above a person.

6. Once in the upright position, secure secondary safety rope. Always use safety rope during maintenance.

7. Replace the grating before continuing any work on or near the module.

8. Perform maintenance; repeat step 3; remove safety rope and lower module into the reactor.

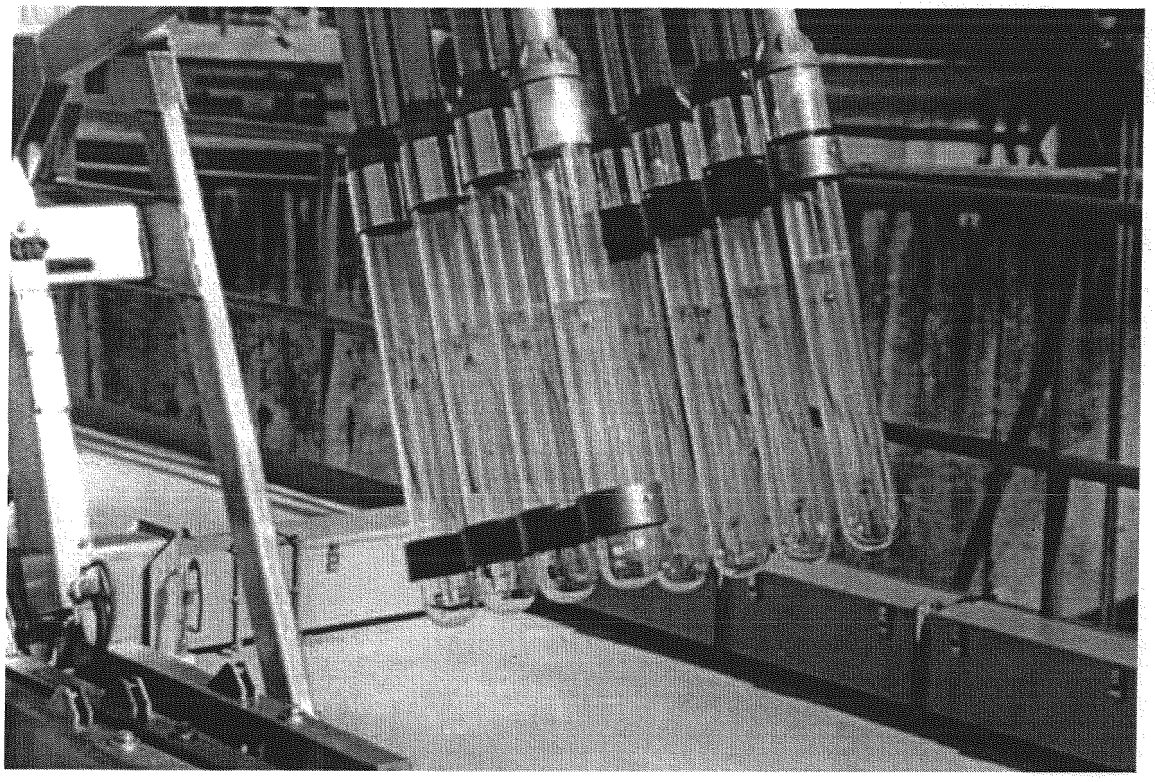
9. Repeat steps 4 to 8 inclusive, for all modules in the bank requiring maintenance.

10. Return the bank to service by replacing the grating and the locking bar over the bank, and turning on the power at the SCC.

Note: Key for interlocks can only be removed from the locking bar when the bar is in place. Power cannot be restored to bank without key.

Section 5.7 LAMP REMOVAL/REPLACEMENT

1. Remove and secure the appropriate modules as described in Section 5.6



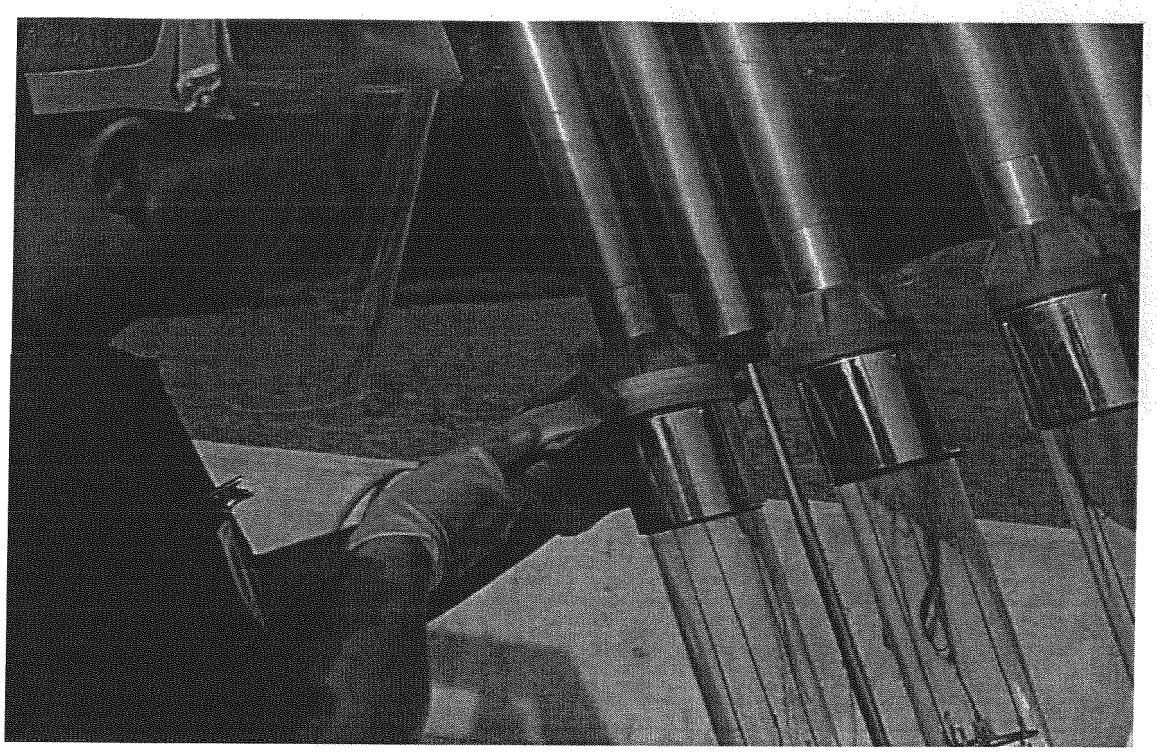
2. With the wiper selector switch in the LOCAL position place the second selector at the EXTEND position. This will move the wiper collar assembly to the end of its stroke.

   It is not necessary to remove the wiper collar.

Note: Remember to return the wiper mode to AUTO once all modules have undergone maintenance and are reinstalled.

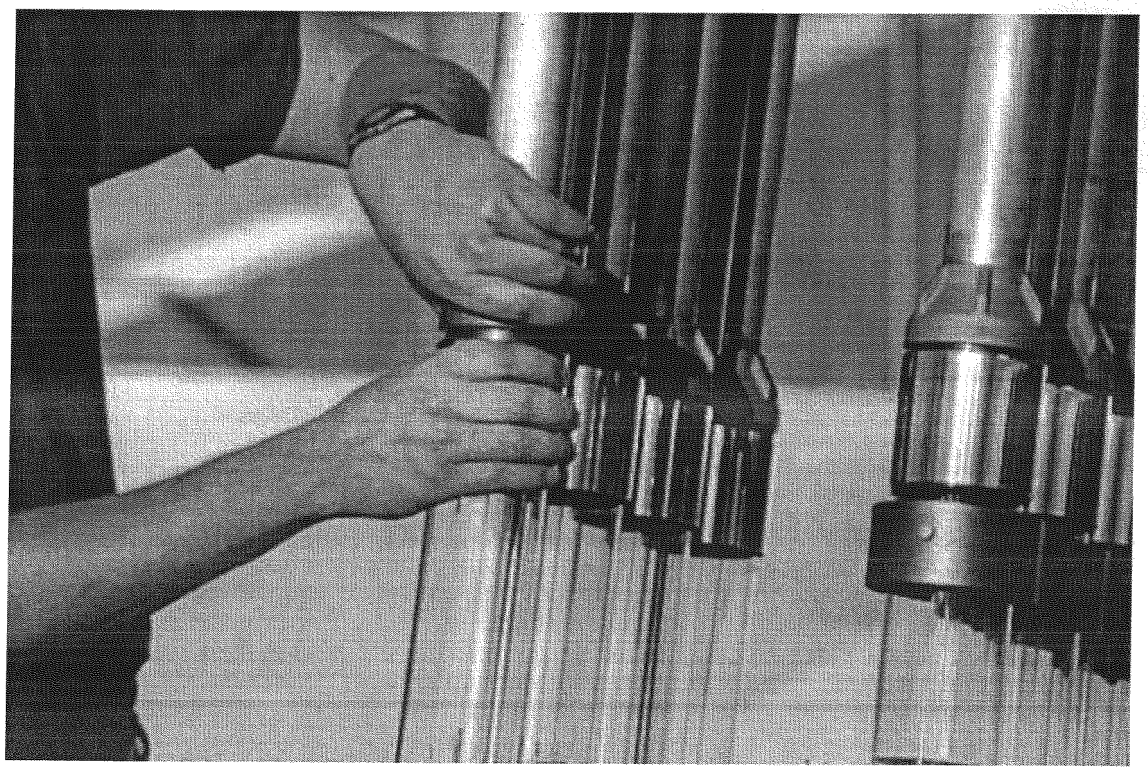
WARNING:
THE 480V ELECTRICAL SERVICE MUST BE DISCONNECTED BEFORE PERFORMING ANY MAINTENANCE.

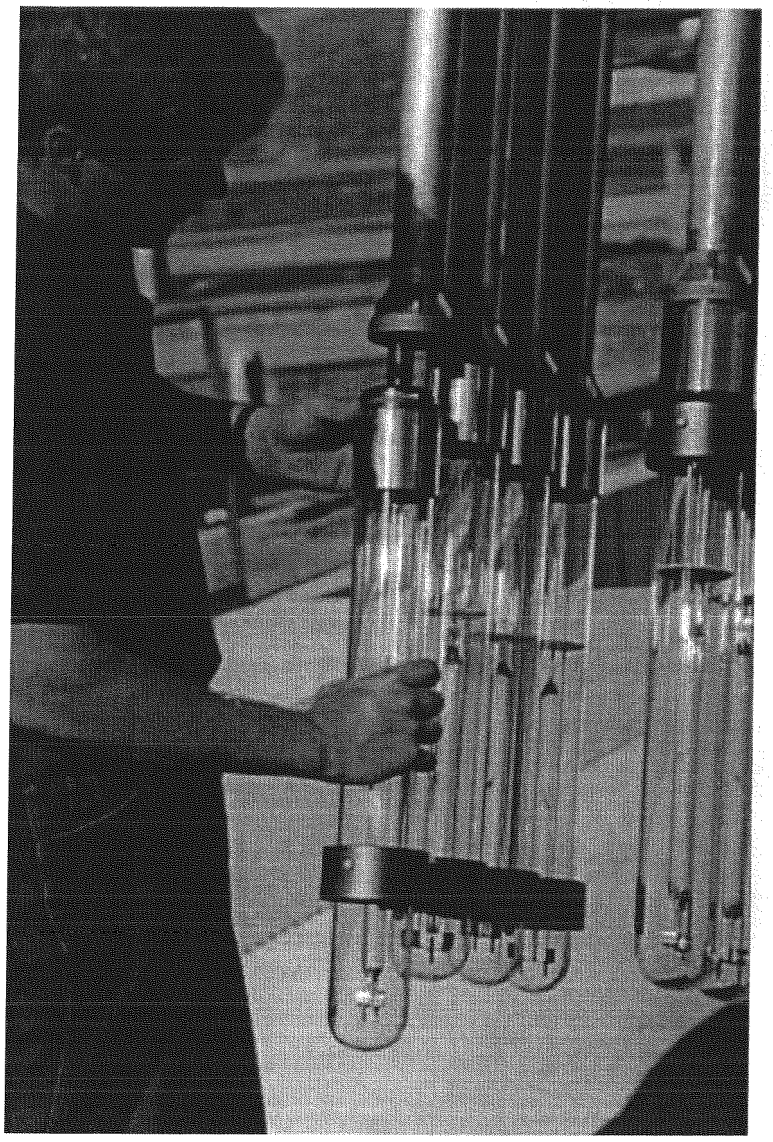
Note: Ensure sleeve is wet before extending wiper.



3. Using the strap wrench or the nut tool, loosen the stainless sleeve securing nut. **Note: Never allow the quartz sleeve to rotate, always turn the stainless steel nut.**

4. Once loose, turn the sleeve securing nut by hand until it is completely free from the sleeve holder.

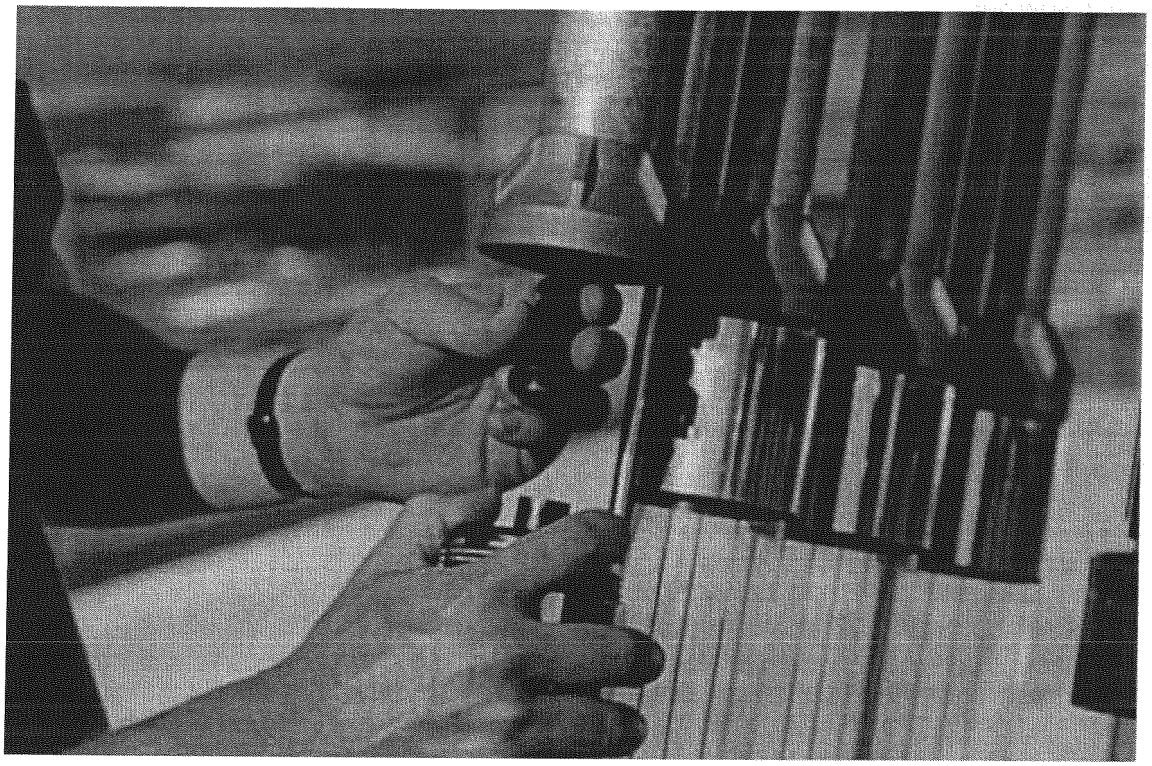




5. Slide the sleeve away from its securing nut just enough to allow access to the moulded lamp connector.

   Do not pull on lamp connector unnecessarily, as this may damage the lamp power cable inside the stainless steel module frame.

   The quartz sleeve will not fall as it is still being held by the wiper collar.



6. Disconnect the moulded lamp connector.

Take care to ensure that no foreign material gets inside either part of the connector. These connectors must be clean and dry. Clean with isopropyl alcohol (rubbing alcohol) if required.

7. Slide the quartz sleeve through the wiper collar as shown above.

8. The entire lamp assembly is pulled out of the sleeve as a complete unit. New lamp assemblies supplied by Trojan Technologies Inc. will also be complete with the integral frame and base as shown above.

9. To install a new lamp assembly, reverse the procedure paying attention to the following:

- Lamp connectors **must** be **clean** and **dry**. They may be cleaned with isopropyl alcohol if required.
- All sealing o-rings to be in good condition; free of nicks, grit, and water.
- Do not apply any lubricant to the O-ring seals.
- **Do not touch the clear quartz of the new lamp.** If it is touched or otherwise contaminated, clean it with isopropyl alcohol.
- Orient the new lamp assembly so that one of its long stainless steel wires will be at the bottom of the sleeve when the module is reinstalled in the channel.
- Use strap wrenches to firmly tighten the sleeve securing nut. **Never allow the quartz sleeve to rotate when tightening.**

10. When finished working on a module, **always** retract the wiper collars.

WARNING:
NEVER REINSTALL A MODULE WITH ITS WIPER COLLARS EXTENDED.

Section 5.8 CLEANING SOLUTION DRAINING/FILLING

WARNING:
ALWAYS WEAR PROTECTIVE CLOTHING AND FULL EYE PROTECTION GOGGLES WHEN WORKING WITH ACIDIC SOLUTION.

Material Safety Data sheets are found in Section 1.0.

Each module wiper collar contains a small amount (approximately 200 mL for each quartz sleeve) of acidic cleaning solution. It is recommended to use industrial strength Lime-A-Way.

The acidic cleaning solution is contained within the wiper collar seals. After months of wiping the quartz sleeves, the acid will become consumed as part of the sleeve cleaning process. It is necessary to change the cleaning solution periodically to ensure that the quartz sleeves remain clean and that disinfection will be maintained. Life of cleaning solution is approximately six months.

The time interval between cleaning solution changes will vary depending on the nature of the effluent and related sleeve fouling characteristics. It is recommended to change the cleaning solution at the regular scheduled lamp changes or whenever it appears that a coating is forming on the outside of the quartz sleeves.

WARNING:
THE 480V ELECTRICAL SERVICE MUST BE DISCONNECTED BEFORE PERFORMING ANY MAINTENANCE.

1. Remove and secure modules as described in Section 5.7.

2. With the wiper selector switch in the LOCAL position place the second selector at the EXTEND position. This will move the wiper collar assembly to the end of its stroke.

Note: Ensure sleeve is wet before extending wiper.

Remember to return the wiper mode to AUTO once all modules have been maintenanced and reinstalled.

3. Place a plastic pail underneath the wiper collar.

4. **First**, remove the **lower** threaded drain plug on one wiper collar. The cleaning solution will not start to drain until the **upper** threaded fill plug is removed as shown above and on the following page.

Once the wiper collars fill plug and drain plug are removed, the cleaning solution will drain.

Contact with the cleaning solution can be avoided by removing the drain plug first, since the fluid will not drain until the fill plug is also removed.

5. **Immediately and thoroughly rinse any spills with water.**

6. To refill the wiper collar, reinstall the drain plug and gently inject fresh cleaning solution with the squeeze bottle provided. Fill the wiper collar as full as possible and reinstall the fill plug.

7. When finished working on a module, <u>always</u> retract the wiper collars

WARNING:
NEVER REINSTALL A MODULE WITH ITS WIPER COLLARS EXTENDED.

Section 5.9 SLEEVE REMOVAL/REPLACEMENT

1. Remove and secure modules as described in Section 5.6.

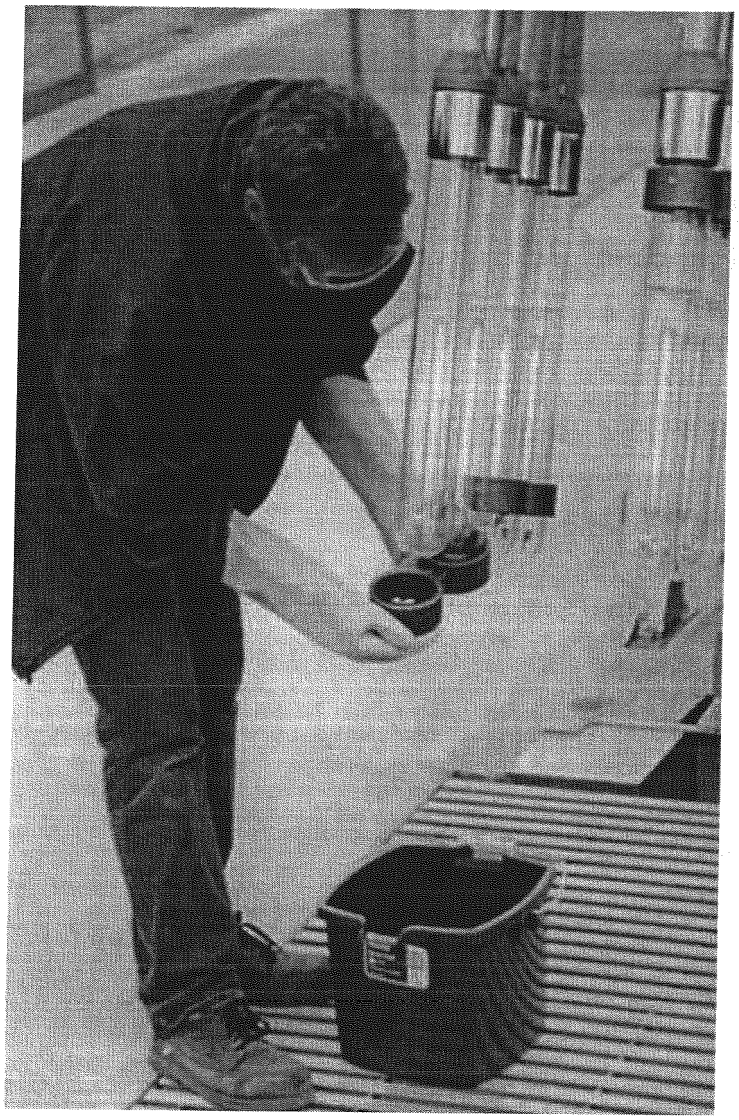
2. With the wiper selector switch in the LOCAL position place the second selector at the EXTEND position. This will move the wiper collar assembly to the end of its stroke.

Remember to return the wiper mode to REMOTE once all modules have been maintenanced and reinstalled.

3. In order to remove the quartz sleeve, it is necessary to first remove the wiper collar. Therefore, drain the cleaning solution as described in Section 5.9.

4. Remove the stainless steel nut and lock washer as shown.

WARNING:
THE 480V ELECTRICAL SERVICE MUST BE DISCONNECTED BEFORE PERFORMING ANY MAINTENANCE.



5. Slide the wiper collar off the sleeves. Note the plastic pail underneath.

6. Undo the sleeve securing nut and disconnect the lamp as described in Section 5.8. **Do not let go of the sleeve.**

7. Remove the sleeve with the lamp assembly inside.

8. If the sleeve is contaminated on the inside, it may be cleaned with isopropyl alcohol.

Note: If the sleeve is cracked or otherwise damaged, replace it with a new sleeve.

9. To reinstall the quartz sleeve, reverse the procedure paying attention to the following:

- Lamp connectors **must** be **clean** and **dry**. They may be cleaned with isopropyl alcohol if required.
- All sealing o-rings to be in good condition; free of nicks, grit, and water.
- Do Not apply any Lube to the o-ring seals
- **Do not touch the clear quartz of the lamp.** If it is touched or otherwise contaminated, clean it with isopropyl alcohol.
- Orient the new lamp assembly so that one of its long stainless steel wires will be at the bottom of the sleeve when the module is reinstalled in the channel.
- Use strap wrenches to firmly tighten the sleeve securing nut. **Never allow the quartz sleeve to rotate when tightening.**

10. When finished working on a module, **always retract the wiper collars using the operator interface** (see Section 4.2).

WARNING:
NEVER REINSTALL A MODULE WITH ITS WIPER COLLARS EXTENDED.

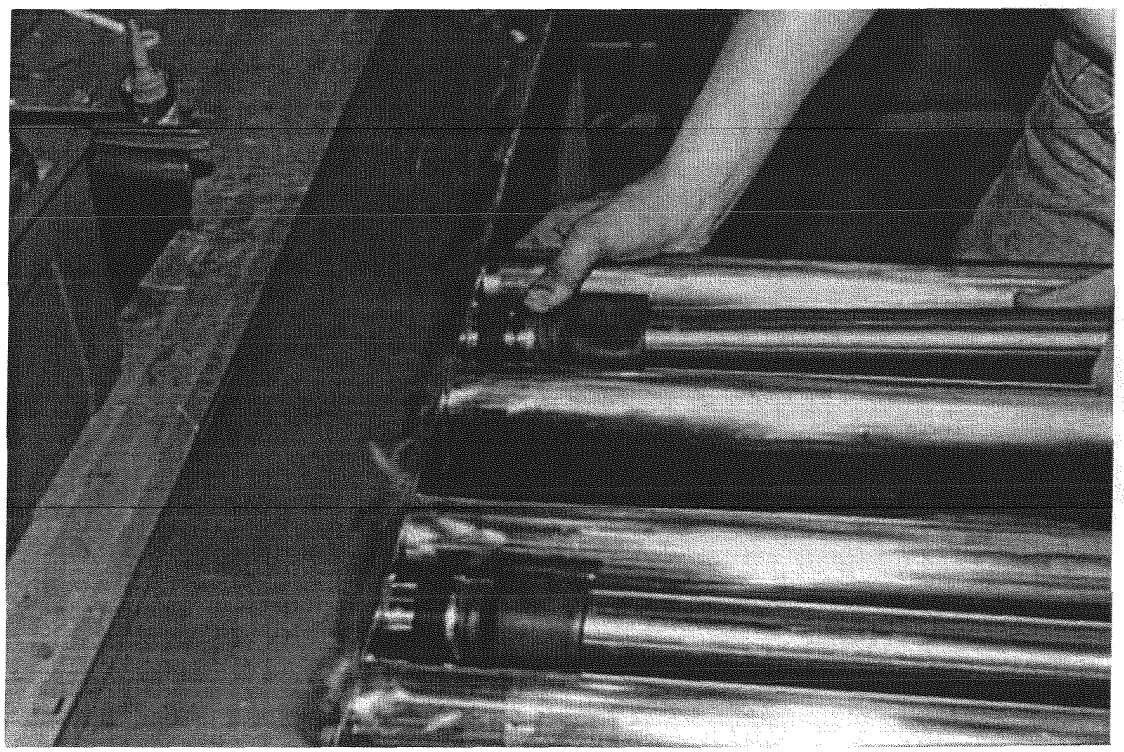
Section 5.10 HYDRAULIC CYLINDER REPLACEMENT

1. Remove and secure modules as described in Section 5.6. Ensure module is electrically disabled.

2. Remove wiper collar assembly as described in Section 5.9.

3. Remove and discard the (2) ear clamps which hold boot in place. See module drawing 4M0064 for details.

4. Carefully slide boot along cylinder case until black plastic mounting nutfastening cylinder to module frame is exposed. Replace boot if cracked or cut.

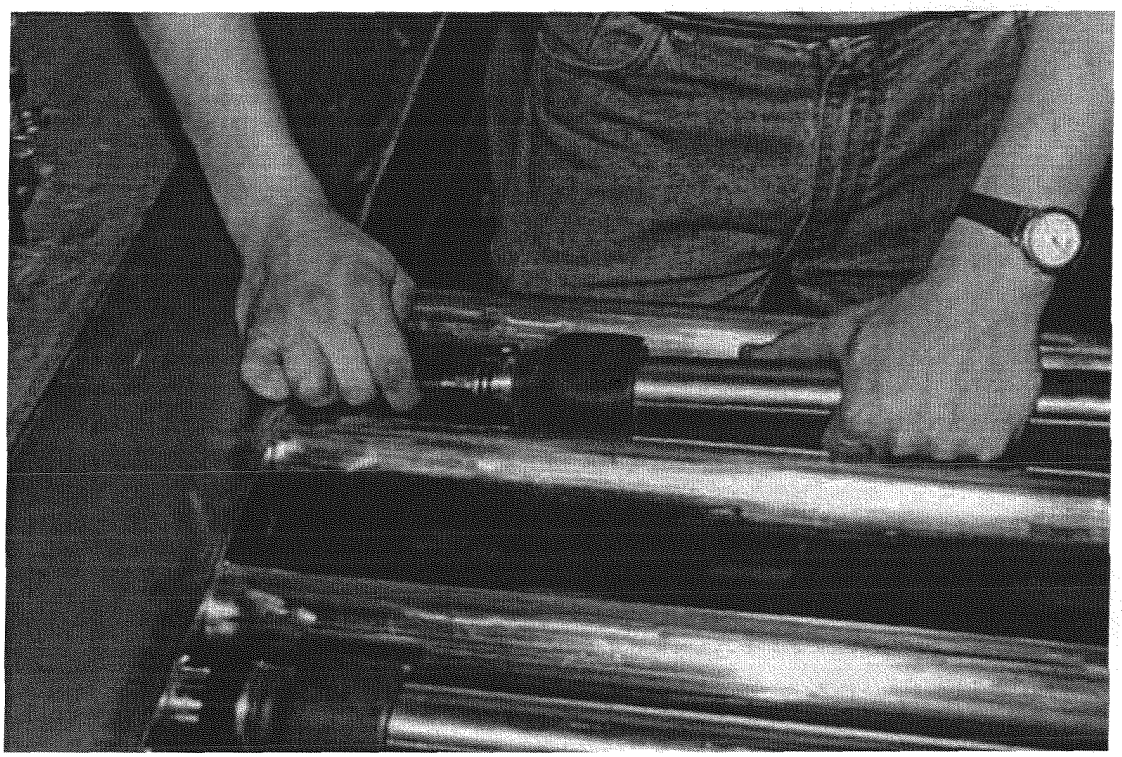


WARNING:
THE 480V ELECTRICAL SERVICE MUST BE DISCONNECTED BEFORE PERFORMING ANY MAINTENANCE.

5. Loosen nut with pipe strap wrench provided in operators kit. At the same time supporting cylinder with hands as not to damage lamp sleeve assembly.

6. Carefully slide cylinder from module frame until connections of hydraulic lines can be seen.

7. Disconnect lines from cylinder by loosening brass fittings.



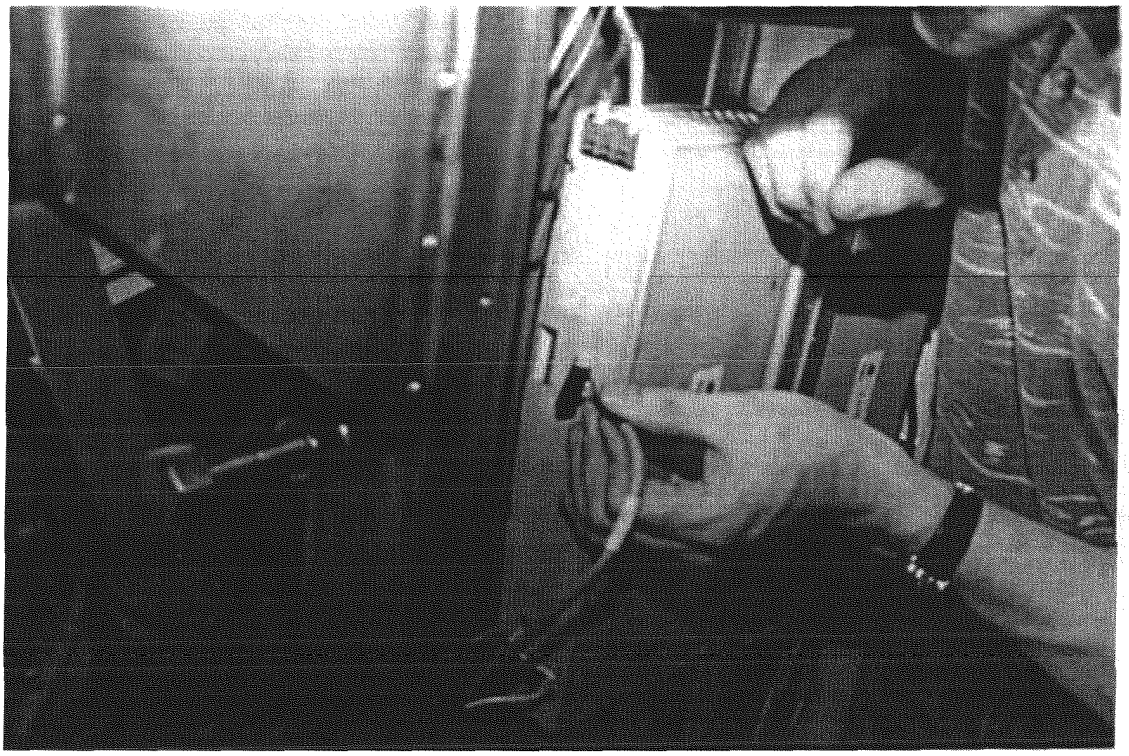
8. Replace with new cylinder by repeating steps in reverse order.

WARNING:
ENSURE BLUE (EXTEND) HOSE IS CONNECTED TO "E" CONNECTION OF CYLINDER AND RED (RETRACT) HOSE IS CONNECTED TO UNMARKED CONNECTION.

Section 5.11 ELECTRONIC BALLAST REPLACEMENT

1. Remove and secure modules as described in Section 5.6.
   Ensure module is electrically disabled.

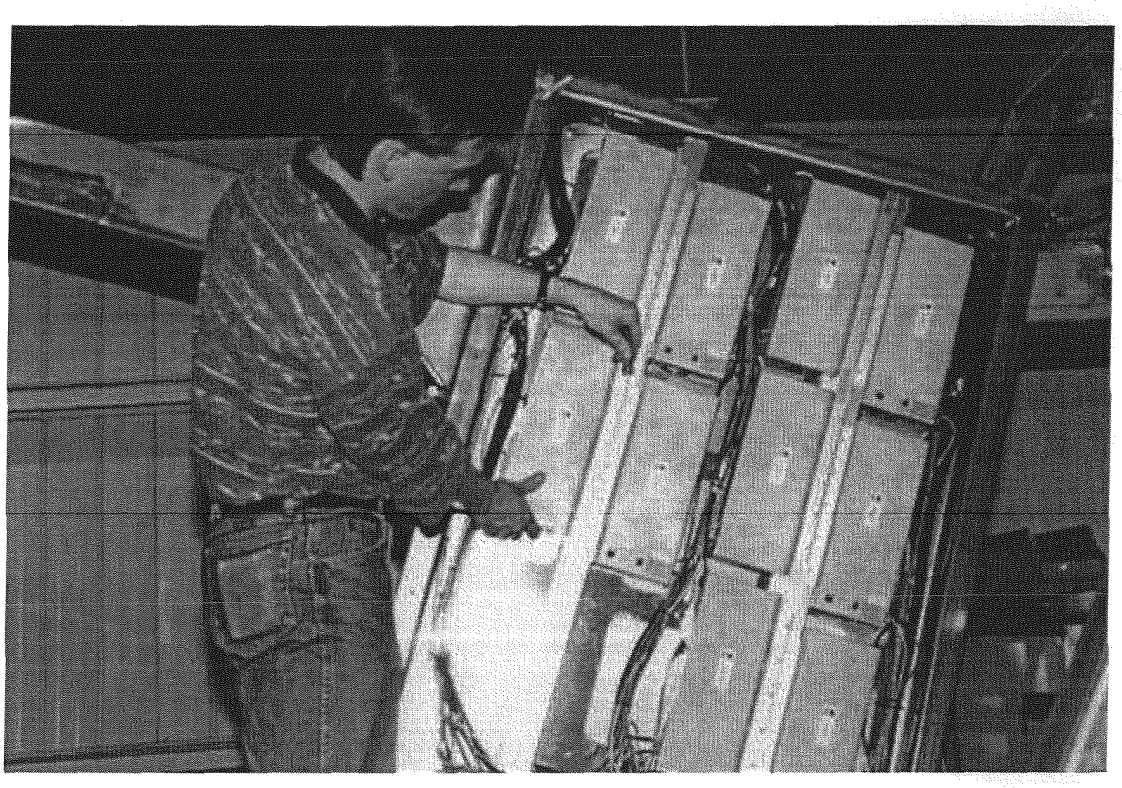
2. Remove black cover assembly from module suitcase by removing 1/4" bolts around perimeter of enclosure.



3. Disconnect communication interconnect cable from effected ballast. Note connector simply pulls off and pushes on.

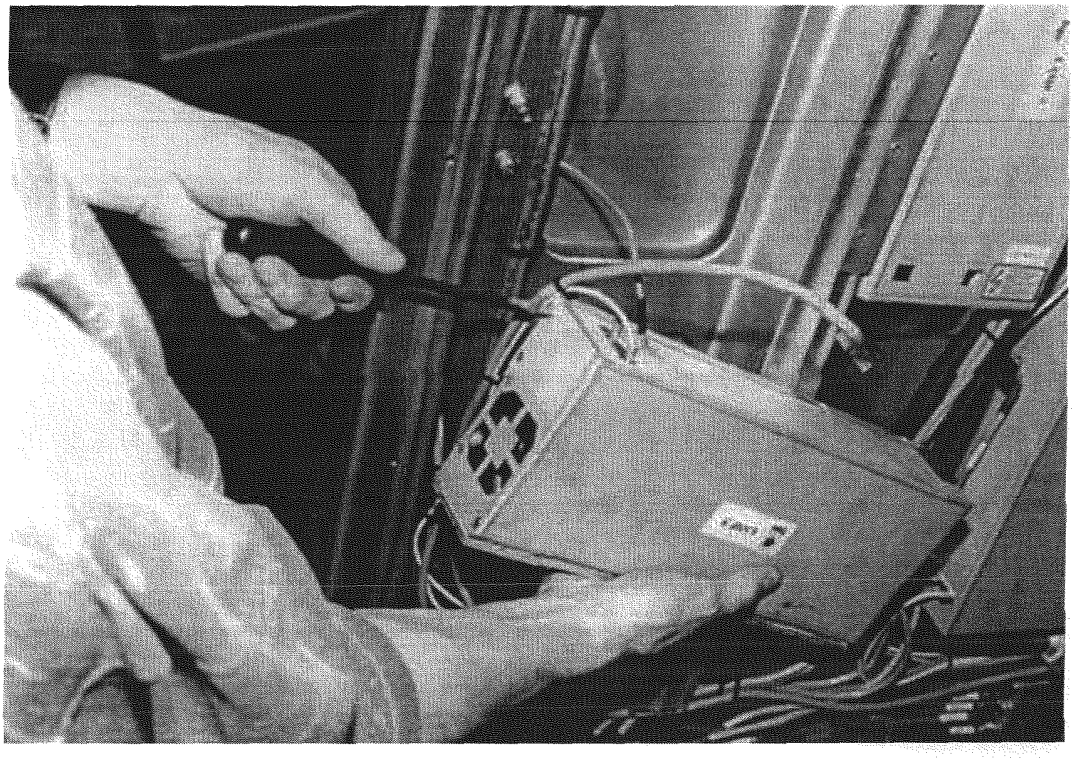
WARNING:
THE 480V ELECTRICAL SERVICE MUST BE DISCONNECTED BEFORE PERFORMING ANY MAINTENANCE.

4. Loosen set screws on ballast clamp at the same time supporting the ballast with other hand. At this point the ballast should simply slide out from under clamp.



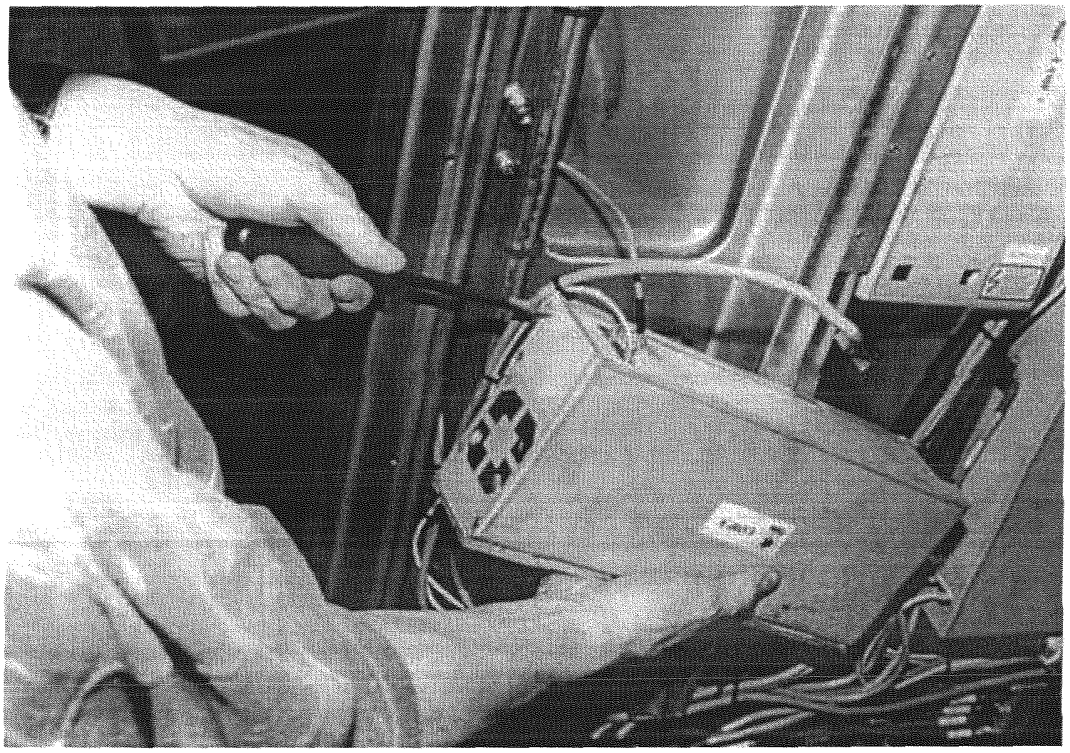
5. Using a screwdriver disconnect power cable harness from end of ballast.

6. Using a screwdriver remove cover plate on end of the ballast to expose black and white power conductors.



7. Loosen screws and remove conductors from terminal connection.

8. Install new ballast by repeating previous steps in reverse order.



SYSTEM UV4000™ TYPE FLOW OPERATION AND MAINTENANCE MANUAL

SECTION 6.0

UV4000™ Mechanical Systems

Section 6.0 UV4000^{TM} MECHANICAL SYSTEMS

Trojan's UV4000^{TM} system incorporates support mechanisms to ensure the reliability and performance of the disinfection process.

Section 6.1 MODULE REMOVAL MECHANISM (MRM)

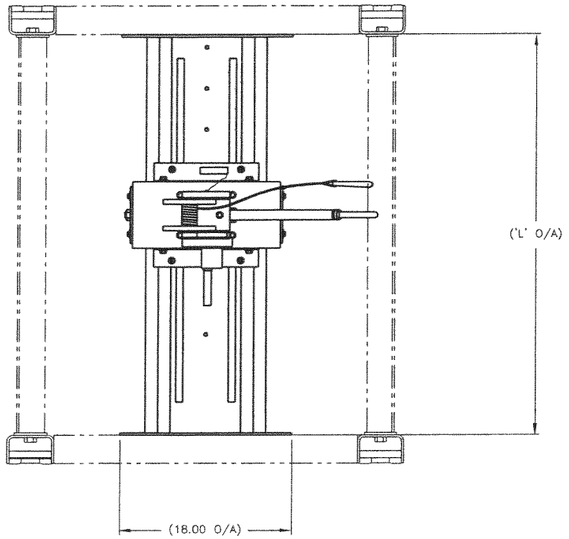
The Module Removal Mechanism (MRM) is a hand operated device used to lift individual modules for cleaning and inspection.

Use of the MRM is fully described in Section 5.6.

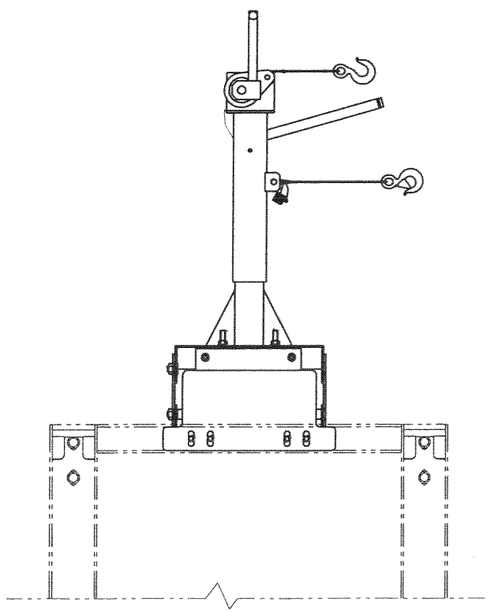
Section 6.1 MODULE REMOVAL MECHANISM

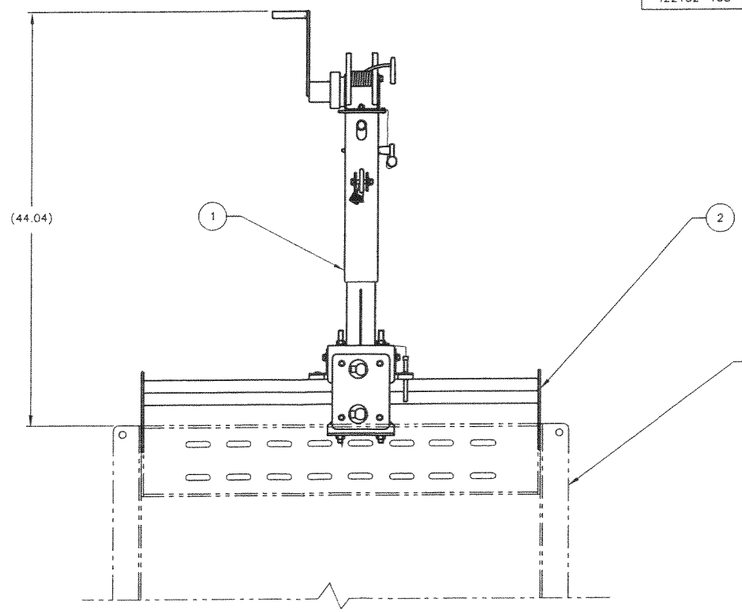
The following pages contain detailed drawings and Component Specifications of the removal mechanism along with a manufacturer's operation and maintenance manual.

REV	REVISION DESCRIPTION	LOG NO.	REV BY	CHK BY	APPROVAL AND DATE
A	DWG RELEASED.	98-1735	DW	CNB	AC 98JL14
B	1. UPDATED DRAWING PICTORIALLY TO MATCH CURRENT REVISIONS OF ALL PARTS. 2. ADDED REVISION LEVEL COLUMN TO CHART.	98-2348	JB	RG	ADS 98DEC09



MRM ASSY P/N	NUMBER OF MODULES	PEDESTAL ASSY P/N 'A'	TRACK WLDT P/N 'B'	'L' (IN)	REV LVL
422152-002	2	422148-000	422136-002	16.37	2
422152-003	3	422148-000	422136-003	20.70	2
422152-004	4	422148-000	422136-004	25.03	2
422152-005	5	422148-000	422136-005	29.36	2
422152-006	6	422148-000	422136-006	33.69	2
422152-007	7	422148-000	422136-007	38.02	2
422152-008	8	422148-000	422136-008	42.35	2
422152-102	2	422148-100	422136-102	16.37	2
422152-103	3	422148-100	422136-103	20.70	2
422152-104	4	422148-100	422136-104	25.03	2
422152-105	5	422148-100	422136-105	29.36	2
422152-106	6	422148-100	422136-106	33.69	2
422152-107	7	422148-100	422136-107	38.02	2
422152-108	8	422148-100	422136-108	42.35	2





8 MODULE MRM ASSEMBLY SHOWN

NOTES:

1. REF PHANTOM SHOWING THE ORIENTATION OF MRM ASSEMBLY.
2. SEE MIS BOM FOR LATEST REVISION LEVEL.

ITEM	QTY	ITEM DESCRIPTION	PART NUMBER	DOCUMENT NUMBER
2	1	TRACK WLDT, MDL MRM UV4LF	'B'	422136G
1	1	PEDESTAL ASSY, MRM UV4LF	'A'	422148G

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES: 2 PL DEC ± 0.03
3 PL DEC ± 0.005
ANGLE ± 0.5°
REMOVE ALL BURRS
ALL CORNERS R 0.010 OR BREAK
▽ - MIN RECEIVING INSPECTION PT

TROJAN TECHNOLOGIES INC.
LONDON, ONTARIO, CANADA

DESCRIPTION: MRM ASSY, UV4LF
PART NO.: SEE CHART
REV: B
THIRD ANGLE PROJECTION
0 0.5 1.0
1.0" ON ORIGINAL DWG
SCALE: 1:8
SHEET 1 OF 1
SIZE D
DWG NO. 422152G

Trojan

COMPONENT SPECIFICATION (CS)

DESCRIPTION: **WINCH, HAND W/BRAKE 1000 LBS**

PART/DOC. #: **422030**

SPECIFICATION: This specification is for a Thern Spur Gear Hand Winch that meet the following criteria:

2nd Layer Load Rating:	**1000 lbs**
Full Drum Load Rating:	**300 lbs**
Weight (Approx):	**14 lbs**

Automatic Brake providing positive load control for lifting and lower operations

Corrosion Resistant zinc and iridescent dichormate plated. (Winch is to be suitable for use in a marine environment)

Each winch is to be **supplied with a test certificate**, stating the **serial number** of the winch and the **load rating** for which the winch is certified.

Refer to the attached cut-sheets for additional information.

Manufacturer:	**Thern Inc.**
Part Number:	**M4021PB**
Manufacturer's Contact:	**Jeff Wilkowski**
	1-800-843-7648

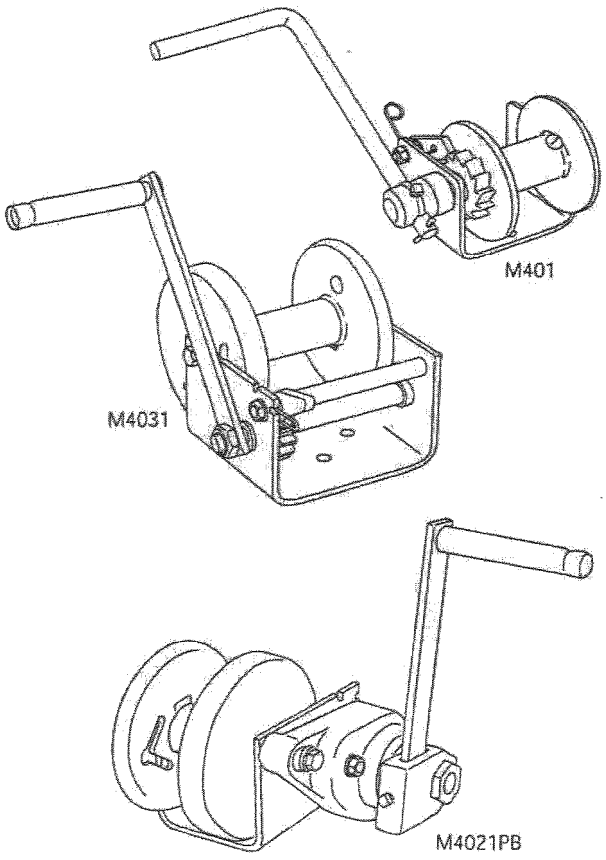
SOURCE OF SUPPLY:

Grand View Chain and Cable
351 West St. Units 1 & 3
Brantford, Ontario
N3R 3V8
Tel. (519) 756-0590
Fax. (519) 756-2215

THERN INCORPORATED

FAST FACTS 99

TO:	FROM:
FAX: PHONE:	FAX: PHONE:



Spur Gear Hand Winches Single Reduction

Up to 1000 lb capacity

- **Machine Cut Spur Gears** provide accurate operation and long lasting service. Model M401 has no gearing.
- **Automatic Brake Models** provide positive load control for lifting and lowering operations. Brake models have a PB suffix.
- **Corrosion Resistant** zinc and iridescent dichromate plated finish provides marine duty protection against corrosion in harsh environments.
- **Quick Disconnect Anchor** for quickly attaching or removing wire rope equipped with a swagged ball fitting. Model M401 does not include a quick disconnect anchor.
- **Bronze Bearings** provide smooth and efficient operation. Model M401 operates without bearings.
- **Large Diameter Drums** minimize wear to the wire rope and help extend its life.
- **Steel Gear Covers** provide protection for gears and help prevent injuries.
- **Handles Adjust** in length on Models M401, M4021PB, and M4031PB, to change the force required to move load.
- **Spring Loaded Ratchets** ensure positive engagement of ratchet with gear. Brake models do not include ratchets.
- **Wire Rope Assemblies** sold separately.

Spur Gear Hand Winches – Configurations and Performance Characteristics – Section 1 Pricing

model number	description	load rating (lb) 1st layer	load rating (lb) mid drum	load rating (lb) full drum	wire rope dia. (in)	drum capacity (ft) [1] 1st layer	drum capacity (ft) [1] mid drum	drum capacity (ft) [1] full drum	gear ratio	force [2] to lift 1000 lb	approx. ship wt. (lb)	user [3] price
M401	500 lb – marine duty (for pulling only)	500	330	240	1/8	7	60	130	—	—	8	$ 47
					3/16	4	27	60				
M4021	1000 lb – marine duty (for pulling only)	1000	680	470	1/8	4	52	120	2.85:1	55 lb	11	134
					3/16	2	24	52				
M4021PB	1000 lb – marine duty with brake (for lifting)	1000	680	470	1/8	4	52	120	2.85:1	55 lb	15	225
					3/16	2	24	52				
M4031	1000 lb – marine duty (for pulling only)	1000	680	470	1/8	11	110	250	2.85:1	55 lb	13	145
					3/16	7	51	110				
M4031PB	1000 lb – marine duty with brake (for lifting)	1000	680	470	1/8	11	110	250	2.85:1	55 lb	17	239
					3/16	7	51	110				

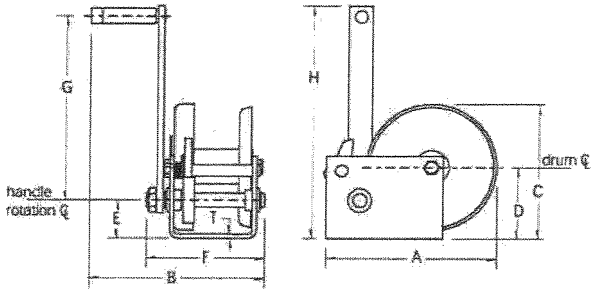
[1] Actual drum capacities may be 25-30% less, due to nonuniform winding. Wire rope tension will also affect drum capacity.
[2] Approximate handle force required to lift 1000 lb with an empty drum, and maximum handle length.
[3] Please contact factory or nearest Thern Distributor for firm fixed price and delivery.

THERN INCORPORATED

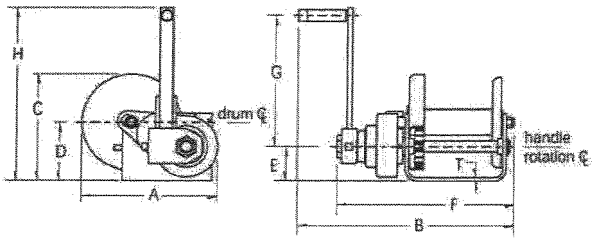
FAST FACTS 99

TO:	FROM:
FAX: PHONE:	FAX: PHONE:

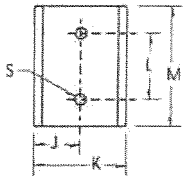
Models M4021 and M4031



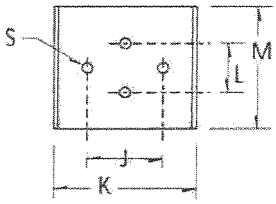
Models M4021PB and M4031PB



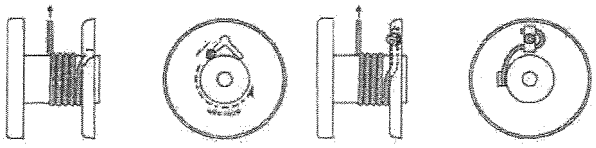
M4021 and M4021PB Base



M4031 and M4031PB Base



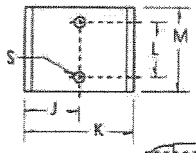
Wire Rope Installation – Models M4021, M4021PB, M4031, and M4031PB



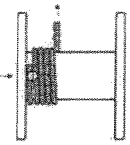
Quick Disconnect Anchor

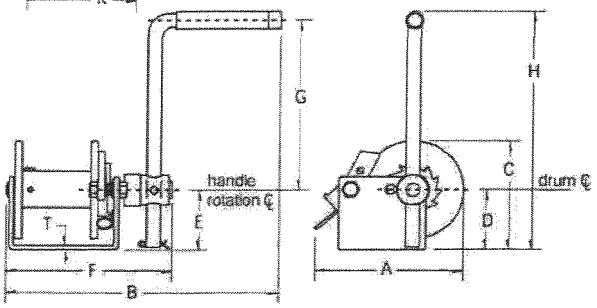
Flange Clip Anchor

Model M401



Wire Rope Installation – Model M401





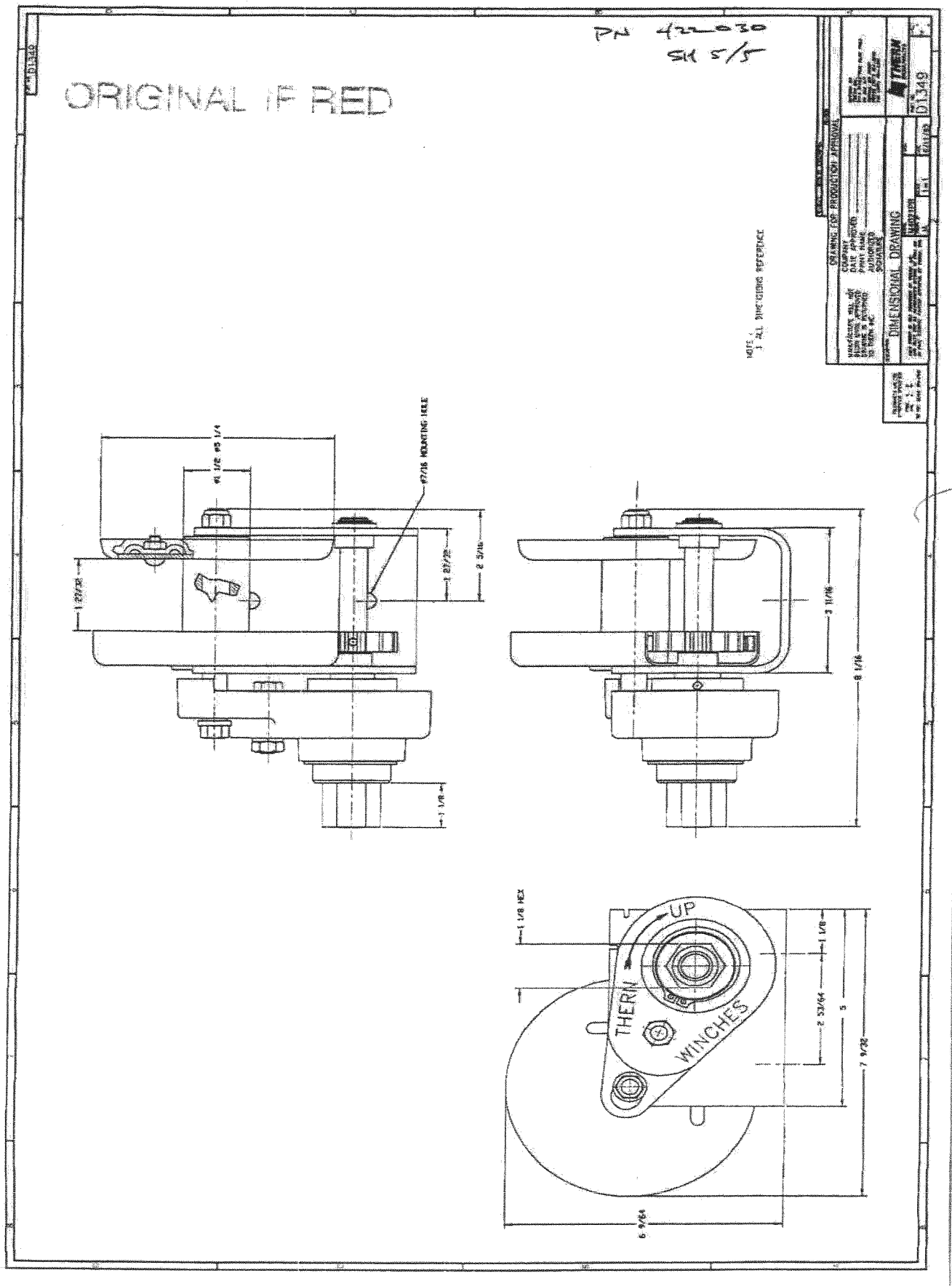
Spur Gear Hand Winches – Dimensions (in)

	M401	M4021	M4021PB	M4031	M4031PB
drum dia.	1.50	1.50	1.50	1.50	1.50
flange dia.	4.06	4.56	4.56	4.56	4.56
drum width	2.75	2.00	2.00	4.00	4.00
A	6.56	7.25	7.27	7.25	7.27
B	10.56	8.63	11.75	10.68	13.75
C	4.56	6.12	6.14	6.12	6.14
D	2.50	3.37	3.37	3.31	3.37
E	2.50	2.00	2.00	2.00	2.00
F	5.81	4.96	8.05	6.96	10.05
G [4]	8.50	8.00	8.00	8.00	8.00
H [4]	11.28	10.43	10.43	10.43	10.43
J	2.19	1.84	1.84	3.00	3.00
K	4.38	3.68	3.68	5.68	5.68
L	2.50	2.82	2.82	2.00	2.00
M	3.50	5.00	5.00	5.00	5.00
S (hole dia.)	.40	.43	.43	.43	.43
T	.18	.18	.18	.18	.18

Dimensions are for reference only and subject to change without notice.

[4] Model M401, M4021PB, and M4031PB handles are adjustable. dimension shown is for maximum handle length.

Important: It is the owner's or operator's responsibility to determine the suitability of the equipment to its intended use. Study all applicable codes, manuals, and regulations. Be sure to read the Owner's Manual supplied with the equipment before operating it.


PN 422030
SH 5/5
ORIGINAL IF RED
DIMENSIONAL DRAWING
D1349
UP
THERM
WINCHES

Trojan

COMPONENT SPECIFICATION (CS)

DESCRIPTION: **HOOK, SAFETY ALY STL UV4LF**

PART/DOC. #: **422052**

SPECIFICATION: This specification is for a safety eye-hook with a latch.

This hook mus have a latch.

Manufacturer:	Crosby
Manufacturer Part Number:	S-320C
Manufacturer Stock Number:	1022200
Hook Identification Code:	DC
Working Load limit:	¾ Ton
Design Factor:	5:1
Material:	Painted Carbon Steel
Weight:	0.61 lbs
Overall Dimensions:	4.42" x 2.83"

SOURCE OF SUPPLY:

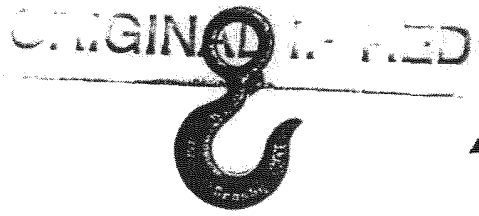
UNIROPE LTD.
3085 Universal Drive
Mississauga, Ontario
L4X 2E2

Tel. (905) 624-5131
Fax. (905) 624-9265

SEE ATTACHED SHEETS FOR ADDITIONAL INFORMATION

Crosby® Hoist Hooks

EYE HOOKS



S-320

SEE APPLICATION AND WARNING INFORMATION
On Pages 78 - 79

Look for the color Red - Crosby Carbon Steel Hooks

S-320N

All Crosby 320 Eye Hoist Hooks incorporate the following features:

- Designed with a 5:1 Design Factor.
- The most complete line of Eye hoist hooks.
- Proper design, careful forging and precision controlled quenched and tempering give maximum strength without excessive weight and bulk.
- Every Crosby Eye Hook has a pre-drilled cam which can be equipped with a latch. Even years after purchase of the original hook, latch assemblies can be added. (see pages 107 - 111)
- Eye hooks are load rated.
- Available in carbon steel and alloy steel.
- QUIC-CHECK™: Hoist hooks incorporate two types of strategically placed markings forged into the product which address two (2) QUIC-CHECK™ features: they are Deformation Indicators and Angle Indicators (see page 85 for detailed definition).

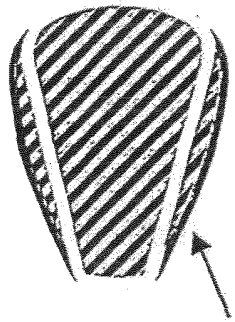
The following additional features have been incorporated into the new Crosby S-320N Eye Hoist Hooks. (Sizes ¾ ton Carbon thru 22 ton Alloy.)

- A new cross section design (see inset drawing) that enhances the overall performance.
- Fatigue rated at 1½ times the Working Load Limit at 20,000 cycles.
- Can be proof tested to 2½ times the Working Load Limit.
- Can be Metric Rated at 5:1 Design Factor.
- Low profile hook tip.
- New integrated latch (S-4320) meets the World class standard for lifting. See page 107.
  - Heavy duty stamped latch interlocks with the hook tip.
  - High cycle, long life spring.
  - When secured with proper cotter pin through the hole in the tip of hook, meets the intent of OSHA Rule 1926.550 (g) for personnel hoisting.

QUIC-CHECK™ Load Rated

Fatigue Rated

THE 320N HAS A NEW CROSS SECTION THAT ENHANCES OVERALL PERFORMANCE



OLD NEW

FOR USE WITH GRADE 8 CHAIN, SEE PAGE 174.

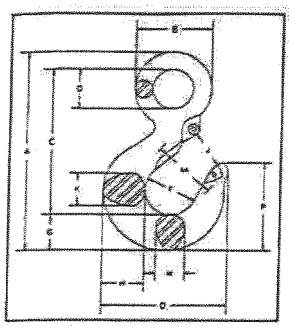
Working Load Limit (tons)		Hook Identification Code		Stock No.			
Carbon	Alloy	S-320C Carbon	S-320A Alloy	Carbon S-320-C S.C.	Carbon G-320-C Galv.	Alloy S-320-A S.C.	Weight Each (lbs.)
¾†	1†	DC	DA	1022200	1022208	1022375	.61
1†	1½†	FC	FA	1022211	1022219	1022386	.89
1½†	2†	GC	GA	1022222	1022230	1022397	1.44
2†	3†	HC	HA	1022233	1022241	1022406	2.07
3†	5†	IC	IA	1022244	1022249	1022419	4.30
5†	7†	JC	JA	1022255	1022262	1022430	8.30
7½†	11†	KC	KA	1022264	1022274	1022441	15.00
10†	15†	LC	LA	1022277	1022285	1022452	21.60
15†	22†	NC	NA	1022288	1022296	1022465	39.50
20	30	OC	OA	1023289	—	1023546	60.00
25	37	PC	PA	1023305	—	1023564	105.00
30	45	SC	SA	1023323	—	1023582	148.00
40	60	TC	TA	1023341	—	1023608	228.00

† New 320N Style Hook. Utilizes S-4320 Latch Kit only.
* NOTE: see footnote on page 85.

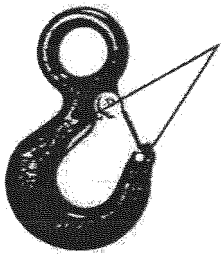
Crosby® Hoist Hook

EYE HOOKS

ORIGINAL IF F.



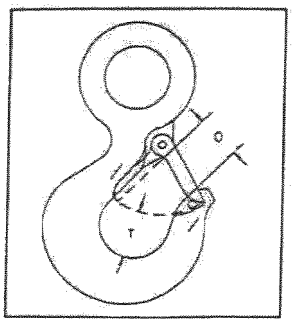
Hoist hooks incorporate markings forged into the product which address two (2) QUIC-CHECK™ features:

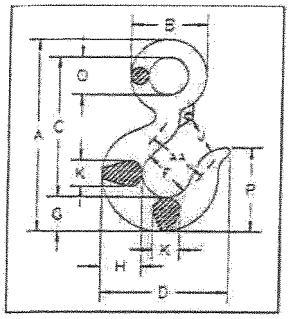


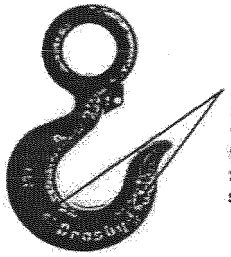
S-320N

Deformation Indicators —Two strategically placed marks, one just below the shank or eye and the other on the hook tip, which allows for a QUIC-CHECK™ measurement to determine if the throat opening has changed, thus indicating abuse or overload.

To check, use a measuring device (i.e., tape measure) to measure the distance between the marks. The marks should align to either an inch or half-inch increment on the measuring device. If the measurement does not meet this criteria, the hook should be inpected further for possible damage.



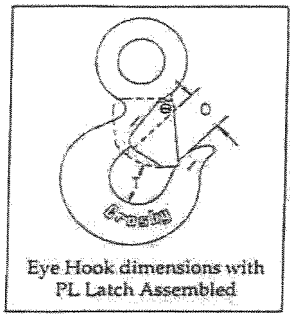




S-320

Angle Indicators — Indicates the maximum included angle which is allowed between two (2) sling legs in the hook. These indicators also provide the opportunity to approximate other included angles between two sling legs.

Fatigue Rated®



Eye Hook dimensions with PL Latch Assembled

Load Rated® QUIC-CHECK™ Q

⚠ SEE APPLICATION AND WARNING INFORMATION
On Pages 78 - 79

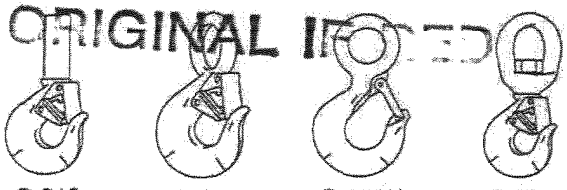
Working Load Limit* (tons)		Dimensions (in.)															Deformation Indicator
Carbon †	Alloy	A	B	C	D	F	G	H	J	K	M	O	P	Q	T	AA
¾ †	1 †	4.42	1.47	3.34	2.83	1.25	.73	.81	.90	.63	.63	.89	2.00	.75	.87	1.50
1 †	1½ †	5.07	1.75	3.81	3.11	1.38	.84	.94	.93	.71	.71	.91	2.24	.91	.98	2.00
1½ †	2 †	5.64	2.13	4.14	3.53	1.50	1.00	1.16	1.00	.88	.88	1.00	2.50	1.13	1.03	2.00
2 †	3 †	6.39	2.41	4.69	3.97	1.63	1.13	1.32	1.13	.94	.94	1.09	2.82	1.25	1.16	2.00
3 †	5 †	7.90	2.94	5.77	4.81	2.00	1.44	1.63	1.47	1.31	1.31	1.36	3.51	1.56	1.53	2.50
5 †	7 †	10.09	3.81	7.37	6.27	2.50	1.81	2.06	1.75	1.66	1.66	1.61	4.52	2.00	1.96	3.00
7½ †	11 †	12.43	4.66	9.07	7.45	3.00	2.25	2.63	2.29	1.88	1.63	2.08	5.40	2.44	2.47	4.00
10 †	15 †	13.94	5.38	10.08	8.30	3.25	2.59	2.94	2.50	2.19	1.94	2.27	6.00	2.84	2.62	4.00
15 †	22 †	17.09	6.63	12.53	10.30	4.25	3.00	3.50	3.30	2.69	2.38	3.02	6.93	3.50	2.83	5.00
20 ††	30 ††	19.47	7.00	14.06	13.62	5.00	3.62	4.62	4.00	3.00	—	3.25	8.78	3.50	3.44	6.50
25 ††	37 ††	24.81	8.50	18.19	14.06	5.38	4.56	5.00	4.25	3.62	—	3.00	11.38	4.50	3.88	7.00
30 ††	45 ††	27.44	9.31	20.12	15.44	6.00	5.06	5.50	4.75	3.72	—	3.38	12.63	4.94	4.75	8.00
40 ††	60 ††	32.31	10.75	23.72	18.50	7.00	6.00	6.50	5.75	4.44	—	4.12	14.81	5.69	5.69	10.00

† New 320N Style Hook.
†† S-320 Style Hook.

* NOTE: Eye Hooks (¾ TC - 22TA), Proof load is 2.5 times Working Load Limit. Eye Hooks (20 TC - 60 TA), Proof load is 2 times Working Load Limit. All carbon hooks - average straightening load (ultimate load) is 5 times Working Load Limit. Alloy eye hooks 1 ton through 22 ton - average straightening load (ultimate load) is 5 times Working Load Limit. Alloy eye hooks 30 tons through 60 tons - average straightening load (ultimate load) is 4.5 times Working Load Limit. All Alloy shank hooks - average straightening load (ultimate load) is 4.5 times the Working Load Limit. All Bronze hooks - average straightening load (ultimate load) is 4 times Working Load Limit.

CROSBY HOIST HOOK

WARNINGS AND APPLICATION INSTRUCTIONS



S-319 S-320 S-320N S-322

Important Safety Information - Read and Follow

- A visual periodic inspection for cracks, nicks, wear, gouges and deformation as part of a comprehensive documented inspection program, should be conducted by trained personnel in compliance with the schedule in ANSI B30. 10.
- For hooks used in frequent load cycles or pulsating loads, the hook and threads should be periodically inspected by Magnetic Particle or Dye Penetrant. (Note: Some disassembly may be required.)
- Never use a hook whose throat opening has been increased, or whose tip has been bent more than 10 degrees out of plane from the hook body, or is in any other way distorted or bent. Note: A latch will not work properly on a hook with a bent or worn tip.
- Never use a hook that is worn beyond the limits shown in Figure 1.
- Remove from service any hook with a crack, nick, or gouge. Hooks with a crack, nick, or gouge shall be repaired by grinding lengthwise, following the contour of the hook, provided that the reduced dimension is within the limits shown in Figure 1.
- Never repair, alter, rework, or reshape a hook by welding, heating, burning, or bending.
- Never side load, back load, or tip load a hook. (See Figure 2.)
- Eye hooks, shank hooks and swivel hooks are designed to be used with wire rope or chain. Efficiency of assembly may be reduced when used with synthetic material.
- Do not swivel the S-322 swivel hook while it is supporting a load.
- The use of a latch may be mandatory by regulations or safety codes; e.g., OSHA, MSHA, ANSI/ASME B30, Insurance, etc.. (Note: When using latches, see instructions in "Understanding: The Crosby Group Warnings" for further information.)
- Always make sure the hook supports the load. (See Figure 3). The latch must never support the load (See Figure 4).
- When placing two (2) sling legs in hook, make sure the angle from the vertical to the outermost leg is not greater than 45 degrees, and the included angle between the legs does not exceed 90 degrees* (See Figure 5).
- See ANSI/ASME B30.10 "Hooks" for additional information.

* For angles greater than 90 degrees, or more than two (2) legs, a master link or bolt type anchor shackle should be used to attach the legs of the sling to the hook.

⚠ WARNING

- Loads may disengage from hook if proper procedures are not followed.
- A falling load may cause serious injury or death.
- See OSHA Rule 1926.550(g) for personnel hoisting by cranes or derricks. A Crosby 319, 320, or 322 hook with a PL Latch attached (when secured with bolt, nut and pin) may be used for lifting personnel. A Crosby S-320N Hook with a S-4320 Latch attached (when secured with cotter pin or bolt, nut and pin) may be used for lifting personnel.
- Threads may corrode and/or strip and drop the load.
- Hook must always support the load. The load must never be supported by the latch.
- Never apply more force than the hook's assigned Working Load Limit (WLL) rating.
- Read and understand these instructions before using hook.

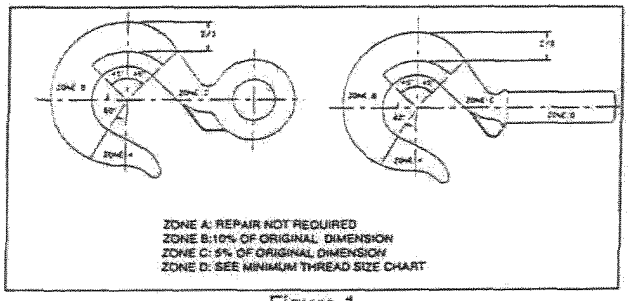


Figure 1

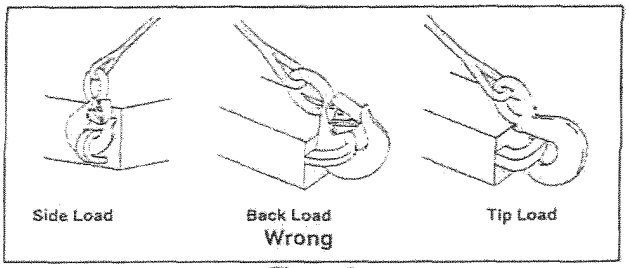


Figure 2

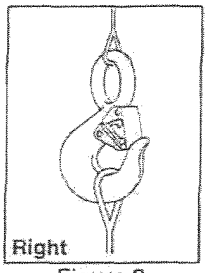


Figure 3

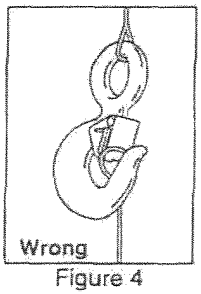


Figure 4

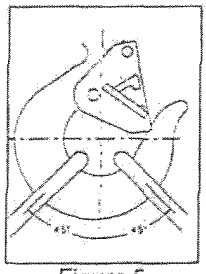
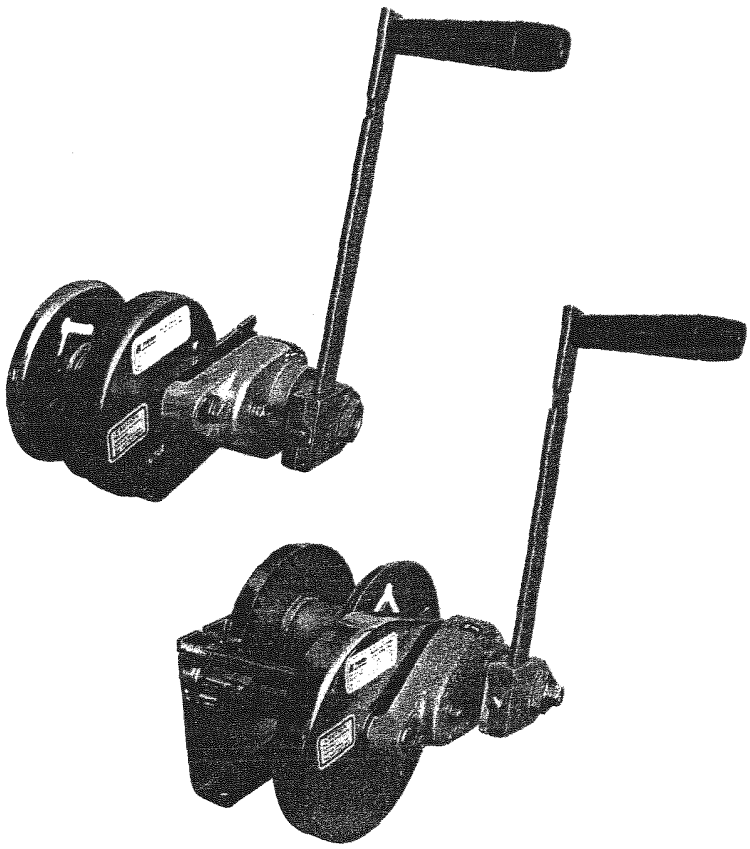


Figure 5

THERN INCORPORATED

Read this Owner's Manual thoroughly before operating the equipment. Keep it with the equipment at all times. Replacements are available from Thern, Inc., PO Box 347, Winona, MN 55987, 507-454-2996.

IMPORTANT: Please record product information on page 2. This information is required when calling the factory for service.



Owner's Manual

For Thern
Spur Gear Hand Winches

A8097-1101

Two-Year Limited Warranty

Please record the following:

Date Purchased:

Model No.:

Code No.:

This information is required when calling the factory for service.

Thern, Inc. warrants its products against defects in material or workmanship for two years from the date of purchase by the original using buyer, or if this date cannot be established, the date the product was sold by Thern, Inc. to the dealer. To make a claim under this warranty, contact the factory for an RGA number. The product must be returned, prepaid, directly to Thern, Inc., 5712 Industrial Park Road, Winona, Minnesota 55987. The following information must accompany the product: the RGA number, the date of purchase, the description of the claimed defect, and a complete explanation of the circumstances involved. If the product is found to be defective, it will be repaired or replaced free of charge, and Thern, Inc. will reimburse the shipping cost within the contiguous USA.

This warranty does not cover any damage due to accident, misuse, abuse, or negligence. Any alteration, repair or modification of the product outside the Thern, Inc. factory shall void this warranty. This warranty does not cover any costs for removal of our product, downtime, or any other incidental or consequential costs or damages resulting from the claimed defects. This warranty does not cover brake discs, as these are wear components and their life is subject to use conditions which vary between applications.

FACTORY AUTHORIZED REPAIR OR REPLACEMENT AS PROVIDED UNDER THIS WARRANTY IS THE EXCLUSIVE REMEDY TO THE CONSUMER. THERN, INC. SHALL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR BREACH OF ANY EXPRESS OR IMPLIED WARRANTY ON THIS PRODUCT. EXCEPT TO THE EXTENT PROHIBITED BY APPLICABLE LAW, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ON THIS PRODUCT IS LIMITED IN DURATION TO THE DURATION OF THIS WARRANTY.

Some states do not allow the exclusion or limitation of incidental or consequential damages, or allow limitations on how long an implied warranty lasts, so the above limitation or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Note: Thern, Inc. reserves the right to change the design or discontinue the production of any product without prior notice.

About This Manual

The Occupational Safety and Health Act of 1970 states that it is the employer's responsibility to provide a workplace free of hazard. To this end, all equipment should be installed, operated, and maintained in compliance with applicable trade, industrial, federal, state, and local regulations. It is the equipment owner's responsibility to obtain copies of these regulations and to determine the suitability of the equipment to its intended use.

This Owner's Manual, and warning labels attached to the equipment, are to serve as guidelines for hazard-free installation, operation, and maintenance. They should not be understood to prepare you for every possible situation.

The information contained in this manual is applicable only to Thern Spur Gear Hand Winches. Do not use this manual as a source of information for any other equipment.

The following symbols are used for emphasis throughout this manual:

⚠WARNING

Failure to follow 'WARNING!' instructions may result in equipment damage, property damage, and/or serious personal injury.

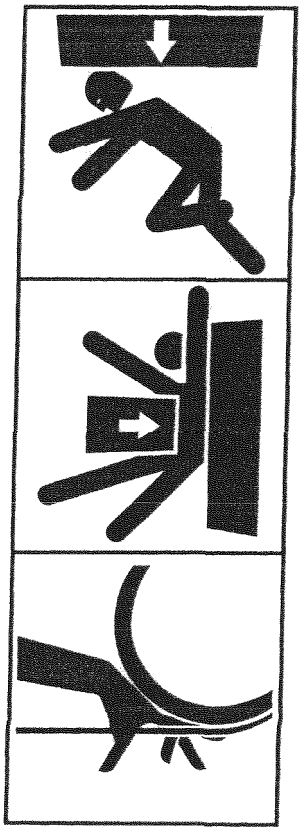
⚠CAUTION

Failure to follow 'CAUTION!' instructions may result in equipment damage, property damage, and/or minor personal injury.

Important!

Failure to follow 'important!' instructions may result in poor performance of the equipment.

Suggestions for Safe Operation



⚠WARNING

DO the following:

Read and comply with the guidelines set forth in this Owner's Manual. Keep this manual, and all labels attached to the winch, readable and with the equipment at all times. Contact Thern, Inc. for replacements.

Check lubrication before use.

Install the wire rope securely to the winch drum.

Keep at least 4 wraps of wire rope wound on the drum at all times, to serve as anchor wraps. With less than 4 wraps on the drum the wire rope could come loose, causing the load to fall.

Keep hands away from the drum, gears, wire rope, and other moving parts of the equipment.

Keep all people, including operators and yourself, away from the winch. Keep out of the path of the load, and out of the path of a broken wire rope that might snap back and cause injury.

DO NOT do the following:

Do not lift people, or things over people. Do not walk or work under a load or in the line of force of any load.

Do not exceed the load rating of the winch or any other component in the system. To do so could result in failure of the equipment.

Do not use more than one winch to move a load that exceeds the load rating of a single winch. A shift in load weight could overload the equipment.

Do not use damaged or malfunctioning equipment. To do so could result in failure of the equipment.

Do not modify the equipment in any way. To do so could cause equipment failure.

Do not wrap the wire rope around the load. This damages the wire rope and could cause the load to fall. Use a sling or other approved lifting device.

Do not operate the winch with guards removed or improperly installed.

Do not divert your attention from the operation. Stay alert to the possibility of accidents, and try to prevent them from happening.

Do not jerk or swing the load. Avoid shock loads by starting and stopping the load smoothly. Shock loads overload the equipment and may cause damage.

Do not lift loads or pull loads on an incline unless the winch is equipped with a brake.

Do not leave a suspended load unattended. Place the load on the ground if it must be left unattended.

1.1 Installing the Winch

Important!

- Inspect the winch immediately following installation according to the Instructions for Periodic Inspection. This will give you a record of the condition of the winch with which to compare future inspections.
- A qualified professional should inspect or design the foundation to insure that it will provide adequate support.
- Locate the winch so it will be visible during the entire operation.

⚠WARNING

Do not install the winch in an area defined as hazardous by the National Electric Code, unless installation in such an area has been thoroughly approved.

Do not install the winch near corrosive chemicals, flammable materials, explosives, or other elements that may damage the winch or injure the operator. Adequately protect the winch and the operator from such elements.

Position the winch so the operator can stand clear of the load, and out of the path of a broken wire rope that could snap back and cause injury.

Attach the winch to a rigid and level foundation that will support the winch and its load under all load conditions, including shock loading.

1.1.1 CONSULT APPLICABLE CODES AND REGULATIONS for specific rules on installing the equipment.

1.1.2 LOCATE THE WINCH in an area clear of traffic and obstacles that could interfere with operation. Make sure the winch is accessible for maintenance and operation.

1.1.3 MAINTAIN A FLEET ANGLE between 1/2 and 1-1/2 degrees. The proper fleet angle minimizes wire rope damage by helping the wire rope wind uniformly onto the drum. See figure 1.

1.1.4 FASTEN THE WINCH securely to the foundation.

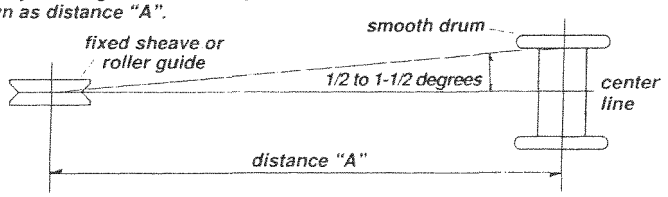
CONTACT A QUALIFIED PROFESSIONAL FOR MOUNTING INSTRUCTIONS TO COMPLY WITH LOCAL CODES.

Important!

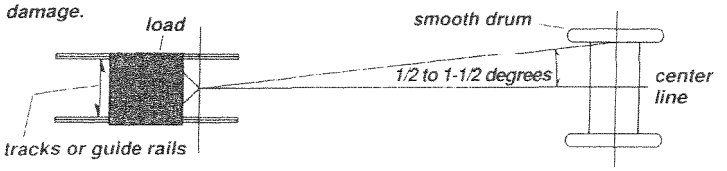
- Use a sheave or roller guide to direct the wire rope to the drum whenever possible.
- Install sheaves, tracks and other equipment so they will remain fixed under all load conditions. Follow the recommendations of the equipment manufacturer.
- Use sheaves of proper diameter to minimize wear on the wire rope. Follow the recommendations of the sheave manufacturer.

Figure 1 – Maintaining the Fleet Angle

- *When wire rope travels over a sheave or through a roller guide – maintain fleet angle by locating the sheave or guide an appropriate distance from the drum, shown as distance "A".*



- *When wire rope travels directly to the load – maintain fleet angle by controlling side-to-side movement of the load with tracks or guide rails. Allowing the load to move too far to one side causes stress on the drum flange which may cause damage.*



1.2 Installing the Handle

1.2.1 FOR MODELS M4022PB, M4032PB, M4042PBSS, M4312PB, M4312PBSS, and M4412PB equipped with PB Brankes, install the handle as follows:

a LOOSEN THE SETSCREW and slide the handle toward the medallion as shown. See figure 2A.

b LINE UP THE NOTCH in the handle with the point of the hex in the medallion. See figure 2B.

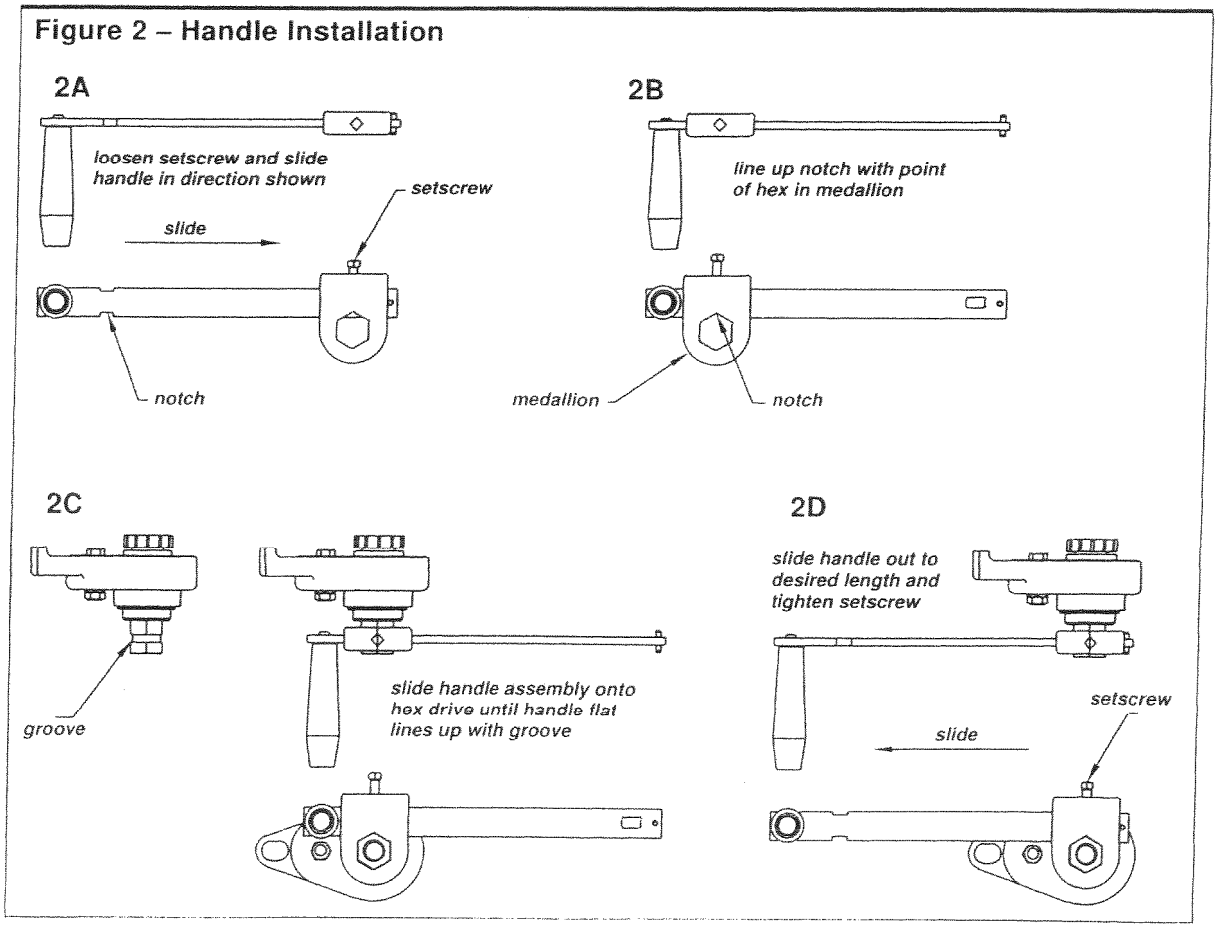
c SLIDE THE HANDLE AND MEDALLION ASSEMBLY onto the hex drive on the brake until the flat of the handle lines up with the groove in hex drive. See figure 2C.

d SLIDE THE HANDLE outward away from the medallion to the desired length and tighten the setscrew. See figure 2D.

1.2.2 FOR MODELS M4022 AND M4032, place the handle assembly on the handle shaft and secure in place with the lock washer and hex nut.

1.2.3 FOR MODELS M4312 AND M4412, place the handle assembly on the drum shaft and install the hair pin cotter in the end of the drum shaft to hold the handle in place.

Figure 2 – Handle Installation



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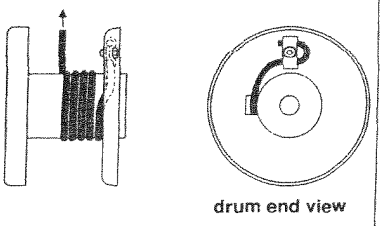
1.3 Installing the Wire Rope

Important!

- Use wire rope and other rigging equipment rated for the size of the largest load you will be moving.
- Do not drag the wire rope through dirt or debris that could cause damage, or poor operation.
- Always wear protective clothing when handling wire rope.

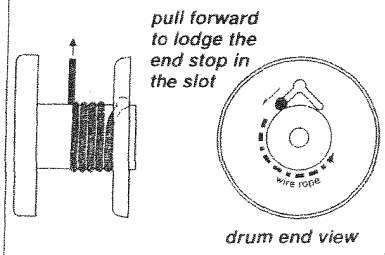
Figure 3A – Flange Clip Anchor



drum end view

typical installation shown
right lay – underwound

Figure 3B – Quick Disconnect Anchor



drum end view

typical installation shown
right lay – underwound

⚠WARNING

Install the wire rope so it is wound correctly as shown, or the winch will not work properly, and could release the load.

Install the wire rope securely to the winch drum. A poorly secured wire rope could come loose from its anchor and could release the load.

1.3.1 PURCHASE THE PROPER WIRE ROPE for your application. Keep the following in mind when selecting a wire rope. Contact a reputable wire rope supplier for help.

a BREAKING STRENGTH of new wire rope should be at least 3 times greater than the largest load placed on the winch. If loads are lifted or pulled on an incline, the breaking strength must be at least 5 times greater than the largest load. These are minimum values and will vary with the type of load and how you are moving it.

b WIRE ROPE LAY must agree with the winding direction of the drum to help insure proper winding.

c WE RECOMMEND 7 x 19 galvanized aircraft cable for diameters up to 5/16 inch.

1.3.2 ANCHOR THE WIRE ROPE to the drum using either the flange clip or quick disconnect anchor.

a FLANGE CLIP ANCHOR. See figure 3A.

- PASS THE END OF THE WIRE ROPE through the hole in the flange.
- INSERT THE CARRIAGE BOLT, loop the wire rope around the bolt, and install the clip so the wire rope is held by the curves of the clip.
- INSTALL THE JAM NUT and tighten it until the wire rope is flattened against the drum flange.

b QUICK DISCONNECT ANCHOR. See figure 3B.

- PUSH THE END STOP through the large center hole in the drum flange.
- PULL THE WIRE ROPE forward to lodge the end stop in the slot.

1.3.3 TURN THE HANDLE CLOCKWISE to wind wire rope onto the drum. If wire rope unwinds from the drum when the handle is rotated clockwise, the wire rope is installed incorrectly. **Install the wire rope correctly before continuing.**

1.3.4 WIND FOUR FULL WRAPS of wire rope onto the drum by operating the winch while holding the wire rope taught. **These wraps serve as anchor wraps and must remain on the drum at all times.**

2.1 General Theory of Operation

Important!

- Limit nonuniform winding by keeping tension on the wire rope and by maintaining the proper fleet angle.
- It is your responsibility to detect and account for different factors affecting the condition and performance of the equipment.

2.1.1 THE PULL REQUIRED to move the load must not exceed the load rating of the winch. Consider the total force required to move the load, not the weight of the load.

2.1.2 THIS EQUIPMENT CAN develop forces that will exceed the load rating. It is the responsibility of the equipment user to limit the size of the load. Inspect the equipment regularly for damage according to the instructions contained in this manual.

2.1.3 USE A DISC BRAKE on all hand winches used to lift loads or pull loads on an incline.

2.1.4 PERFORMANCE RATINGS of the equipment are affected by the amount of wire rope wound on the drum, the way in which it is wound, and the way the winch is used.

a DRUM CAPACITY depends on how tightly and evenly the wire rope is wound on the drum. Actual drum capacities are usually 25-30% less than values shown in performance tables, due to loose winding and overlapping.

b FORCE REQUIRED TO LIFT the load increases with each additional layer of wire rope wound onto the drum. The value shown in performance tables is based on an empty drum and maximum handle length.

c LOAD RATING represents the maximum pull that can be placed on new equipment. Load ratings are assigned values for specific amounts of load travel or wire rope accumulation. The load rating decreases as layers of wire rope accumulate on the drum.

2.1.5 DUTY RATINGS refer to the type of use the equipment is subject to. Consider the following when determining duty rating.

a ENVIRONMENT: harsh environments include hot, cold, dirty, wet, corrosive, or explosive surroundings. **Protect the equipment from harsh environments when possible.**

b MAINTENANCE: poor maintenance, meaning poor cleaning, lubrication, or inspection, leads to poor operation and possible damage of the equipment. **Minimize poor maintenance by carefully following the instructions contained in this manual.**

c LOADING: severe loading includes shock loading and moving loads that exceed the load rating of the equipment. **Avoid shock loads, and do not exceed the load rating of the equipment.**

d FREQUENCY OF OPERATION: frequent or lengthy operations increase wear and shorten the life span of gears, bearings, and other components. **Increase maintenance of the equipment if used in frequent operations.**

CONTACT THE FACTORY FOR MORE INFORMATION.

2.2 Breaking-In the Winch

2.2.1 BREAK-IN OCCURS during the first 10 hours of normal operation. During break-in, mating surfaces become polished, and clearances increase. This is desired for efficient operation of bearings and gears.

2.2.2 INSPECT THE WINCH following break-in according to the Instructions for Periodic Inspection.

2.3 Preparing for Operation

Important!

- When determining whether the load will exceed the load rating, consider the total force required to move the load.

2.3.1 CONSIDER THE OPERATION. Do not begin until you are sure you can perform the entire operation without hazard.

2.3.2 INSPECT ALL COMPONENTS of the system.

a INSPECT THE WINCH and other equipment according to the Instructions for Frequent Inspection.

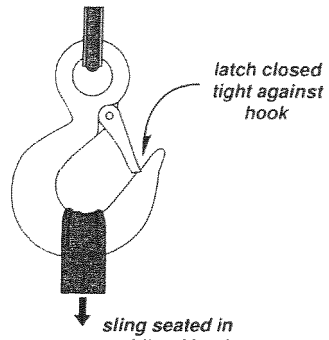
b OPERATORS must be in good health, alert, thoroughly trained in operating the equipment, and properly clothed (hard hat, safety shoes and safety glasses, no loose clothing).

c THE LOAD must be clear of other objects and free to move. Make sure the load will not tip, spin, roll away, or in any way move uncontrollably.

2.3.3 KNOW YOUR LOAD and make sure you do not exceed the load rating of the winch or any other equipment in the system.

2.4 Attaching the Load

Figure 4 – Attaching Load



⚠WARNING

Do not wrap the wire rope around the load. This damages the wire rope and could cause the load to fall. Use a sling or other approved lifting device.

2.4.1 CLEAR OBJECTS from the path of the load so you can move it freely and observe it at all times during the operation.

2.4.2 ATTACH THE LOAD using a nylon sling, or other approved lifting device. Follow the recommendations of the sling manufacturer.

a SEAT THE SLING in the saddle of the hook with the hook latch completely closed. See figure 4.

b CENTER THE LOAD on the hook so it will remain balanced and not tip or rotate to one side.

2.5 Moving the Load

Important!

- Obey a stop signal from anyone.
- Maintain tension on the wire rope to keep it tightly and evenly wound on the drum.
- If the winch and load are not visible during the entire operation, get help from another person.
- Appoint a supervisor if more than one person is involved in the operation. This will reduce confusion and increase safety.
- When lifting a load, use a tag line to keep the load from swinging or twisting, while keeping yourself away from the load.
- Remove the winch handle when the winch is not in use, to help avoid unauthorized use.

2.5.1 MOVE THE LOAD slowly and smoothly, only a small distance at first. Make sure the load is balanced and securely attached before continuing.

2.5.2 TURN THE HANDLE CLOCKWISE to wind wire rope onto the drum. If wire rope unwinds from the drum when the handle is rotated clockwise, the wire rope is installed incorrectly. **Install the wire rope correctly before continuing.**

2.5.3 OBSERVE THE WIRE ROPE as it winds onto the drum. If it becomes loose, uneven, or overlapped, stop the operation and rewind the wire rope before continuing. **Continued operation with overlapped or uneven wire rope can damage the wire rope and shorten its life.**

2.5.4 FOR MODELS M4312 AND M4412 ONLY.

a MOVE THE HANDLE TO THE COUNTERSHAFT to quickly wind or unwind UNLOADED wire rope. **Do not attempt to move a load with the handle installed on the countershaft.**

2.5.5 FOR MODELS M4022, M4032, M4312 AND M4412 ONLY.

a ENGAGE THE RATCHET when winding wire rope onto the drum, disengage the ratchet to unwind the wire rope.

b **Do not engage the ratchet while the winch gears are turning.** Stop the winch before engaging the ratchet.

c DISENGAGE THE RATCHET by raising the load slightly to remove pressure from the ratchet, then pull out and turn the ratchet knob 90 degrees.

d GRIP THE HANDLE TIGHTLY at all times during operation. If you release the handle the load may backdrive causing the handle to spin. **Do not try to stop a spinning handle, step clear until the spinning stops.**

3.1 Cleaning the Winch

Important!

Increase the frequency of maintenance procedures if the winch is:

- Operated for long periods.
- Used to pull heavy loads.
- Operated in wet, dirty, hot, or cold surroundings.

Clean the winch to remove dirt and help prevent rust and corrosion.

3.1.1 CLEAN THE WINCH every six months or whenever it is dirty.

a WIPE ALL EQUIPMENT with an oily rag to remove dirt and grease.

b LEAVE A LIGHT FILM of oil on all surfaces to protect them against rust and corrosion.

c WIPE OFF excessive amounts of oil to avoid the accumulation of dirt.

3.1.2 REMOVE ALL UNNECESSARY OBJECTS from the area surrounding the winch.

3.2 Lubricating the Winch

Important!

- Make sure lubricant has a temperature rating appropriate for the ambient temperatures of the operation.

⚠CAUTION

Do not over lubricate the brake bushings on models equipped with a brake. Over lubricating may cause oil to leak onto the friction discs, which may damage the friction discs or result in poor operation of the disc brake.

Lubricate the spur gears before each operation, and periodically during operation. Failure to lubricate the gears will cause damage or deformation of gear teeth.

Lubricate the winch properly to help protect it from wear and rust. Read the following instructions carefully.

3.2.1 CONSULT MANUFACTURER'S RECOMMENDATIONS for specific information on lubricating the wire rope and other equipment.

3.2.2 LUBRICATE WINCH BEARINGS AND SHAFTS at least every 6 months.

a APPLY 2 TO 3 DROPS of SAE 30 non-detergent oil to bearings and shafts at all friction points.

b ROTATE THE DRUM several times to allow the oil to penetrate, and wipe off excess oil to avoid accumulation of dirt.

3.2.3 LUBRICATE WINCH GEARS before every operation and at least every 10 hours during operation.

a APPLY A LIGHT FILM of open gear lubricant to the gear teeth on all gears.

b USE SPRAYON 201 or equivalent open gear lube. For dirty conditions use a dry lubricant such as dry graphite or Moly.

3.2.4 LUBRICATE THE DISC BRAKE IF APPLICABLE at least every 6 months. Place 1 or 2 drops of SAE 30 non-detergent oil into the hole in the brake housing marked "oil", and turn the brake several times to allow the oil to penetrate.

3.2.5 LUBRICATE THE WIRE ROPE by following the wire rope manufacturer's recommendations.

3.3 Inspecting the Equipment

Important!

- Start an inspection program as soon as you put the winch into use.
- Appoint a qualified person to be responsible for regularly inspecting the equipment.
- Keep written records of inspection. This allows comparison with comments from previous inspections so you can see changes in condition or performance.

Perform frequent inspections:

- Before each operation.
- Every 3 hours during operation.
- Whenever you notice signs of damage or poor operation.

⚠WARNING

Do not use damaged or malfunctioning equipment. Place an "OUT OF ORDER" sign on the winch. Do not use the winch until the sign is removed by a qualified maintenance person who has completely corrected the problem.

Inspect the winch to detect signs of damage or poor operation before they become hazardous.

3.3.1 CONSULT APPLICABLE CODES AND REGULATIONS for specific rules on inspecting the winch and other equipment.

3.3.2 CONSULT MANUFACTURER'S RECOMMENDATIONS for information on inspecting the wire rope and other equipment.

3.3.3 **Instructions for Frequent Inspection**

a VISUALLY INSPECT the entire winch and all other equipment involved in the operation.

- Check all equipment for cracks, dents, bending, rust, wear, corrosion and other damage.
- Make sure the wire rope is installed correctly and anchored securely to the drum.
- Make sure the winch and brake are properly lubricated.
- Make sure fasteners are installed to securely hold the handle in place.
- Make sure mounting fasteners are tightened securely.
- Make sure the foundation is in good condition, and capable of supporting the winch and its load under all load conditions.

b TEST WINCH PERFORMANCE by moving a test load of 100 pounds.

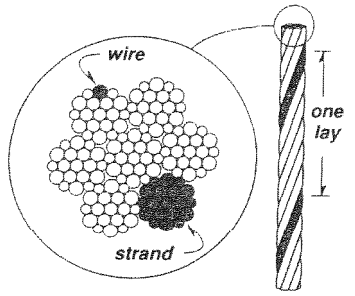
- Listen for unusual noises, and look for signs of damage as you operate the winch.
- Make sure the wire rope winds evenly and tightly onto the drum. If it is loose or uneven, rewind it before continuing.
- Make sure the handle rotates freely in both directions.
- On models equipped with a ratchet, make sure the ratchet engages and disengages completely.
- On models equipped with a brake, make sure the disc brake ratchet pawl clicks firmly as the brake handle is turned clockwise.
- On models equipped with a brake, check the brake. Raise the load, then lower it and stop it a few feet off the ground. If the load continues to coast or creep, the friction discs may be worn and in need of replacement.

Completely correct all problems before continuing. Use the Troubleshooting Chart to help determine the cause of certain problems. See table 2.

Perform periodic inspections:

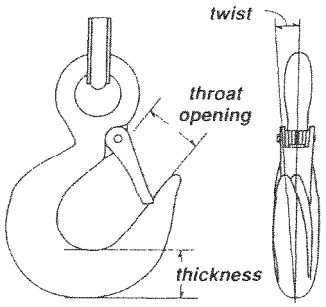
- Every 6 months.
- Whenever you return the winch to service from storage.
- Whenever you notice damage or poor operation in a frequent inspection.
- Whenever you have, or think you may have, overloaded or shock loaded the winch.

Figure 5 – Broken Wires



Wire rope assembly must be replaced if more than 6 wires are broken in one lay, or if more than 3 wires are broken in one strand in one lay.

Figure 6 – Load Hook Inspection



The wire rope assembly must be replaced if the throat opening is 15% wider than nominal, if the thickness is 10% less than nominal, or if the hook is twisted 10° or more.

3.3.4 **Instructions for Periodic Inspection**

a VISUALLY INSPECT the winch and all other equipment.

- Check the finish for wear, flaking, or other damage.
- Check all equipment for cracks, dents, bending, rust, wear, corrosion and other damage. If the winch was overloaded, or if you notice cracks and other signs of overloading, check for damage using magnetic or chemical crack detecting procedures.
- Check all fasteners for stripped threads, wear, bending, and other damage.
- Check the foundation for cracks, corrosion, and other damage.
- Make sure the winch and brake are properly lubricated.
- Make sure all labels and plates are readable, firmly attached, free of damage and clean. Replacements are available from the factory.

b REMOVE THE WIRE ROPE entirely from the drum.

- Always wear protective clothing when handling wire rope.
- Check the entire length of wire rope for bent wires, crushed areas, broken or cut wires, corrosion, and other damage. Carefully inspect areas that pass over sheaves or through roller guides.
- Note the location and concentration of broken wires. Replace wire rope if more than 6 wires are broken in one lay, or more than 3 wires are broken in one strand in one lay. See figure 5.
- Make sure the load hook or other device is securely attached to the wire rope, and the wire rope where it is attached is not frayed, corroded, broken, or otherwise damaged.
- Measure the throat opening, thickness, and twist of the hook. Replace the hook if it shows signs of damage. See figure 6.
- Make sure hook latch opens without binding and closes when released.
- Check the anchor holes in the drum flange for signs of wear or distortion.

c PLACE 100 POUNDS of tension on the wire rope.

- Measure the diameter of the wire rope, especially in areas where wear is noticeable. Replace the wire rope if the diameter measures below the minimum diameter at any point. See figure 7.

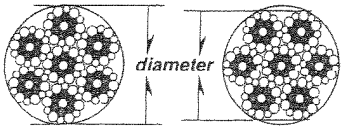
d REMOVE THE WINCH from the foundation.

- Check fasteners for stripped threads, wear, bends, and other damage.
- Check the frame for bending, distortion, cracks and other damage. A bent frame is caused by overloading, and is a sign that your application may require a winch with a larger load rating.

e MOVE THE DRUM with your hands.

- Check for excessive movement indicating worn or loose gears, bearings, or shafts.
- Disassemble the winch and brake if necessary. Inspect gears, bearings, spring pins, and shafts for wear, corrosion, distortion, and other damage.

Figure 7 – Rope Diameter



correct *incorrect*

The wire rope assembly must be replaced if the diameter measures less than the minimum diameter at any point.

wire rope diameter	minimum diameter
1/8 in	7/64 in (.1094 in)
3/16 in	11/64 in (.1719 in)
1/4 in	15/64 in (.2344 in)
5/16 in	19/64 in (.2969 in)

f FASTEN THE WINCH securely to the foundation.

g INSTALL THE WIRE ROPE.

h TEST WINCH PERFORMANCE by operating the winch with a test load equal to the load rating.

- Listen for unusual noises, and look for signs of damage as you operate the winch.
- Make sure the wire rope winds evenly and tightly onto the drum. If it is loose or uneven, rewind it before continuing.
- Observe the rotating drum, look for signs of loose or misaligned bearings.
- Make sure the handle rotates freely in both directions.
- On models equipped with a ratchet, make sure the ratchet engages and disengages completely.
- On models equipped with a brake, make sure the disc brake ratchet pawl clicks firmly as the brake handle is turned clockwise.
- On models equipped with a brake, check the brake. Raise the load, then lower it and stop it a few feet off the ground. If the load continues to coast or creep, the friction discs may be worn and in need of replacement.

Completely correct all problems before continuing. Use the troubleshooting chart to help determine the cause of certain problems. See table 2.

Table 1 – Inspection Checklist

checked boxes indicate damage or problem in need of repair

	damages	problems
general	☐ finish weathered, flaking, otherwise damaged ☐ parts cracked, bent, rusted, worn, otherwise damaged	☐ winch jerks or hesitates during operation ☐ unusual noises, other signs of malfunction
fasteners	☐ stripped threads, bent, worn, otherwise damaged	☐ loose, not tightened to proper torque
gears	☐ excessively worn, cracked, corroded, otherwise damaged	☐ loose or improperly lubricated
ratchet	☐ ratchet corroded, cracked, worn, otherwise damaged	☐ ratchet does not engage or disengage
brake assembly	☐ brake corroded, cracked, worn, otherwise damaged	☐ brake does not operate properly
drum	☐ anchor hole worn, distorted, otherwise damaged	☐ excessive movement or backlash
wire rope	☐ bent, crushed, otherwise damaged ☐ broken wires, see figure 5 replace if more than 6 wires in one lay, or 3 wires in one strand in one lay, are broken ☐ diameter reduced, see figure 7 replace if diameter is excessively worn	☐ wire rope loosely or unevenly wound number per strand = number per lay = diameter =
end connections	☐ corroded, rusted, worn, otherwise damaged	☐ not securely attached
hook or other device	☐ twisted, bent, worn, otherwise damaged, see figure 6 replace if twist is 10 degrees or more replace if throat width is 15% larger than nominal replace if thickness is 10% less than nominal	☐ hook latch fails to close when released twist = throat width = thickness =
labels and plates	☐ dirty, illegible, otherwise damaged	☐ loosely attached or missing

comments _____

authorized signature _____ date _____

3.4 Repairing the Winch

Important!

- It is your responsibility to determine when to replace parts. When considering whether to continue using a part or to replace it, remember that replacing it is the best way to avoid further equipment damage.
- Replace all spring pins and retaining rings when you disassemble the winch or brake for repair or replacement.
- Appoint a qualified person to be responsible for all repairs to the equipment.

3.4.1 GET FACTORY AUTHORIZATION for all repairs. Unauthorized repairs will void the warranty, and may lead to damage or failure of the winch.

3.4.2 REPLACE DAMAGED OR POORLY OPERATING PARTS with Thern repair parts.

3.4.3 REFINISH AREAS where the paint is worn or flaking. A good finish helps to protect against corrosion and weather damage.

a REMOVE THE FINISH from damaged areas, down to the bare metal.

b CLEAN THE AREA thoroughly.

c REPAINT with a high quality primer and finishing coat.

3.4.4 TO ORDER REPAIR PARTS, contact your local dealer. Include the following information when ordering:

- model number
- serial number (or code number)
- part number
- date purchased, and from whom
- description of what happened, or what is wrong
- your name and return address

Table 2 – Troubleshooting Chart

problem	cause	correction
handle turns, drum doesn't turn	• loose or broken spring pins	inspect winch and brake, repair as necessary
	• loose, stripped or broken gears	inspect gears and repair as necessary
handle turns hard or not at all	• ratchet on winch engaged	disengage winch ratchet
	• load too heavy	lighten load
	• spring pins loose or broken on winch or brake	inspect winch and brake, repair as necessary
	• disc brake damaged or locked	inspect brake, repair as necessary
	• gears or bearings broken or locked	inspect and repair as necessary
brake does not operate properly	• friction discs worn or damaged	inspect and replace as necessary
	• friction discs damaged from over lubrication	inspect and replace as necessary
	• disc brake ratchet pawl damaged	inspect and repair as necessary
excessively worn gears or bearings	• load too heavy	lighten load
(excessive backlash)	• poor lubrication of gears or bearings	inspect and relubricate as necessary
overheating	• operated too long without rest	allow to cool
	• load too heavy	lighten load
	• poor lubrication	inspect and lubricate as necessary
	• bearing seized up	inspect and replace as necessary
unusual noises		
high pitched squeak	• poor lubrication	inspect and relubricate as necessary
grinding noise	• contaminated lubrication	clean and relubricate winch
	• dirt in brake or winch gears	inspect and clean as necessary
	• broken gears or bearings	inspect and replace as necessary
rattling noise	• loose bolts, set screws or other fasteners	tighten all bolts and other fasteners
uneven clicking noise in brake	• broken gear tooth in brake	inspect and repair as necessary
weak clicking noise in brake	• spring or ratchet pawl dirty or damaged	inspect and clean or repair as necessary
	• worn brake ratchet pawl, gear, or spring	inspect and replace as necessary
no clicking noise in brake	• ratchet incorrectly installed	disassemble and install correctly
	• ratchet pawl damaged or worn excessively	inspect and replace as necessary

4.1 Transporting the Winch

Important!

- Keep a record of what you ship, and when you send it.

4.1.1 PACK THE WINCH using the original packaging materials, if possible.

4.1.2 SEAL THE WINCH in plastic with a desiccant to help protect it from rust, corrosion, and other damage.

4.1.3 INSPECT THE WINCH according to the Instructions for Periodic Inspection before installing it in a new location.

4.2 Storing the Winch

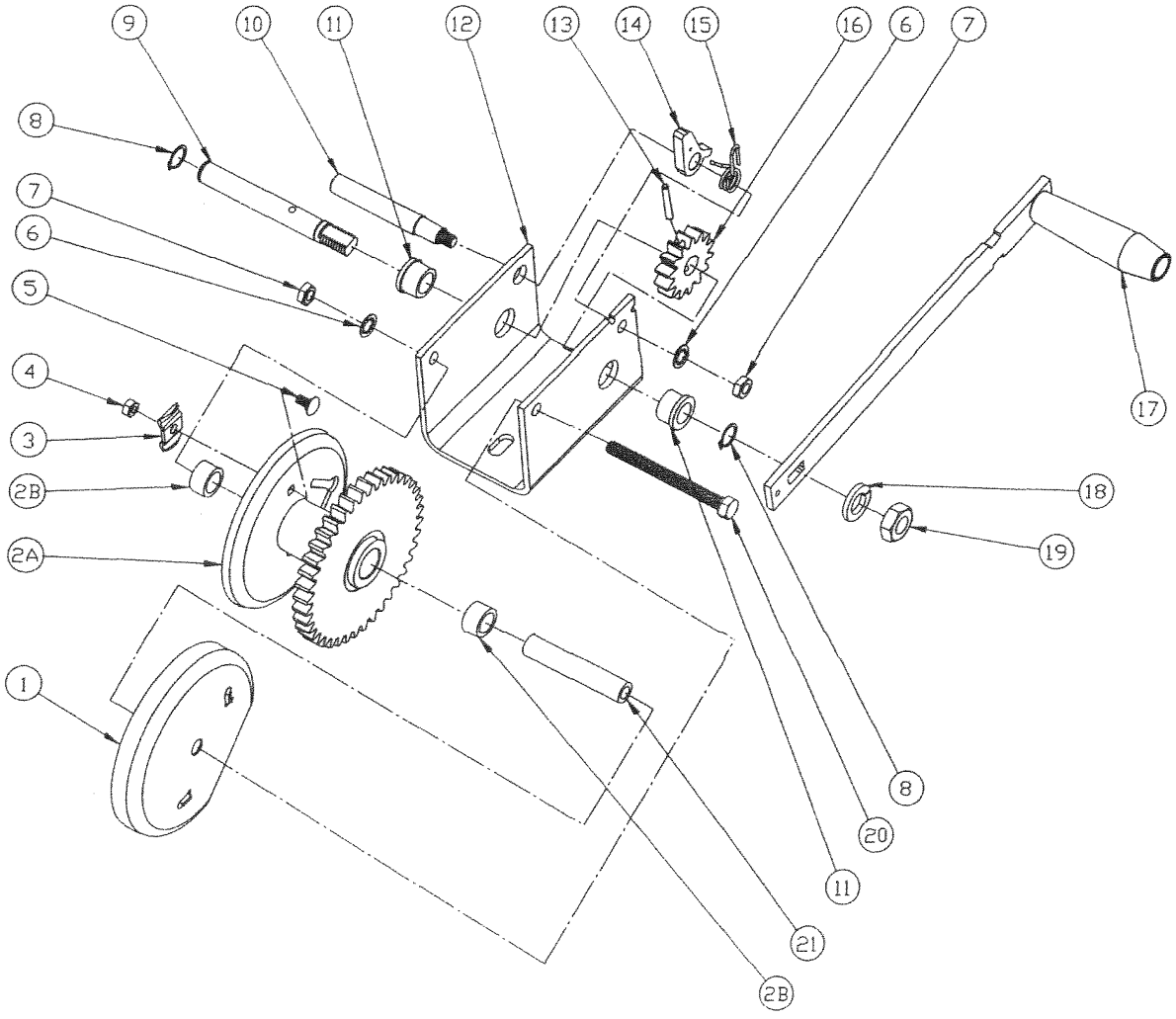
4.2.1 SEAL THE WINCH in plastic with a desiccant to help protect it from rust, corrosion, and other damage.

4.2.2 STORE THE WINCH in a cool clean place away from corrosive chemicals and moisture.

4.2.3 ROTATE THE DRUM periodically to keep bearing and gear surfaces from becoming lacquered.

4.2.4 INSPECT THE WINCH according to the Instructions for Periodic Inspection before installing it for operation.

Parts List for		Model M4022		Model M4032	
item	description	part number	qty.	part number	qty.
1	Drum Gear Guard ZNPLIRDI	B1066	1	B1066	1
2	Drum Assembly	B1040	1	B2365	1
2a	Drum Weldment	B2350	1	B2364	1
2b	Sleeve Bearing	A3326	2	A3326	2
3	Tie Down	A1013	1	A1013	1
4	Hex Nut .250-20NC SST	A3331	1	A3331	1
5	Carriage Bolt .250-20NC x .500 SST	A3333	1	A3333	1
6	Lock Washer Splk Int .375 x .692 x .035 SST	A3939	2	A3939	2
7	Hex Jam Nut .375-16NC SST	A3330	2	A3330	2
8	Retaining Ring Ext .625 SST	A4136	2	A4136	2
9	Handle Shaft	A1141	1	A1144	1
10	Ratchet Pin	A1142	1	A1146	1
11	Flange Bearing .627ID x .877OD x .625 BRZ	A1003	2	A1003	2
12	Frame	C1030	1	C1032	1
13	Groove Pin .187 x 1.375	A4851	1	A4851	1
14	Ratchet Pawl	A1047	1	A1047	1
15	Torsion Spring .690 x .080 SST	B1145	1	B1145	1
16	Pinion	A1008	1	A1008	1
17	Handle Assembly	B4187	1	B4187	1
18	Lock Washer Helspr .625 x 1.086 x .156 SST	A3327	1	A3327	1
19	Hex Jam Nut .625-11NC SST	A3329	1	A3329	1
20	Capscrew Hxhd .375-16NC ZNPL GR5	A3492	1	A3520	1
21	Drum Spacer .625DIA x 11GA	A1143	1	A1145	1



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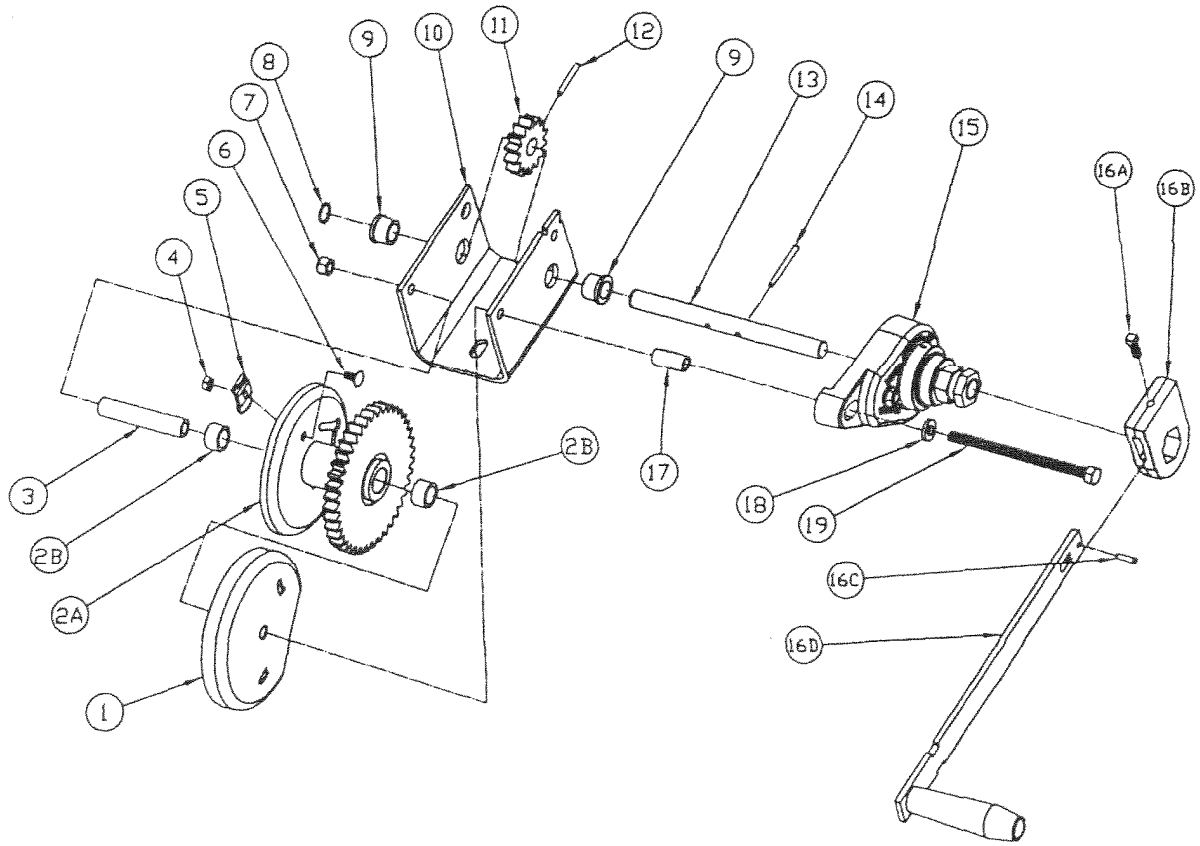
Parts List for		Model M4022PB		M4032PB	
item	description	part number	qty.	part number	qty.
1	Drum Gear Guard	B1066	1	B1066	1
2	Drum Assembly	B1040	1	B2365	1
2a	Drum Weldment	B2350	1	B2364	1
2b	Sleeve Bearing	A3326	2	A3326	2
3	Drum Spacer .625 x 11 ga x 3.235	A1143	1	A1145	1
4	Hex Nut .250-20NC SST	A3331	1	A3331	1
5	Tie Down	A1013	1	A1013	1
6	Carriage Bolt .250-20NC x .500 SST	A3333	1	A3333	1
7	Hex Nut Nylk .375-16NC gr 2 ZNPL	A3113	1	A3113	1
8	Retaining Ring .625 SST	A4136	1	A4136	1
9	Flange Bearing .627 x .877 x .625 BRZ	A1003	2	A1003	2
10	Frame	C1030	1	C1032	1
11	Pinion	A1008	1	A1008	1
12	Groove Pin Type A .187 x 1.375 ALYSTL	A4851	1	A4851	1
13	Handle Shaft	SB3904	1	B2366	1
14	Groove Pin Type A .187 x 2.000 ALYSTL	A4532	1	A4532	1
15	Disc Brake Assembly	C3823	1	C3823	1
16	Handle Medallion Assembly	B4218	1	B4218	1
16a	Setscrew Sqhd Cuppt .312-18NC x .750 SST	A3885	1	A3885	1
16b	Medallion	B4189	1	B4189	1
16c	Slotted Spring Pin	A4282	1	A4282	1
16d	Handle Assembly	B4187	1	B4187	1
17	Spacer .391 x .560 x 1.212 ZNPLIRDI	A1259	1	A1259	1
18	Flat Washer .375 x .750 x .125 SST	A1907	1	A1907	1
19	Capscrew Hxhd .375-16NC x gr 5 ZNPL	A3519	1	A3528	1



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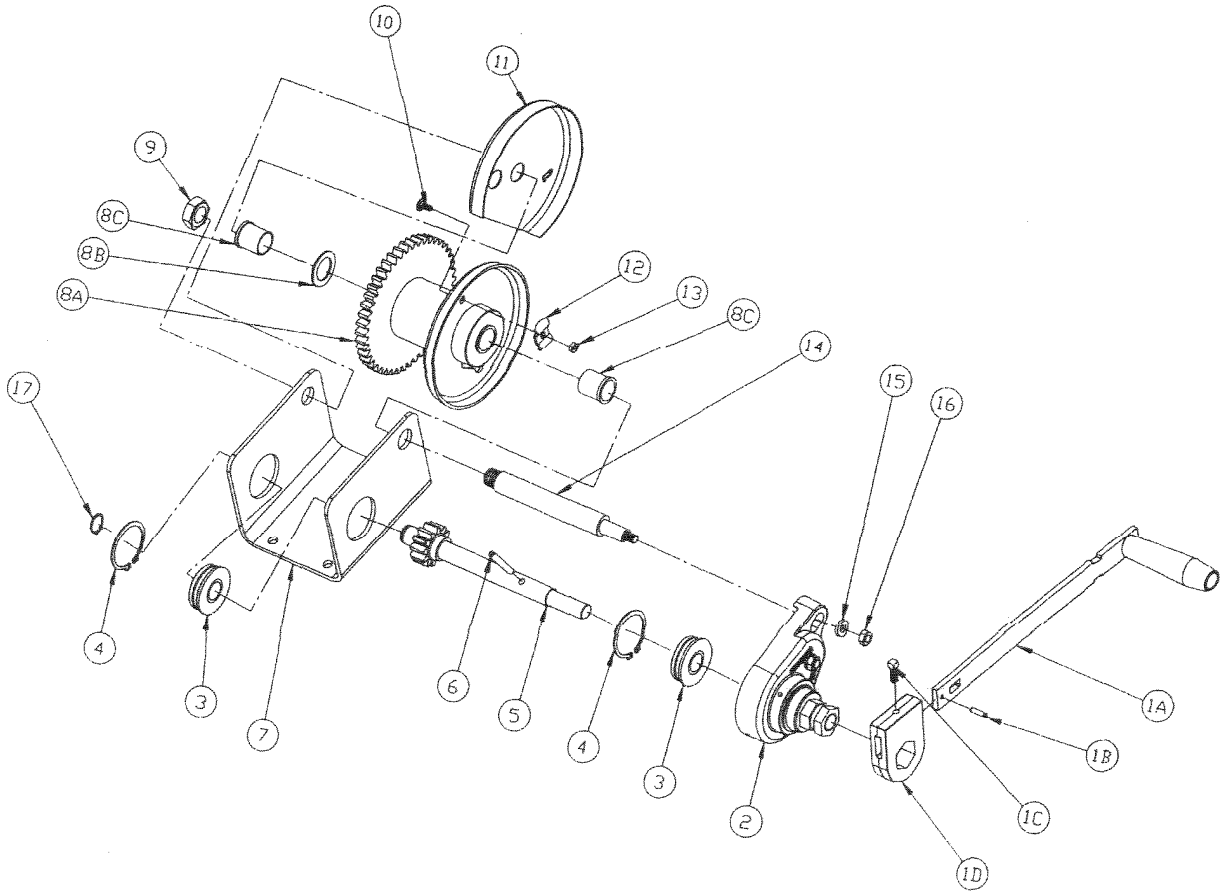
Parts List for Model M4042PBSS

item	description	part number	qty.
1	Handle Medallion Assembly	B4217	1
1a	Handle Assembly	B4201	1
1b	Slotted Spring Pin .187 x .750 SST	A4282	1
1c	Setscrew Sqhd Cuppt .312-18NC x .750 SST	A3885	1
1d	Medallion	B4199	1
2	Brake Assembly	C3825	1
3	Bearing Housing Assembly	A4420	2
4	Retaining Ring 01.875	A4409	2
5	Counter Shaft Weldment	B2415	1
6	Groove Pin .250 x 2.00	A4946	1
7	Frame Bending	B2409	1
8	Drum Assembly	C2542	1
8a	Drum Weldment	C2541	1
8b	Machinery Bushing	A4418	1
8c	Flange Bearing	A1071	2
9	Hex Jam Nut .750-16UNF	A3886	1
10	Carriage Bolt, .250-20NC x .75	A2846	1
11	Drum Gear Guard	C2543	1
12	Tie Down	A5922	1
13	Nut, Hex .250-20NC	A3331	1
14	Drum Shaft	B2410	1
15	Washer	A1907	1
16	Hex Jam Nut .375-16UNC	A3330	1
17	Retaining Ring 0.750	A4408	1



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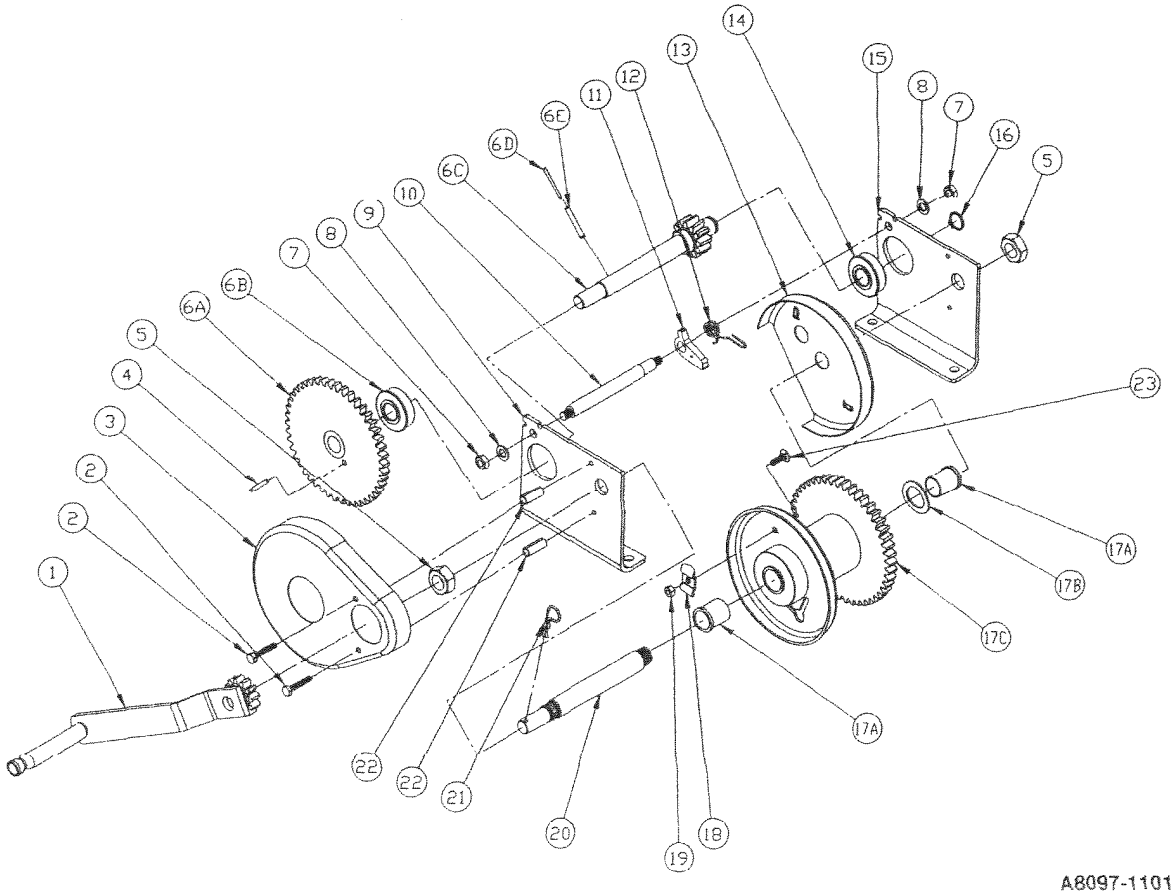
Parts List for		Model M4312		Model M4412	
item	description	part number	qty.	part number	qty.
1	Handle Assembly	B1032	1	B1032	1
2	Capscrew Hxhd Nylk .250-20NC x 1.250 SST	A1870	2	A1870	2
3	Countershaft Gear Guard	B1021	1	B1021	1
4	Slotted Spring Pin .250 x .750 SST	A4290	1	A4290	1
5	Hex Jam Nut .750-16NF SST	A3886	2	A3886	2
6	Countershaft Assembly	SB3880	1	B1026	1
6a	Gear Weldment	SB3876	1	SB3876	1
6b	Radial Ball Bearing .750ID x 1.750OD x .60W	A1256	1	A1256	1
6c	Counter Shaft Weldment	SB3879	1	B2386	1
6d	Slotted Spring Pin .125 x 1.500 STL	A4868	1	A4868	1
6e	Slotted Spring Pin .218 x 1.500 STL	A4083	1	A4083	1
7	Hex Jam Nut .375-16NC SST	A3330	2	A3330	2
8	Lock Washer Splk Int .375 x .692 x .035 SST	A3939	2	A3939	2
9	Right Frame Plate	C1033	1	C1033	1
10	Frame Rod	A1148	1	A1147	1
11	Ratchet Pawl	A1047	1	A1047	1
12	Torsion Spring .690OD x .080WD SST	B1145	1	B1145	1
13	Drum Gear Guard	B1067	1	B1067	1
14	Radial Ball Bearing .750ID x 1.750OD x .60W	A1256	1	A1256	1
15	Left Frame Plate	C1034	1	C1034	1
16	Retaining Ring .750 SST	A4406	1	A4406	1
17	Drum Assembly	C1566	1	C1564	1
17a	Flange Bearing	A1071	2	A1071	2
17b	Machinery Bushing 1.000 x 1.500 x 14 ga	A3887	1	A3887	1
17c	Drum Weldment	C2664	1	C1013	1
18	Tie Down	A1013	1	A1013	1
19	Hex Nut .250-20NC SST	A3331	1	A3331	1
20	Drum Shaft	A1086	1	B1030	1
21	Hair Pin Cotter 1.500 x .091 SST	A4665	1	A4665	1
22	Spacer .312 x .406 x 1.000 ZNPLIRDI	A2820	2	A2820	2
23	Carriage Bolt .250-20NC x .750 SST	A2846	1	A2846	1



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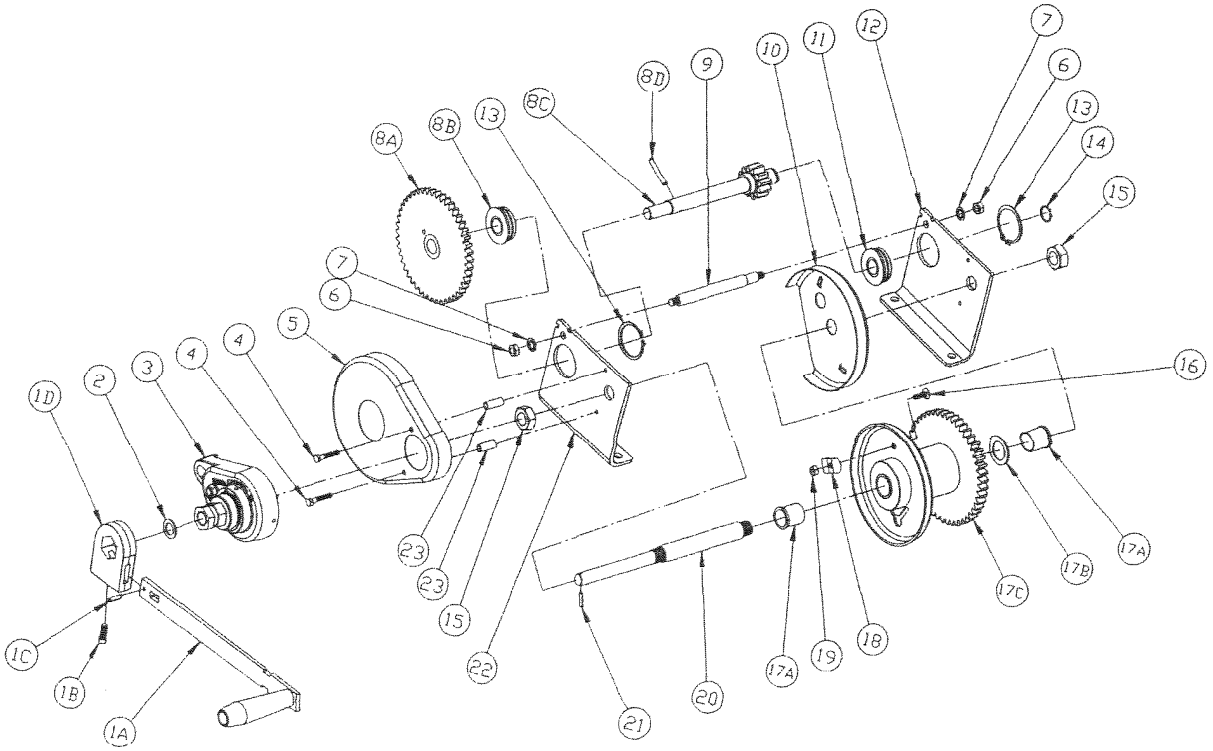
Parts List for Models		M4312PB		M4312PBSS		M4412PB	
item	description	part number	qty.	part number	qty.	part number	qty.
1	Handle Medallion Assembly	B4218	1	B4217	1	B4218	1
1a	Handle Assembly	B4187	1	B4201	1	B4187	1
1b	Setscrew Sqhd Cuppt .312-18NC x .750	A3885	1	A3885	1	A3885	1
1c	Slotted Spring Pin .187 x .750 SST	A4282	1	A4282	1	A4282	1
1d	Medallion	B4189	1	B4199	1	B4189	1
2	Machinery Bushing .625 x 14 ga SST	A5059	1	A5059	1	A5059	1
3	Brake Assembly	C3824	1	C3826	1	C3824	1
4	Capscrew Hxhd Nylk .250-20NC x 1.250	A1870	2	A1870	2	A1870	2
5	Countershaft Gear Guard	B1021	1	B2475	1	B1021	1
6	Hex Jam Nut .375-16NC SST	A3330	2	A3330	2	A3330	2
7	Shakeproof Lock Washer .375 x .692 x .035	A3939	2	A3939	2	A3939	2
8	Countershaft Assembly	SB3880	1	B2472	1	B2387	1
8a	Gear Weldment	SB3876	1	B2471	1	SB3876	1
8b	Bearing	A1256	1	A4599	1	A1256	1
8c	Counter Shaft Weldment	SB3879	1	B2469	1	B2386	1
8d	Pin	A4083	1	A4943	1	A4083	1
8e [1]	Spring Pin	A4868	1	-	-	A4868	1
9	Frame Rod	A1148	1	B2476	1	A1147	1
10	Drum Gear Guard	B1067	1	C2543	1	B1067	1
11	Bearing	A1256	1	A4599	1	A1256	1
12	Left Frame Plate	C1034	1	C2564	1	C1034	1
13	Retaining Ring 1.750 SST	-	-	A3883	2	-	-
14	Retaining Ring .750 SST	A4408	1	A4408	1	A4408	1
15	Hex Jam Nut .750-16NF SST	A3886	2	A3886	2	A3886	2
16	Carriage Bolt .250-20NC x .750 SST	A2846	1	A2846	1	A2846	1
17	Drum Assembly	C1566	1	C2542	1	C1564	1
17a	Flange Bearing	A1071	2	A1071	2	A1071	2
17b	Machinery Bushing	B3887	1	A4418	1	B3887	1
17c	Drum Weldment	C2664	1	C2541	1	C1013	1
18	Tie Down	A1013	1	A5922	1	A1013	1
19	Hex Nut .250-20NC SST	A3331	1	A3331	1	A3331	1
20	Drum Shaft	SB3806	1	B2474	1	C1558	1
21	Slotted Spring Pin .187 x .750 SST	A4282	1	A4282	1	A4282	1
22	Right Frame Plate	C1033	1	C2562	1	C1033	1
23	Spacer .312 x .406 x 1.000	A2820	2	A4457	2	A2820	2

[1] Item 8e is not shown in parts drawing.



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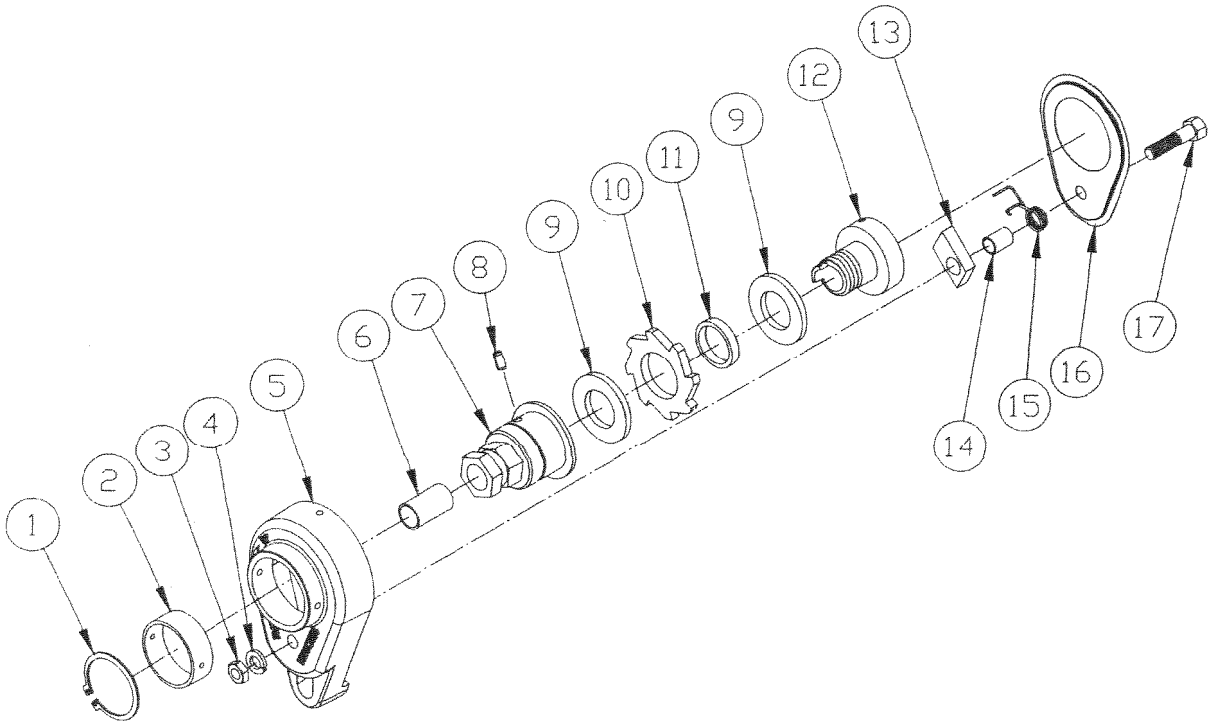
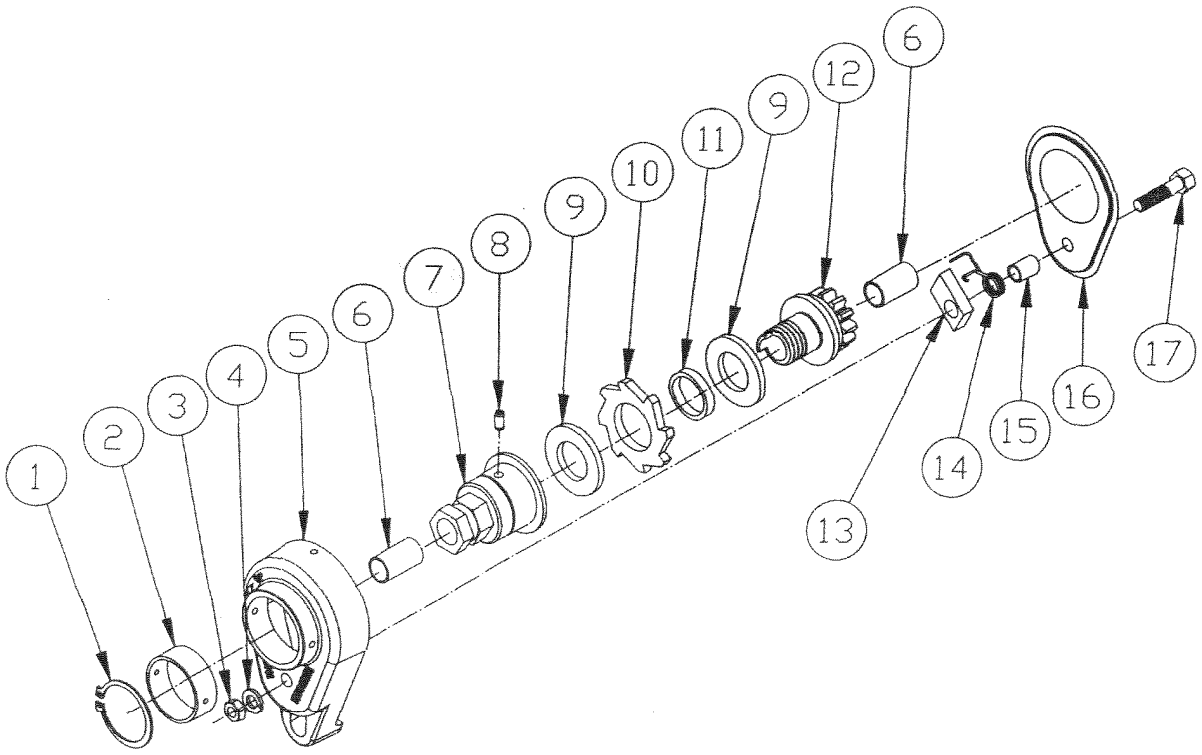
Parts List for Disc Brake Assemblies		C3823		C3825	
item	description	part number	qty.	part number	qty.
1	Retaining Ring 1.750 SST	A3883	1	A3883	1
2	Sleeve Bearing	SA3990	1	SA3990	1
3	Hex Jam Nut .375-16NC SST	A3330	1	A3330	1
4	Lock Washer HelSpr .375 x .683 x .094 SST	A3357	1	A3357	1
5	Brake Housing	C2807	1	C2547	1
6	Sleeve Bearing	A3223	1	A3223	1
7	Hex Drive Nut	B4209	1	B4220	1
8	Slotted Spring Pin	A3275	1	A3275	1
9	Friction Disc	SA4569	2	SA4569	2
10	Brake Ratchet Wheel	SA3992	1	A4600	1
11	Sleeve Bearing	SA3993	1	SA3993	1
12	Brake Bolt	SB3903	1	B2413	1
13	Ratchet Pawl	A1103	1	A4416	1
14	Spacer .391 x .500 x .675	A1104	1	A4415	1
15	Torsion Spring SST	A1842	1	A1842	1
16	Brake Cover	A1105	1	A4417	1
17	Capscrew HexHd .375-16NC x 1.500 SST	A3884	1	A3884	1



Parts List for Disc Brake Assemblies		C3824		C3826	
item	description	part number	qty.	part number	qty.
1	Retaining Ring 1.750 SST	A3883	1	A3883	1
2	Sleeve Bearing	SA3990	1	SA3990	1
3	Hex Jam Nut .375-16NC SST	A3330	1	A3330	1
4	Lock Washer HelSpr .375 x .683 x .094 SST	A3357	1	A3357	1
5	Brake Housing	C2807	1	C2547	1
6	Sleeve Bearing	A3223	2	A3223	2
7	Hex Drive Nut	B4209	1	B4220	1
8	Slotted Spring Pin	A3275	1	A3275	1
9	Friction Disc	SA4569	2	SA4569	2
10	Brake Ratchet Wheel	SA3992	1	A4600	1
11	Sleeve Bearing	SA3993	1	SA3993	1
12	Brake Bolt	SB3807	1	B2478	1
13	Ratchet Pawl	A1103	1	A4416	1
14	Torsion Spring SST	A1842	1	A1842	1
15	Spacer .391 x .500 x .675	A1104	1	A4415	1
16	Cover	A1105	1	A4417	1
17	Capscrew Hxhd .375-16NC x 1.500	A3884	1	A3884	1




THERN
INCORPORATED

Section 6.2 COOLING SYSTEM

The UV4000LF™ utilizes a closed loop system to prevent the overheating of the ballast. Located within the hydraulic systems centre (HSC) are two coolant pumps one duty rated and the other standby. The coolant pump circulates propylene glycol from the reservoir in the HSC through the water jacket around the reactor chamber. Heat is thereby transferred from the ballasts to the effluent stream. Upon exiting the water jacket the coolant is distributed through a manifold system to each module through 1/2" rubber hose. Attached to each ballast within the module is a coolant extrusion, that acts as a heat sink taking heat away from the module. The coolant then circulates back to the reservoir and the cycle continues. Refer to drawing 422154G for details.

The fluid level in this reservoir should be checked occasionally. A pressure gage is located on the high pressure side of the pump. The pressure should be checked occasionally to ensure proper operation of the cooling system. Cooling system pressure ranges are as follows:

Operating Pressure:	**25 - 30 P.S.I.**
Low Pressure:	**10 P.S.I. or lower**
High Pressure:	**45 P.S.I. or higher**

Pressure sensors continuously monitor the coolant pressure. If the pressure is too low or too high, an alarm will be indicated on the operator interface.

Note: The pump must never be run dry or it maybe damaged.

Note: Only use a 50/50 mixture of propylene glycol and water in the cooling system.

Note: Life expectancy of glycol is 4 to 5 years.

The following pages contain detailed drawings of the hydraulic systems center along with a manufacturer's operation and maintenance manual for the coolant pump.

Trojan

COMPONENT SPECIFICATION (CS)

DESCRIPTION: **PUMP, COOL 2HP/460V/60Hz/3PH**

PART/DOC. #: **444283**

SPECIFICATION: This specification is for a stainless steel, close-coupled centrifugal pump. This pump features a standard, open drip-proof enclosure and a rugged ball bearing design for continuous duty under all operating conditions.

Used on: UV4000 Electronic Ballast Systems with 2 to 6 lamp modules

Specifications:

MOTOR:
2HP
460V
3 Phase
60 Hz
NEMA 56J Frame
3500 RPM
Stainless steel shaft with ball bearing.

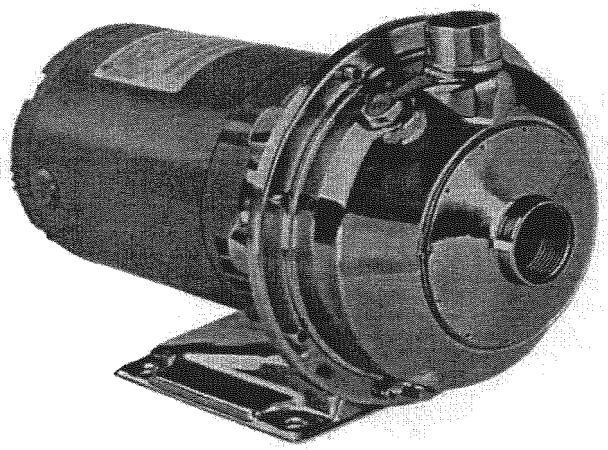
IMPELLER DIAMETER: 4 7/8" DIA.

PUMP SIZE: 1 1/4" X 1 1/2" - 6"

WORKING PRESSURE TO: 125 PSIG (9 bars)

MODEL: **2ST4H2C4**

Supplier:
Nevtro Sales
90 Charterhouse Crescent
London, Ontario
N5W 5V5
Phone: (519) 451-0930
Fax: (519) 451-8764



G&L

STAINLESS STEEL

Close-Coupled Centrifugal Pump

MODEL

NPE

1/2 to 3HP

FEATURES

- **Compact Design:** Close-coupled design saves space and simplifies maintenance and installation.
- **Superior Materials of Construction:** Complete AISI 304 Stainless Steel liquid handling components and mounting bracket for corrosion resistance, quality appearance, and improved strength and ductility.
- **Installation Flexbility:** Can be mounted in horizontal or vertical position.
- **High Efficiency Impeller:** Enclosed impeller with unique floating O-Ring design maintains maximum efficiencies over the life of the pump without adjustment.
- **Casing and Adapter Features:** Stainless Steel construction with NPT threaded, centerline connections, easily accessible vent, prime and drain connections with stainless steel plugs.
- **Mechanical Seal:** Standard John Crane Type 6 with carbon versus ceramic faces, Buna elastomers, and 18-8 stainless metal parts. Optional high temperature and chemical duty seals available.
- **Motors:** NEMA standard open drip-proof, totally enclosed fan cooled or explosion proof enclosures. Rugged ball bearing design for continuous duty under all operating conditions.

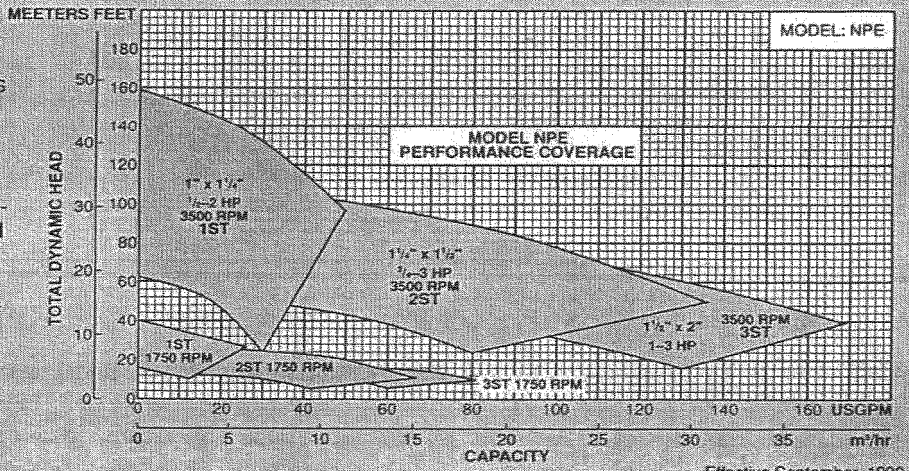
APPLICATIONS

Specifically designed for a broad range of general applications traditionally requiring varying materials such as all iron, bronze fitted or all bronze construction.

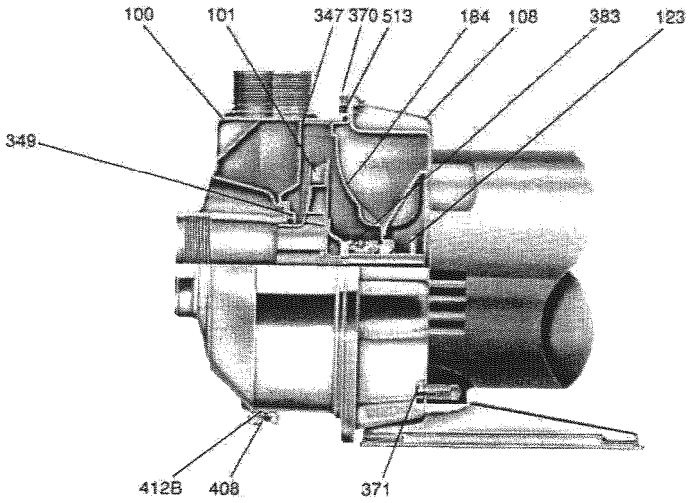
- Water circulation
- Booster service
- Liquid transfer
- Spray systems
- Jockey pumps
- OEM applications
- General water services

SPECIFICATIONS

- **Capacities to:** 75 GPM (283L/min) at 1750 RPM 150 GPM (550L/min) at 3500 RPM
- **Heads to:** 39 feet (11m) at 1750 RPM 150 feet (50m) at 3500 RPM
- **Working pressures to:** 125 PSIG (9 bars).
- **Maximum temperatures to:** 212° F (100° C) with standard seal or 250° F (121° C) with optional high temperature version.
- **Direction of rotation:** Clockwise when viewed from motor end.
- **Motors:** NEMA standard design 1750 RPM 1/2 HP 56CJ frame 3500 RPM 1/2 through 3 HP.
  - Rating open drip-proof, totally enclosed fan-cooled or explosion proof (3 phase) enclosures. Ball bearing design stainless steel shaft.
    Single phase Voltage 115/230 ODP and TEFC. (3HP model - 230 volt only.) Built-in overload with autoreset provided on single phase ratings.
  - Three phase Voltage 208-230/460 ODP, TEFC and EX PROOF.
    NOTE: Overload protection must be provided. Contactor with overload for 1-phase or starters with heaters for 3-phase units ordered separately.



Effective September, 1990



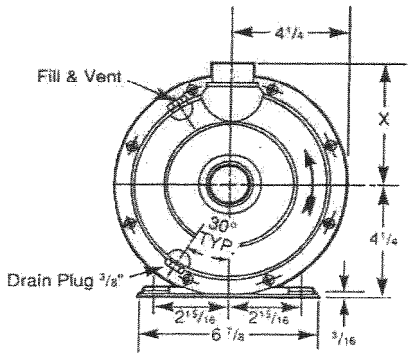
MATERIALS OF CONSTRUCTION

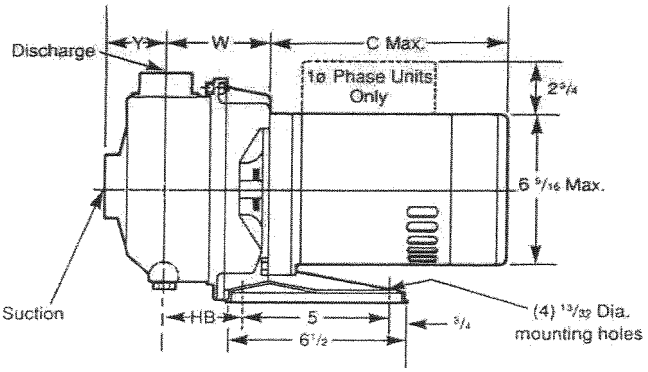
Item No.	Description	Materials
100	Casing	AISI 304 Stainless Steel
101	Impeller	
106	Motor Adapter	
123	Deflector	Buna-N
184	Seal Housing	AISI 304 Stainless Steel
347	Guidevane	
349	O-Ring, Guidevane	Buna-N
370	Socket Hd. Screws, Casing	AISI 304 S.S.
371	Bolts, Motor	Plated/Steel
383	Mechanical Seal	**see chart
408	Drain & Vent Plug, Casing	AISI 304 S.S.
412B	O-Ring, Drain & Vent Plug	Buna-N
513	O-Ring, Casing	
Motor	NEMA Std., 56C Flange	

**Mechanical Seals-Item 383

Part No.	Service	Rotary	Stationary	Elastomer	Metal Parts	Crane Type
10K10	Standard Duty	Carbon	Ceramic	Buna	18-8 S.S.	6
10K6	Fluct. Temp. up to 212° F		Ni-Resist			
10K18	Hot Water up to 250° F			EPR		21
10K24	Mild Chemical		Ceramic	Viton		

PUMP DIMENSIONS & WEIGHTS





Model Size	Pump Size-NPT Suction	Pump Size-NPT Discharge	HP	W	X	Y	HB
1ST	1 1/4	1	1/2-2	3 5/16	4 3/8	2	2 9/16
2ST	1 1/2	1 1/4	3/4-3	3 3/4	4 1/2	2 1/4	3
3ST	2	1 1/2	1-3		4 5/8		

HP	Unit Weight (lbs.) 1ø Phase ODP	1ø Phase TEFC	3ø Phase ODP	3ø Phase TEFC	C Max.
1/2*	24	29	27	26	9 15/16
3/4	27	32	27	29	10 1/4
1	30	34	30	29	11
1 1/2	34	38	33	33	11 5/16
2	40	43	33	35	12 1/16
3	—	—	42	46	12 7/16

*Includes 1750 RPM units, all others 3500 RPM only.

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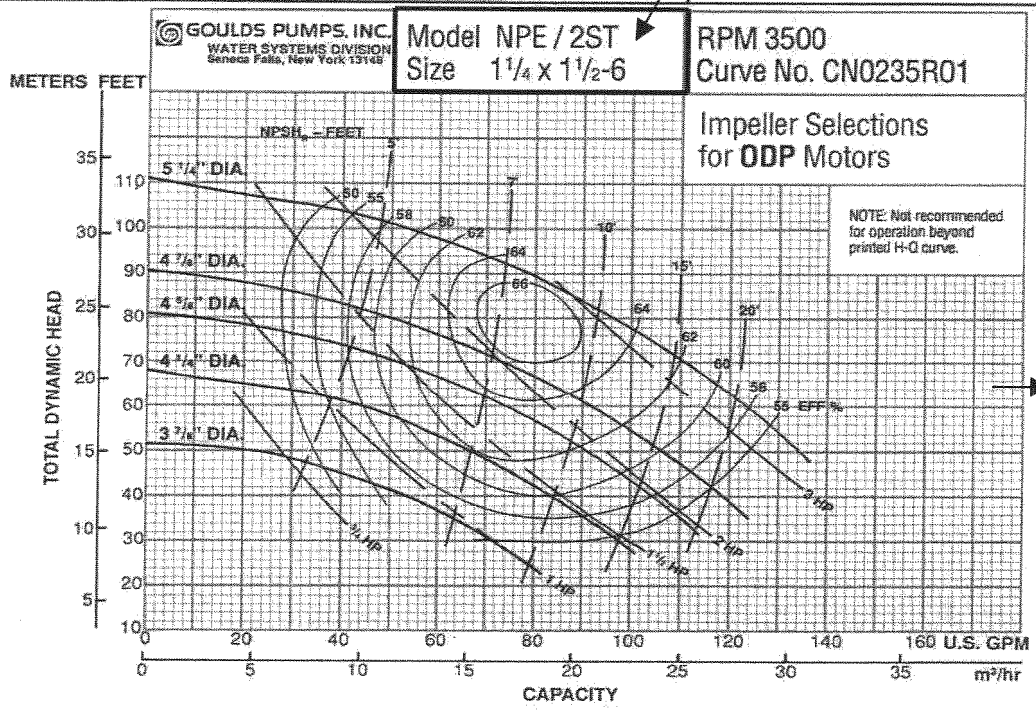
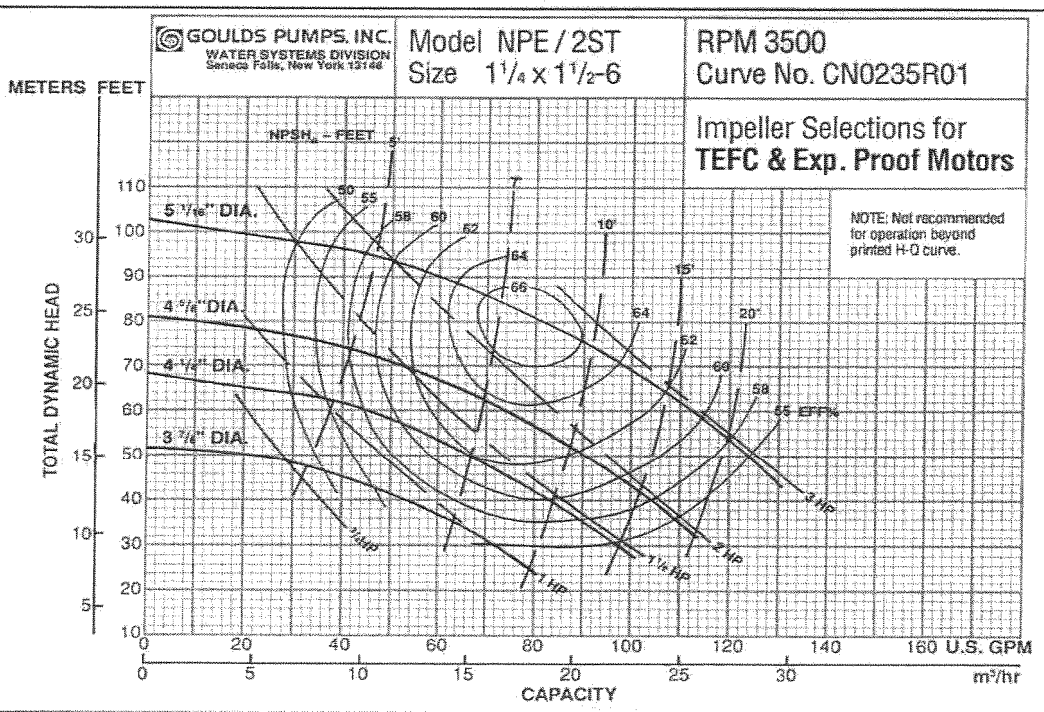
Performance Curve
End Suction Centrifugal
AISI 304 Stainless Steel

Model: NPE
RPM: 3500
Size: As Shown



Unit Motor HP	Imp. Dia.
¾	3 7/8"
1	4 1/4"
1½	4 5/8"
2	4 7/8"
3	5 1/4"



Unit Motor HP	Imp. Dia.
1	3 7/8"
1½	4 1/4"
2	4 5/8"
3	5 1/16"

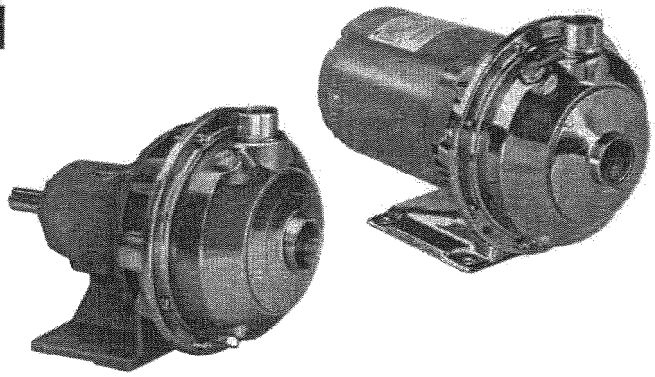
Customer _____	Condition of Service Imp. Dia. _____	Certified for: Approval ☐
Pump Item _____	_____ GPM _____ TDH _____ EFF%	By _____ Date _____ Record ☐

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

Effective January, 1990
PRINTED IN U.S.A.

Installation, Operation and Maintenance Instructions

Model NPE/ NPE-F



DESCRIPTION & SPECIFICATIONS:

The Models NPE (close-coupled) and NPE-F (frame-mounted) are end suction, single stage centrifugal pumps for general liquid transfer service, booster applications, etc. Liquid-end construction is all AISI Type 304 stainless steel, stamped and welded. Impellers are fully enclosed, non-trimable to intermediate diameters. Casings are fitted with a diffuser for efficiency and for negligible radial shaft loading.

Close-coupled units have NEMA 48J or 56J motors with C-face mounting and threaded shaft extension. Frame-mounted units can be coupled to motors through a spacer coupling, or belt driven.

1. Important:

1.1. Inspect unit for damage. Report any damage to carrier/dealer immediately.

1.2. Electrical supply must be a separate branch circuit with fuses or circuit breakers, wire sizes, etc., per National and Local electrical codes. Install an all-leg disconnect switch near pump.

CAUTION

Always disconnect electrical power when handling pump or controls.

1.3. Motors must be wired for proper voltage. Motor wiring diagram is on motor nameplate. Wire size must limit maximum voltage drop to 10% of nameplate voltage at motor terminals, or motor life and pump performance will be lowered.

1.4. Always use horsepower-rated switches, contactor and starters.

1.5. Motor Protection

1.5.1. Single-phase: Thermal protection for single-phase units is sometimes built in (check nameplate). If no built-in protection is provided, use a contactor with a proper overload. Fusing is permissible.

1.5.2. Three-phase: Provide three-leg protection with properly sized magnetic starter and thermal overloads.

1.6. Maximum Operating Limits:

Liquid Temperature:	212 F (100 C) with standard seal.
	250 F (120 C) with optional high temp seal.
Pressure:	75 PSI.
Starts Per Hour:	20, evenly distributed.

1.7. Regular inspection and maintenance will increase service life. Base schedule on operating time. Refer to Section 8.

2. Installation:

2.1. General

2.1.1. Locate pump as near liquid source as possible (below level of liquid for automatic operation).

2.1.2. Protect from freezing or flooding.

2.1.3. Allow adequate space for servicing and ventilation.

2.1.4. All piping must be supported independently of the pump, and must "line-up" naturally.

CAUTION

Never draw piping into place by forcing the pump suction and discharge connections.

2.1.5. Avoid unnecessary fittings. Select sizes to keep friction losses to a minimum.

2.2. Close-Coupled Units:

2.2.1. Units may be installed horizontally, inclined or vertically.

CAUTION

Do not install with motor below pump. Any leakage or condensation will affect the motor.

2.2.2. Foundation must be flat and substantial to eliminate strain when tightening bolts. Use rubber mounts to minimize noise and vibration.

2.2.3. Tighten motor hold-down bolts before connecting piping to pump.

2.3. Frame-Mounted Units:

2.3.1. Bedplate must be grouted to a foundation with solid footing. Refer to Fig.1.

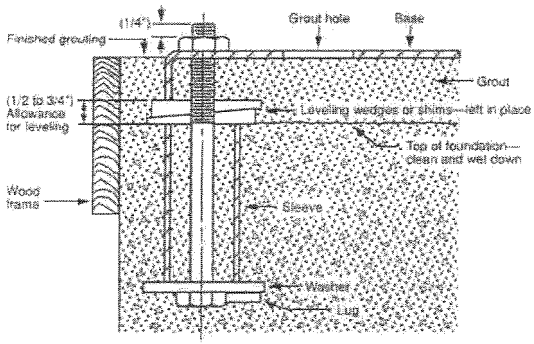


Figure 1

2.3.2. Place unit in position on wedges located at four points (two below approximate center of driver and two below approximate center of pump). Adjust wedges to level unit. Level or plumb suction and discharge flanges.

2.3.3. Make sure bedplate is not distorted and final coupling alignment can be made within the limits of movement of motor and by shimming, if necessary.

2.3.4. Tighten foundation bolts finger tight and build dam around foundation. Pour grout under bedplate making sure the areas under pump and motor feet are filled solid. Allow grout to harden 48 hours before fully tightening foundation bolts.

2.3.5. Tighten pump and motor hold-down bolts before connecting the piping to pump.

3. Suction Piping:

3.1. Low static suction lift and short, direct, suction piping is desired. For suction lift over 10 feet and liquid temperatures over 120 F, consult pump performance curve for Net Positive Suction Head Required.

3.2. Suction pipe must be at least as large as the suction connection of the pump. Smaller size will degrade performance.

3.3. If larger pipe is required, an eccentric pipe reducer (with straight side up) must be installed at the pump.

3.4. Installation with pump below source of supply:

3.4.1. Install full flow isolation valve in piping for inspection and maintenance.

CAUTION

Do not use suction isolation valve to throttle pump.

3.5. Installation with pump above source of supply:

3.5.1. Avoid air pockets. No part of piping should be higher than pump suction connection. Slope piping upward from liquid source.

3.5.2. All joints must be airtight.

3.5.3. Foot valve to be used only if necessary for priming, or to hold prime on intermittent service.

3.5.4. Suction strainer open area must be at least triple the pipe area.

3.6. Size of inlet from liquid source, and minimum submergence over inlet, must be sufficient to prevent air entering pump through vortexing. See Figs. 2-5

3.7. Use 3-4 wraps of Teflon tape to seal threaded connections.

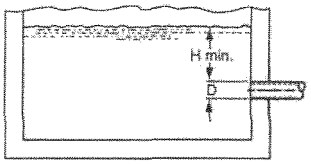


Figure 2

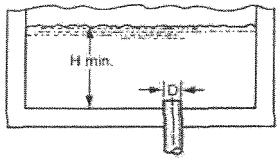


Figure 3

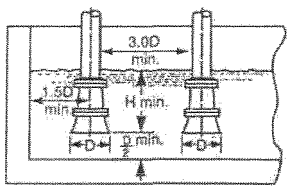


Figure 4

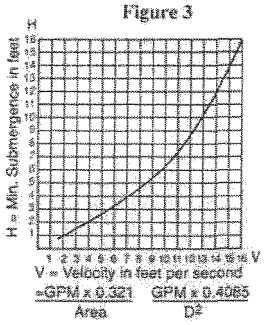


Figure 5

4. Discharge Piping:

4.1. Arrangement must include a check valve located between a gate valve and the pump. The gate valve is for regulation of capacity, or for inspection of the pump or check valve.

4.2. If an increaser is required, place between check valve and pump.

4.3. Use 3-4 wraps of Teflon tape to seal threaded connections.

5. Motor-To-Pump Shaft Alignment:

5.1. Close-Coupled Units:

5.1.1. No field alignment necessary.

5.2. Frame-Mounted Units:

5.2.1. Even though the pump-motor unit may have a factory alignment, this could be disturbed in transit and must be checked prior to running. See Fig. 6.

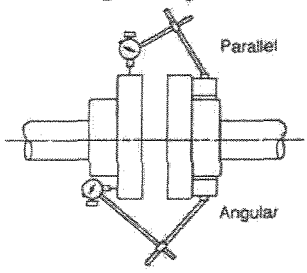


Figure 6

5.2.2. Tighten all hold-down bolts before checking the alignment.

5.2.3. If re-alignment is necessary, always move the motor. Shim as required.

5.2.4. Parallel misalignment - shafts with axis parallel but not concentric. Place dial indicator on one hub and rotate this hub 360 degrees while taking readings on the outside diameter of the other hub. Parallel alignment occurs when Total Indicator Reading is .005", or less.

5.2.5. Angular misalignment - shafts with axis concentric but not parallel. Place dial indicator on one hub and rotate this hub 360 degrees while taking readings on the face of the other hub. Angular alignment is achieved when Total Indicator Reading is .005", or less.

5.2.6. Final alignment is achieved when parallel and angular requirements are satisfied with motor hold-down bolts tight.

CAUTION

Always recheck both alignments after making any adjustment.

6. Rotation:

6.1. Correct rotation is right-hand (clockwise when viewed from the motor end). Switch power on and off quickly. Observe shaft rotation. To change rotation:

6.1.1. Single-phase motor: Non-reversible.

6.1.2. Three-phase motor: Interchange any two power supply leads.

7. Operation:

7.1. Before starting, pump must be primed (free of air and suction pipe full of liquid) and discharge valve partially open.

CAUTION

Pumped liquid provides lubrication. If pump is run dry, rotating parts will seize and mechanical seal will be damaged. Do not operate at or near zero flow. Energy imparted to the liquid is converted into heat. Liquid may flash to vapor. Rotating parts require liquid to prevent scoring or seizing.

7.2. Make complete check after unit is run under operating conditions and temperature has stabilized. Check for expansion of piping. On frame-mounted units coupling alignment may have changed due to the temperature differential between pump and motor. Recheck alignment.

8. Maintenance:

8.1. Close-Coupled Unit. Ball bearings are located in and are part of the motor. They are permanently lubricated. No greasing required.

8.2. Frame-Mounted Units:

8.2.1. Bearing frame should be regreased every 2,000 hours or 3 month interval, whichever occurs first. Use a #2 sodium or lithium based grease. Fill until grease comes out of relief fittings, or lip seals, then wipe off excess.

8.2.2. Follow motor and coupling manufacturers' lubrication instructions.

8.2.3. Alignment must be rechecked after any maintenance work involving any disturbance of the unit.

9. Disassembly:

Complete disassembly of the unit will be described. Proceed only as far as required to perform the maintenance work needed.

9.1. Turn off power.

9.2. Drain system. Flush if necessary.

9.3. Close-Coupled Units: Remove motor hold-down bolts.

Frame-Mounted Units: Remove coupling, spacer, coupling guard and frame hold-down bolts.

9.4. Disassembly of Liquid End:

9.4.1. Remove casing bolts (370).

9.4.2. Remove back pull-out assembly from casing (100).

9.4.3. Remove impeller locknut (304).

CAUTION

Do not insert screwdriver between impeller vanes to prevent rotation of close-coupled units. Remove cap at opposite end of motor. A screwdriver slot or a pair of flats will be exposed. Using them will prevent impeller damage.

9.4.4. Remove impeller (101) by turning counter-clockwise when looking at the front of the pump. Protect hand with rag or glove.

CAUTION

Failure to remove the impeller in a counter-clockwise direction may damage threading on the impeller, shaft or both.

9.4.5. With two pry bars 180 degrees apart and inserted between the seal housing (184) and the motor adapter (108), carefully separate the two parts. The mechanical seal rotary unit (383) should come off the shaft with the seal housing.

9.4.6. Push out the mechanical seal stationary seat from the motor side of the seal housing.

9.5. Disassembly of Bearing Frame:

9.5.1. Remove bearing cover (109).

9.5.2. Remove shaft assembly from frame (228).

9.5.3. Remove lip seals (138 & 139) from bearing frame and bearing cover if worn and are being replaced.

9.5.5. Use bearing puller or arbor press to remove ball bearings (112 & 168).

10. Reassembly:

10.1. All parts should be cleaned before assembly.

10.2. Refer to parts list to identify required replacement items. Specify pump index or catalog number when ordering parts.

10.3. Reassembly is the reverse of disassembly.

10.4. Observe the following when reassembling the bearing frame:

10.4.1. Replace lip seals if worn or damaged.

10.4.2. Replace ball bearings if loose, rough or noisy when rotated.

10.4.3. Check shaft for runout. Maximum permissible is .002" T.I.R.

10.5. Observe the following when reassembling the liquid-end:

10.5.1. All mechanical seal components must be in good condition or leakage may result. Replacement of complete seal assembly, whenever seal has been removed, is good standard practice.

It is permissible to use a light lubricant, such as glycerin, to facilitate assembly. Do not contaminate the mechanical seal faces with lubricant.

10.5.2. Inspect casing O-ring (513) and replace if damaged. This O-ring may be lubricated with petroleum jelly to ease assembly.

10.5.3. Inspect guidevane O-ring (349) and replace if worn.

CAUTION

Do not lubricate guidevane O-ring (349). Insure it is not *pinched by the impeller on reassembly.*

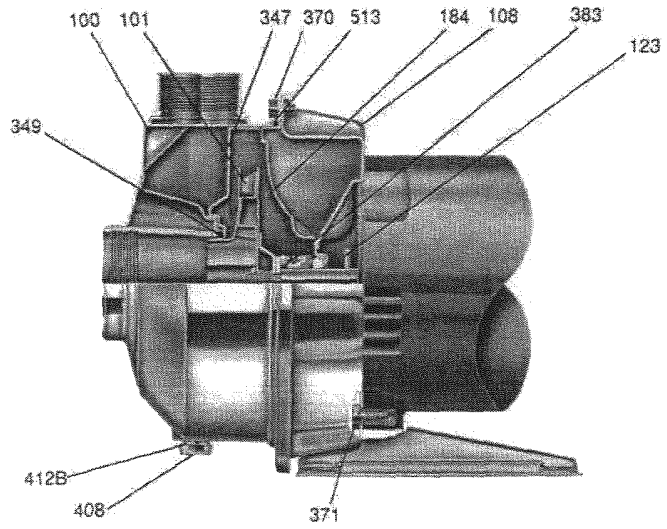
10.6. Check reassembled unit for binding. Correct as required.

10.7. Tighten casing bolts in a star pattern to prevent O-ring binding.

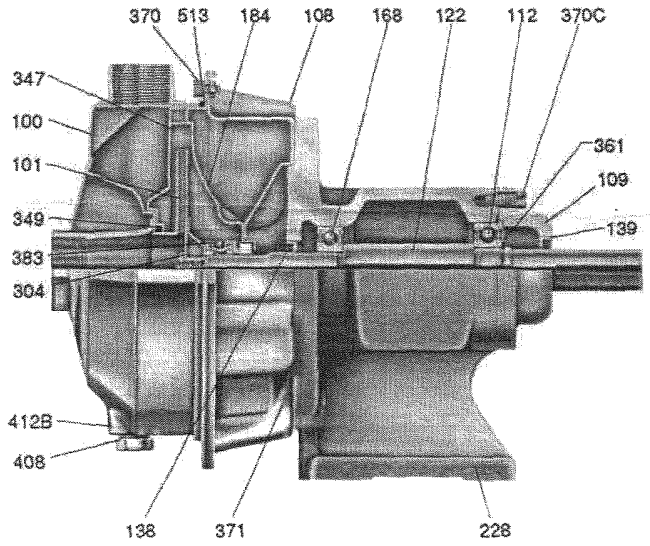
11. Trouble Shooting Chart:

MOTOR NOT RUNNING
(See causes 1 thru 6)
LITTLE OR NO LIQUID DELIVERED:
(See causes 7 thru 17)
POWER CONSUMPTION TOO HIGH:
(See causes 4, 17, 18, 19, 22)
EXCESSIVE NOISE AND VIBRATION:
(See causes 4, 6, 9, 13, 15, 16, 18, 20, 21, 22)
PROBABLE CAUSE:

1. Tripped thermal protector
2. Open circuit breaker
3. Blown fuse
4. Rotating parts binding
5. Motor wired improperly
6. Defective motor
7. Not primed
8. Discharge plugged or valve closed
9. Incorrect rotation
10. Foot valve too small, suction not submerged, inlet screen plugged.
11. Low voltage
12. Phase loss (3-phase only)
13. Air or gasses in liquid
14. System head too high
15. NPSHA too low:
    Suction lift too high or suction losses excessive. Check with vacuum gauge.
16. Impeller worn or plugged
17. Incorrect impeller diameter
18. Head too low causing excessive flow rate
19. Viscosity or specific gravity too high
20. Worn bearings
21. Pump or piping loose
22. Pump and motor misaligned



NPE



NPE-F

Liquid End Components		
Item No.	Description	Materials
100	Casing	AISI 304 Stainless Steel
101	Impeller	
184	Seal Housing	
304	Impeller Locknut	
347	Guidevane	
349	O-Ring, Guidevane	Buna-N
370	Socket Hd. Screws, Casing	AISI 304 S.S.
383	Mechanical Seal	** see chart
408	Drain & Vent Plug, Casing	AISI 304 S.S.
412B	O-Ring, Drain & Vent Plug	Buna-N
513	O-Ring, Casing	Buna-N
	Power End Components	
108	Adapter	AISI 304 S.S.
109	Bearing Cover	Cast Iron
112	Ball Bearing (Outboard)	Steel
122	Shaft	AISI 303 S.S.
138	Lip Seal (Inboard)	Buna/Steel
139	Lip Seal (Outboard)	Buna/Steel
168	Ball Bearing (Inboard)	Steel
228	Bearing Frame	Cast Iron
361	Snap Ring	Steel
370C	Hex. Hd. Cap Screw, Brg. Cvr.	Plated Steel
371	Hex. Hd. Cap Screw, Adapter	Plated Steel

**Mechanical Seals–Item 383						
Part No.	Service	Rotary	Stationary	Elastomer	Metal Parts	Crane Type
10K46	Standard	Carbon	Ceramic	Buna	18-8 S.S.	21
10K18	Option-High Temp.		Ni-Resist	EPR		
10K24	Option-Chemeical Duty		Ceramic	Viton		
10K55	Option-High Temp.		Tungsten			
10K29	Option-Severe Duty	Silicon Carbon		Buna		

LIMITED WARRANTY

This warranty applies to all pumps and related accessories manufactured and/or supplied by Goulds Pumps, Inc. - Water Systems Division.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the buyer or any subsequent owner during the warranty period. The warranty period shall exist for twelve (12) months from date of installation, or eighteen (18) months from date of manufacture, whichever expires first.

A consumer who believes that a warranty claim exists must contact the authorized dealer from whom the equipment was originally purchased and furnish complete details regarding the claim. The dealer is authorized to adjust any warranty claim utilizing Goulds Customer Relations Department and its distributor organization.

This warranty excludes: (a) Labor, transportation and related costs incurred by the consumer to make the allegedly defective equipment available to the dealer for inspection. (b) Re-installation costs of repaired equipment. (c) Re-installation costs of replacement equipment. (d) Consequential damages of any kind. (e) Reimbursement for loss caused by interruption of service.

GOULDS PUMPS, INC.
SENECA FALLS, NEW YORK 13148

G&L
A GOULDS PUMPS COMPANY

Form No. NPE-2/92

Trojan

COMPONENT SPECIFICATION (CS)

DESCRIPTION: **OIL, HYDRAULIC, LOW VISCOSITY**

PART/DOC. #: **444295**

SPECIFICATION: This specification for 20 litre (5 gallon) pails only. (Bulk purchase reference 444222.) This specification is for low viscosity hydraulic oil which is designed for use in environments where wide temperature variations occur. This oil can be used year-round eliminating seasonal oil changes. Oil specs are as follows:

Manufacturer:	Shell Canada
Oil Name:	**Tellus T15**
Product Code:	**407-154**
Density at 15°C, kg/litre:	.836
Pour Point °C:	-60
Flash Point, COC, °C:	110
Kinematic Viscosity:	
cSt at 40°C:	15.7
cSt at 100°C:	4.9
Operating Temp. Range, °C:	-35 to +49 (start up temp.: -51 min.)

See sheets 2 & 3 for more information

Refer to MSDS for Handling, Storage and Precautions

SOURCE OF SUPPLY:

Supplier:
Nevtro Sales
2060 Oxford E
London, ON
Phone: (519) 455-1872

NOTE: Alternate suppliers may be used

LUBE REPORT

Technical information from Shell Canada

T.I.P. 3.13.10

03 -01- 1996

TELLUS® T OILS

SUPERIOR ALL-SEASON HYDRAULIC PERFORMANCE

PRODUCT LINE

Tellus® T Oils are premium quality multigrade anti-wear hydraulic oils for use in mobile and stationary equipment subjected to extremes of temperature. **Tellus ®** T oils are available in ISO viscosity grades 15, 22, 32, 46 and 68, to cover virtually all Canadian climatic conditions on a year-round basis.

Tellus® T 722 is a **Full Synthetic** hydraulic fluid designed for year-round usage in severe applications. It is recommended by Bucyrus Erie for use in their 49R and 59R blast hole drills.

APPLICATIONS

Tellus® T Oils are especially designed for use in hydraulic systems on mobile and stationary equipment operating in environments where wide temperature variations occur:

- excavators, cranes, shovels, drills, crawlers, "cherry pickers", etc. operating at winter temperatures below -40°C and also at summer heats to the mid +30°C range
- woodlands and snow removal equipment
- portable compressors and circulating systems, servicing gears and bearings, where temperatures vary seasonally

In many cases, the correct viscosity grade may be used year-round eliminating the need for seasonal oil changes.

PERFORMANCE BENEFITS

- **Low Temperature Fluidity**
  Formulated with the most effective combination of polymeric additives and specially selected base stocks **Tellus®** T has excellent flow properties at low temperatures. The appropriate grade of **Tellus ®** T enables you to:
  - reduce non-productive warm-up time
  - minimize energy losses in starting equipment at low temperatures compared to more viscous fluids.
  - reduce the risk of pump cavitation problems which can destroy a pump during start-up at low temperatures.
- **All-Season Protection and Longer Pump Life.**
  The use of oils with high viscosity index can extend the operating temperature range of equipment without the need to change the oil. **Tellus®** T Oils are designed to maximize these benefits by offering excellent low temperature flow while retaining good high temperature protection.
  An excellent resistance to viscosity breakdown (shear) coupled with a premium anti-wear package ensures long pump life at high operating temperatures.
- **Superior Water Tolerance**
  - **Tellus®** T Oils exhibit excellent **hydrolytic stability**, a measure of the tendency of the additives in an oil to react with water.
  - They also provide excellent **filterability**. Often in the presence of water, poorer quality oils can generate insoluble materials which will result in filter plugging.
  - They are also formulated with additives which ensure excellent **demulsibility**, the ability to separate from water in storage. Water which fails to separate effectively in a reservoir may contribute to excessive wear if recirculated through the system.
- **Greater Resistance to Deterioration at High Operating Temperature** - formulated to resist chemical breakdown and lacquer formation.

Tellus® T = reduced downtime and longer equipment life!

PERFORMANCE SUMMARY

TESTS AND MANUFACTURER APPROVALS

• Denison HFO-HF-2	Approved
• Vickers M-2950-S	Pass
• Vickers 35VQ25 vane	pass
• Vickers 1-286-S	Pass
• Vickers 1-286-S	Pass
• Sundstrand piston pump	Approved

TELLUS T® OILS - TYPICAL PROPERTIES

Grades	T15	T22	T722	T32	T46	T68
PRODUCT CODE	407-154	407-157	407-158	407-159	407-179	417-169
CHARACTERISTICS						
Density at 15°C, kg/litre	0.836	0.866	0.817	0.871	0.876	0.877
Pour Point °C	-60	-57	<-65	-45	-48	-36
Flash Point, COC, °C	110	159	175	194	208	234
Kinematic Viscosity						
cSt at 40°C	15.7	22.7	21.5	31.1	44.1	63.6
cSt at 100°C	4.9	5.3	5.3	6.2	8.0	9.7
cSt at -40°C	-	-	2725	-	-	-
Viscosity Index	280	175	198	155	155	136
Brookfield						
cP at -20°C	-	-	-	-	-	6097
cP at -30°C	-	-	-	5842	11918	-
cP at -40°C	-	8994	-	-	-	-
cP at -50°C	7500	-	-	-	-	-
Typical Operating Temp. Range						
Max [1]	+49	+60	+60	+69	+76	+85
Min. C [1]	-35	-21	<-30	-13	-9	-1
Start-Up C [2]	<-51	-40	<-50	-33	-28	-22

For more information about TELLUS T® Oils please contact the Shell Helps Centre-Technical Desk toll free at 1-800-661-1600

---

1 • Upper limit based on operating oil viscosity of 12.5 cSt minimum.
• Lower limit based on oil viscosity of 750 cP maximum for cold starts.

2 • Based on 9,000 cP viscosity and the use of proper warmup techniques e.g. system should be operated without load until minimum operating temperature achieved etc.
Temperature limits may vary with type, design of equipment and severity of operation.

Section 6.3 HYDRAULIC WIPER SYSTEM

Within the hydraulic systems center is a hydraulic pump complete with an integral 4 way valve and fluid reservoir that is used exclusively to power the sleeve wipers on each module. Refer to drawings 422345G for details.

As described under Section 5.5 fluid is delivered from the reservoir to the hydraulic cylinder. The fluid levels in the reservoir should be checked occasionally.

A pressure gage is located on the high pressure side of the pump. The pressure should be checked to ensure proper operation of the wiper system. Hydraulic system pressure ranges are as follows:

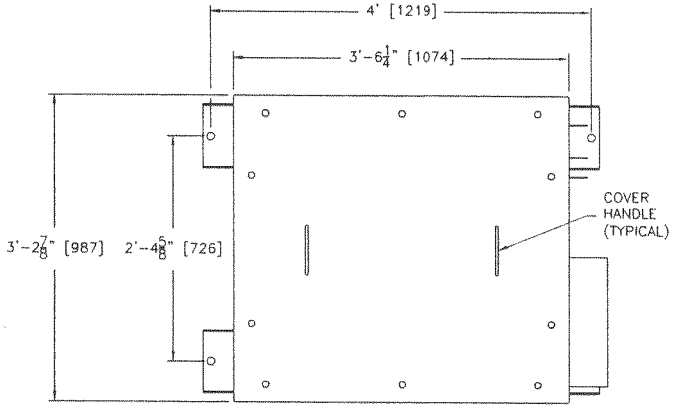
Operating Pressure:	**150 - 200 PSI**
Low Pressure:	**100 PSI**
High Pressure:	**230 PSI**

Pressure sensors continuously monitor the hydraulic pressure. If the pressure is too low or too high, an alarm will be indicated on the operator interface.

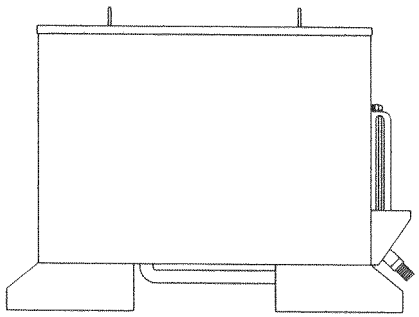
Note: The pump must never be run dry or it maybe damaged.

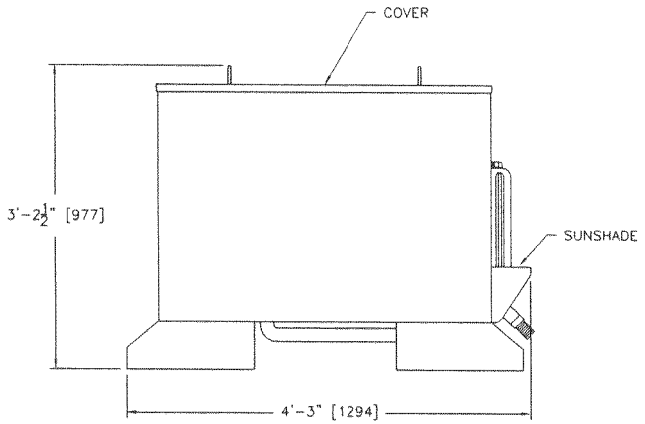
Note: Attached is component spec sheet on recommended hydraulic fluid.

The following pages contain detailed drawings of the hydraulic systems center, component specifications, and a manufacturer's operation and maintenance manual for the hydraulic pump.

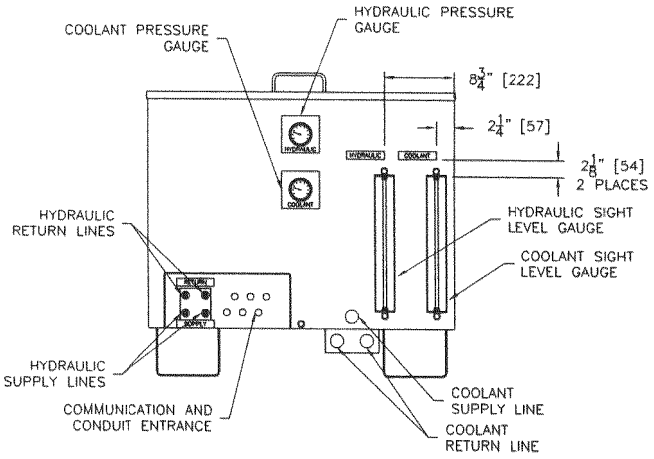


TOP VIEW
SCALE:AS SHOWN





SIDE VIEW
SCALE:AS SHOWN



FRONT VIEW
SCALE:AS SHOWN

NOTES:
STANDARD NORTH AMERICAN MODEL SHOWN
OPPOSITE HAND NORTH AMERICAN MODEL MIRROR IMAGE

Trojan Technologies Inc.

DESCRIPTION: STD, UV4LF HYDRAULIC SYSTEMS CENTER		REFERENCE NO. 422350
DRAWN BY : MMM	DATE : 01JN05	STANDARD DRAWING NO. 4M0229
CHECKED BY : JAW	DATE : 01JN05	
APPROVED BY : DAC	DATE : 01JN05	DWG NO. D01 / REV. A
SCALE (8½x11) : 3/16"=1'-0"	LOG NUMBER : N / A	

Section 6.4 HYDRAULIC CENTER COMPONENT SPECIFICATIONS

The following pages contain component specifications of devices located in the hydraulic systems center.

Trojan

COMPONENT SPECIFICATION (CS)

DESCRIPTION: **PUMP, HYDR** 0.5HP/480/60/3PH

PART/DOC. #: **444496**

SPECIFICATION: This specification is for a pump/motor/reservoir/valve assembly that is purchased as a complete unit. Used on: UV4000 LOW FLOW Electronic Ballast Hydraulic Systems.

Motor: **KMC22**
- 0.5 HP
- 1725 RPM
- 230 V/460 V
- 3 Phase
- 60 Hertz
- Totally Enclosed, Fan Cooled (TEFC) Enclosure
- 1.15 (or better) Service Factor

Pump: **KP12**
- Displacement: 1.2 cc/rev (0.46 gpm US)

Endhead: **KN11**

Integral Valving: **V-7** Adjustable plunger relief valve kit

Reservoir: **KR52**
- Material: Plastic
- Capacity: 2.0 gallons US

Plumbing: **KV** (vertical inlet kit)

Manifold Valve: **KB11**
- Single manifold block for CETOP 3-Valve S.A.E. ports
- Modified to add two ports with isolation plugs between them

Directional Control Valve: **DG4V3S-8C-VM-FW-B5-60-EN21**
- DG4V3S: Standard Performance
- 8C: Spool Type: P-T A-B spring centred
- V: Solenoid "A" is a port "A" end; solenoid "B" is a port "B" end
- FW: 115V AC coil
- B: Standard AC coil rating
- 5: for standard performance models
- 60: Design number
- EN21: CSA Approved

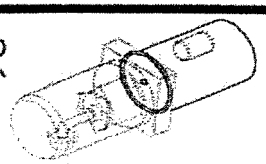
Filter: **SPE 15-25**
25 Micron element
¾" NPT ports
20 GPM return
5 GPM suction
All support tubing and fittings to be stainless steel
(no gauge required)
Add tee (and necessary connectors) to attach a ¼" tube to the existing tubing before the filter.

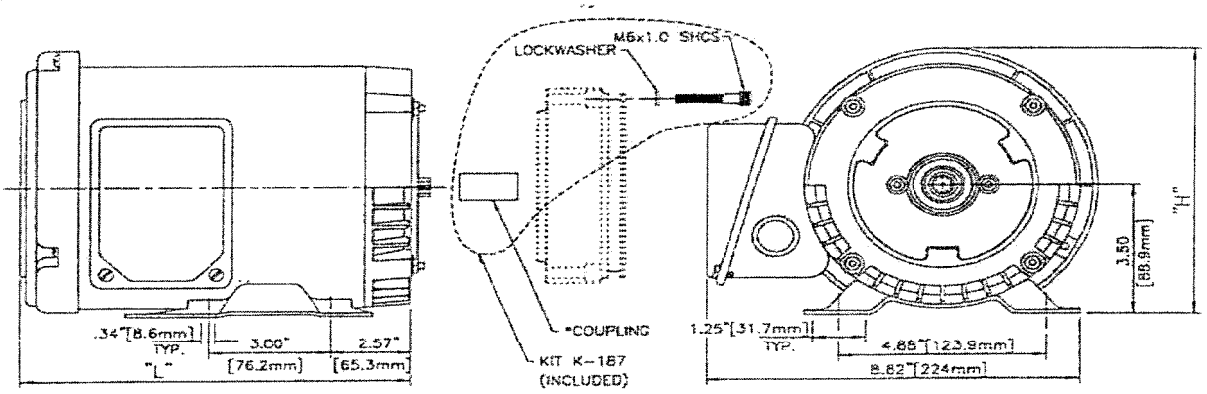
SOURCE OF SUPPLY:

BERENDSEN FLUID POWER LTD
105 Midpark Road, Units 1 & 2
London, ON
N6N 1B2
(519) 681-3350

FOR ADDITIONAL INFORMATION SEE ATTACHED SHEETS

Fenner Fluid Power DISTRIBUTOR POWER UNIT PROGRAM





CW ROTATION

MOTOR UNIT	MAXIMUM DIM. "L"	MAXIMUM DIM. "H"
MC22	11.19"[284.2mm]	7.18"[182.4mm]
MC24	11.19"[284.2mm]	7.18"[182.4mm]

ALL MOTORS ARE TOTALLY ENCLOSED, FAN-COOLED (TEFC).

MOTORS ARE CONTINUOUS DUTY BUT CAN NOT BE USED ABOVE THEIR RATED HORSEPOWER, REGARDLESS OF DUTY CYCLE, AND MUST HAVE FULL VOLTAGE TO ACHIEVE RATED HORSEPOWER.

*NOTE: FOR CONTINUOUS APPLICATIONS FENNER RECOMMENDS COUPLING CHANGED EVERY 5,000 HOURS OF USE.

FOR FLOWS OVER 3 U.S. GPM (11 LPM), USE 1413-AA FILTER.

NOTE: FENNER USES A NETWORK OF QUALIFIED SUPPLIERS TO ENSURE AVAILABILITY. THERE ARE MINOR DIMENSIONAL AND COSMETIC DIFFERENCES BETWEEN VENDOR'S PRODUCTS.

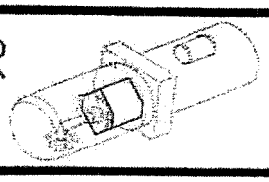
PUMP / MOTOR	KP08	KP10	KP12	KP16	KP20	KP25	KP31	KP40	KP50	KP63	KP80
KMC22 1/2HP 1725 RPM, 3PH 230/460v 60Hz	.29 GPM 2150 PSI 1.1 LPM 150 BAR	.35 GPM 1700 PSI 1.4 LPM 120 BAR	.45 GPM ~~1200 PSI~~ 1.8 LPM 100 BAR	.65 GPM 1050 PSI 2.5 LPM 75 BAR	.84 GPM 850 PSI 3.3 LPM 60 BAR	1.1 GPM 650 PSI 4.2 LPM 45 BAR	1.3 GPM 500 PSI 5.2 LPM 35 BAR	1.7 GPM 400 PSI 6.7 LPM 25 BAR	2.2 GPM 300 PSI 8.5 LPM 20 BAR	2.8 GPM 200 PSI 11 LPM 14 BAR	3.5 GPM 100 PSI 14 LPM 7 BAR
KMC24 1HP 1725 RPM, 3PH 230/460v 60Hz	.22 GPM 4300 PSI 0.9 LPM 300 BAR	.26 GPM 3450 PSI 1.0 LPM 240 BAR	.38 GPM 2850 PSI 1.5 LPM 200 BAR	.59 GPM 2150 PSI 2.3 LPM 150 BAR	.8 GPM 1700 PSI 3.1 LPM 115 BAR	1.0 GPM 1350 PSI 4.0 LPM 95 BAR	1.3 GPM 1100 PSI 5.0 LPM 75 BAR	1.7 GPM 800 PSI 6.5 LPM 55 BAR	2.2 GPM 650 PSI 8.3 LPM 45 BAR	2.7 GPM 450 PSI 11 LPM 30 BAR	3.5 GPM 300 PSI 14 LPM 20 BAR

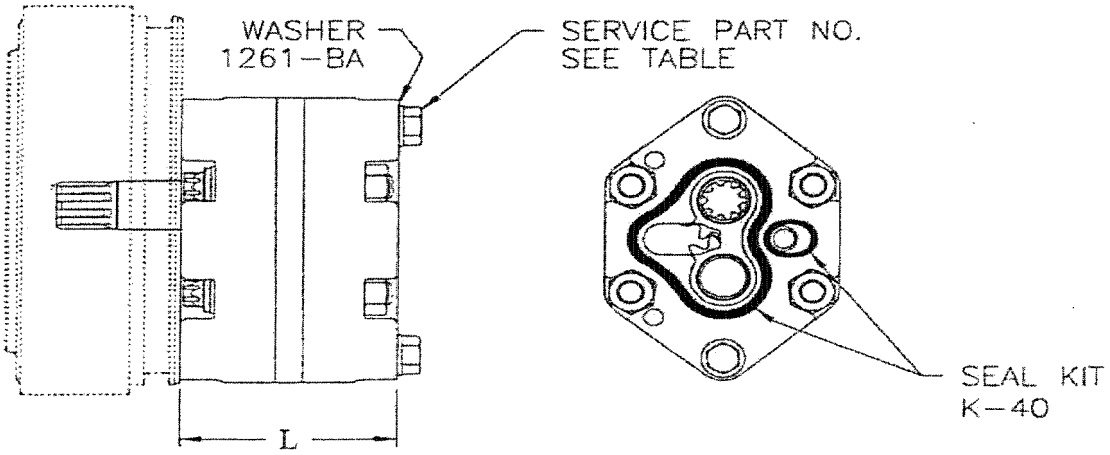
PERFORMANCE AT 45 CST (200 SSU) AND 90% MECHANICAL EFFICIENCY. GPM'S ARE U.S. VALUES.

CHANGE	TITLE	SCALE	REV.
ADDED INCLUDED TO K-187. (REF: ECO# 970718B)	CONTINUOUS DUTY 3 PH AC MOTORS	NONE	D
DRAWN: MM / DATE: 12-AUG-97 / CHECK: MM / DATE: 10-15-97	PAGE 4 OF 4	PART NO.: KMC____	

Fenner Fluid Power

DISTRIBUTOR POWER UNIT PROGRAM





- KIT INCLUDES WASHERS AND METRIC MOUNTING BOLTS.
- USE ALL WASHERS.
- MOUNTING BOLTS ARE GRADE 5. DO NOT SUBSTITUTE.

KP10 CAN NOT BE USED IN DUPLEX PUMP APPLICATIONS.

KIT NO.	DISPLACEMENT		LENGTH		MAXIMUM RPM	MAXIMUM PRESS.		SERVICE BOLT PART NO.
	CC/REV	CIPR	mm	INCH		CONT. PSI / BAR	INTERMIT. PSI / BAR	
KP08	0.8	0.049	57	2.25	5000	5000/350	5000/350	2824-AA
KP10	1.0	0.061	58	2.28	5000	5000/350	5000/350	2824-AA
KP12	1.2	0.073	59	2.32	5000	5000/350	5000/350	2825-AA
KP16	1.6	0.098	60	2.38	5000	5000/350	5000/350	2825-AA
KP20	2.0	0.122	62	2.44	4000	5000/350	5000/350	2825-AA
KP25	2.5	0.153	64	2.52	4000	4600/320	5000/350	2826-AA
KP31	3.1	0.189	67	2.62	4000	3600/250	5000/350	2826-AA
KP40	4.0	0.244	70	2.75	4000	3000/200	4000/280	2826-AA
KP50	5.0	0.305	74	2.90	4000	2300/160	3200/220	2827-AA
KP63	6.3	0.384	79	3.11	3200	1800/125	2500/175	2827-AA
KP80	8.0	0.488	86	3.37	2400	1500/100	2000/140	2828-AA

A	CHANGE	DRAWN	DATE	CHECK	DATE
	ADDED NOTE, USE ALL WASHERS. (REF: ECO# 970718B)	MM	30-JULY-97		10-15-97

TITLE: PUMP KITS AFC SERIES

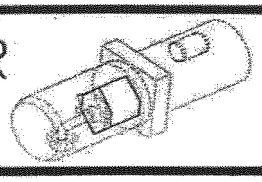
PAGE 1 OF 2

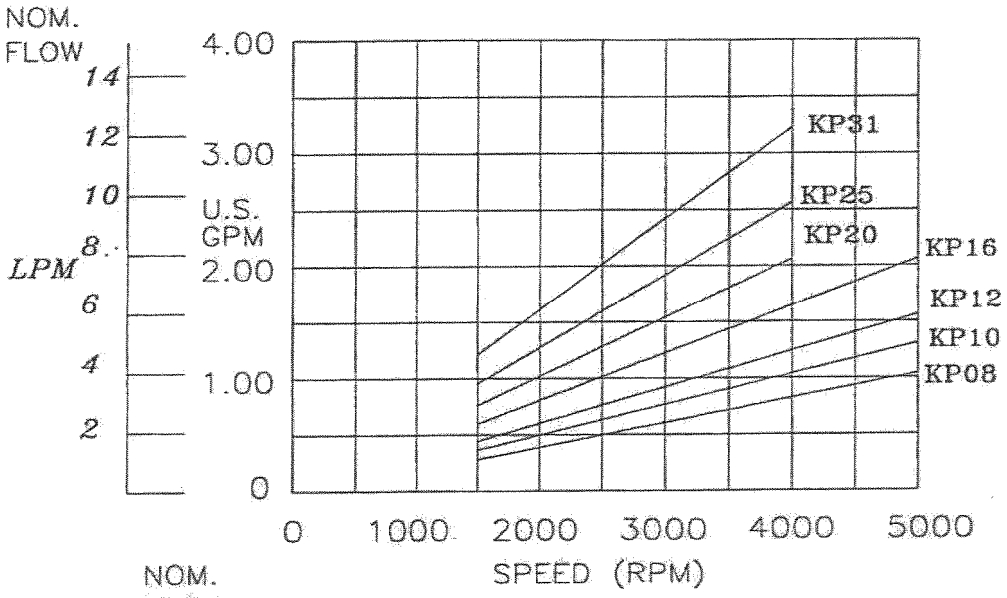
SCALE: NONE | REV.: B

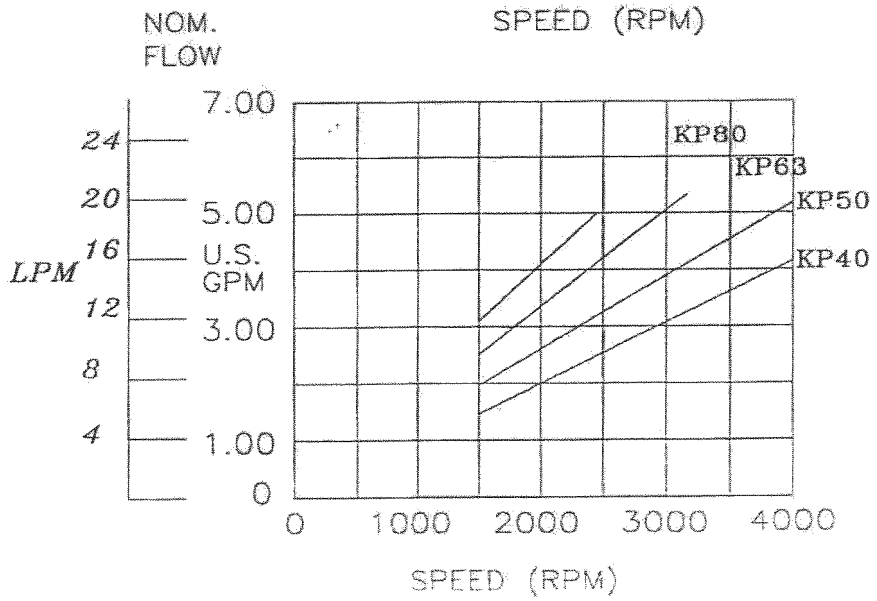
PART NO.: KP__

Fenner Fluid Power

DISTRIBUTOR POWER UNIT PROGRAM





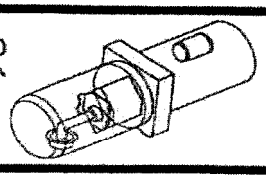


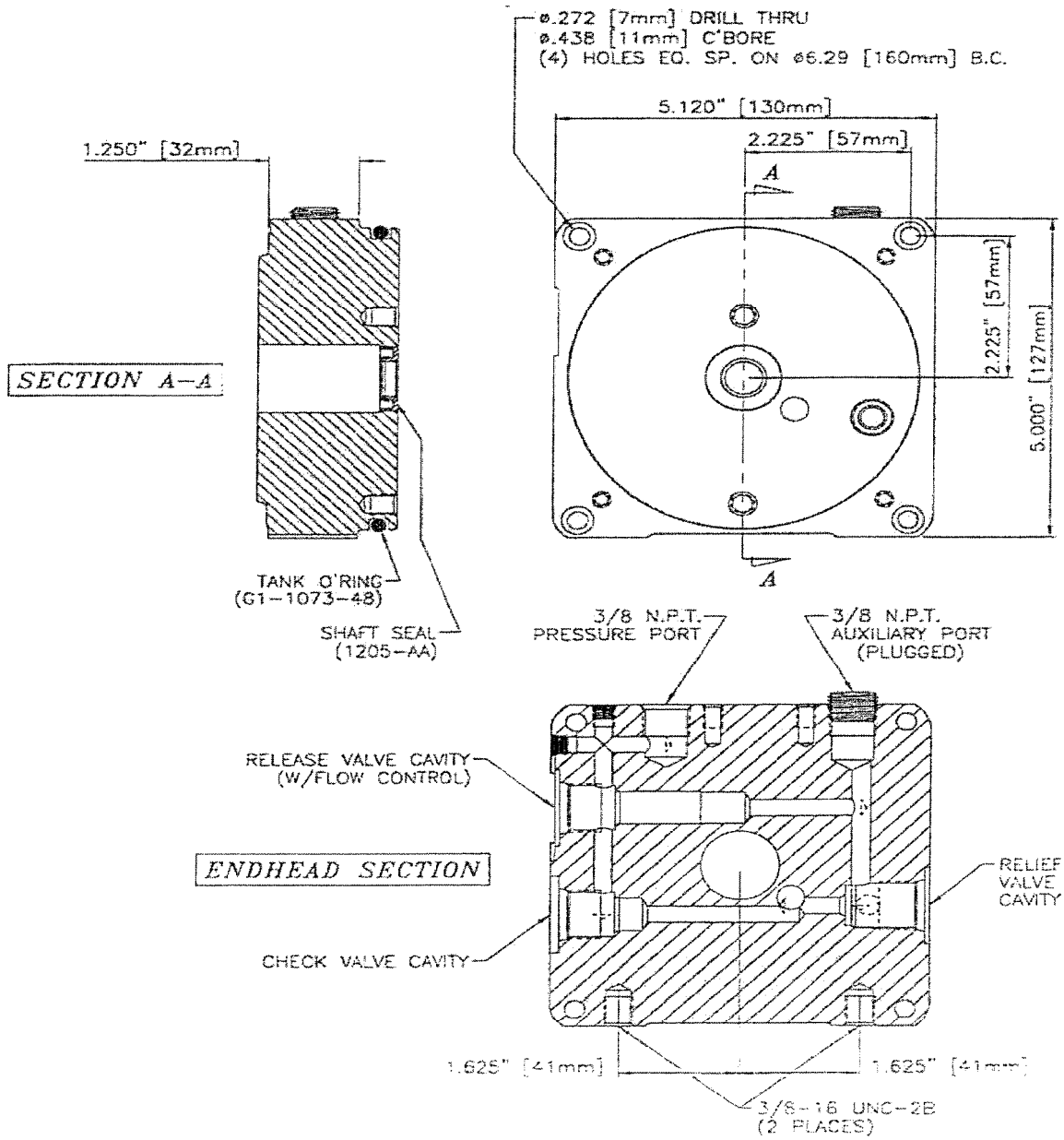
1500 RPM MIN. LIMIT

CHANGE	TITLE	SCALE	REV.
ADD METRIC SCALE	PUMP KITS AFC SERIES	NONE	B
DRAWN: GLC — DATE: 24-JUL-95 — CHECK: [illegible] — DATE: 10-15-97	PAGE 2 OF 2	PART NO. KP___	

Fenner Fluid Power

DISTRIBUTOR POWER UNIT PROGRAM

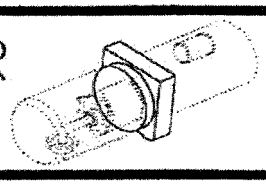


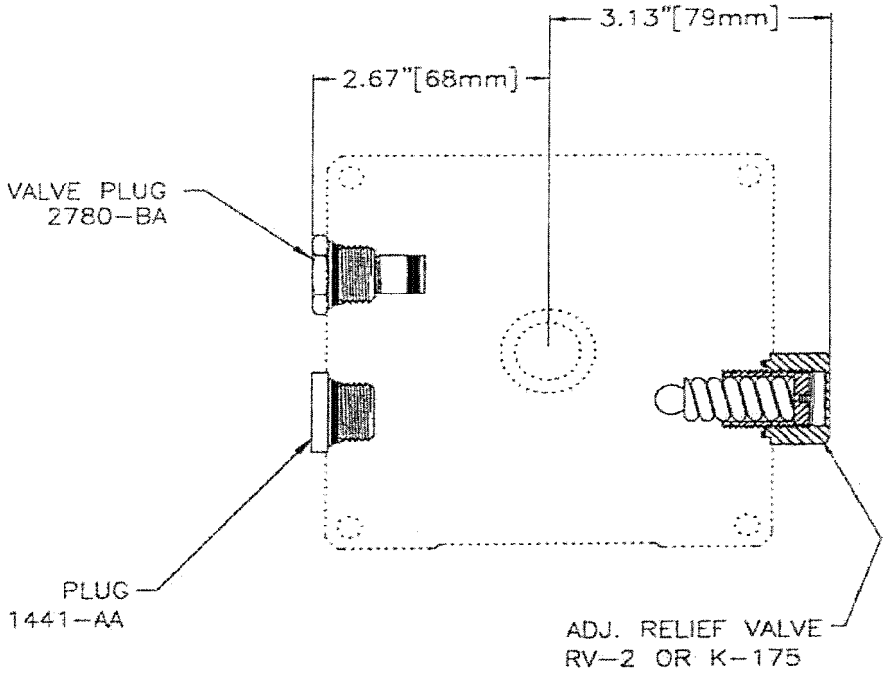


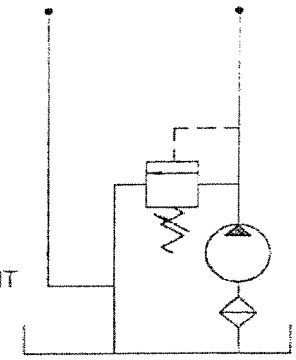
CHANGE				TITLE	SCALE	REV.
C'BORE ONE SIDE ONLY				ENDHEAD UNC FOOTMOUNTS N.P.T. PORTS	NONE	B
DRAWN	DATE	CHECK	DATE		PART NO.	
GLC	28-MAY-96	GH	10-15-97		KN11	

Fenner Fluid Power

DISTRIBUTOR POWER UNIT PROGRAM



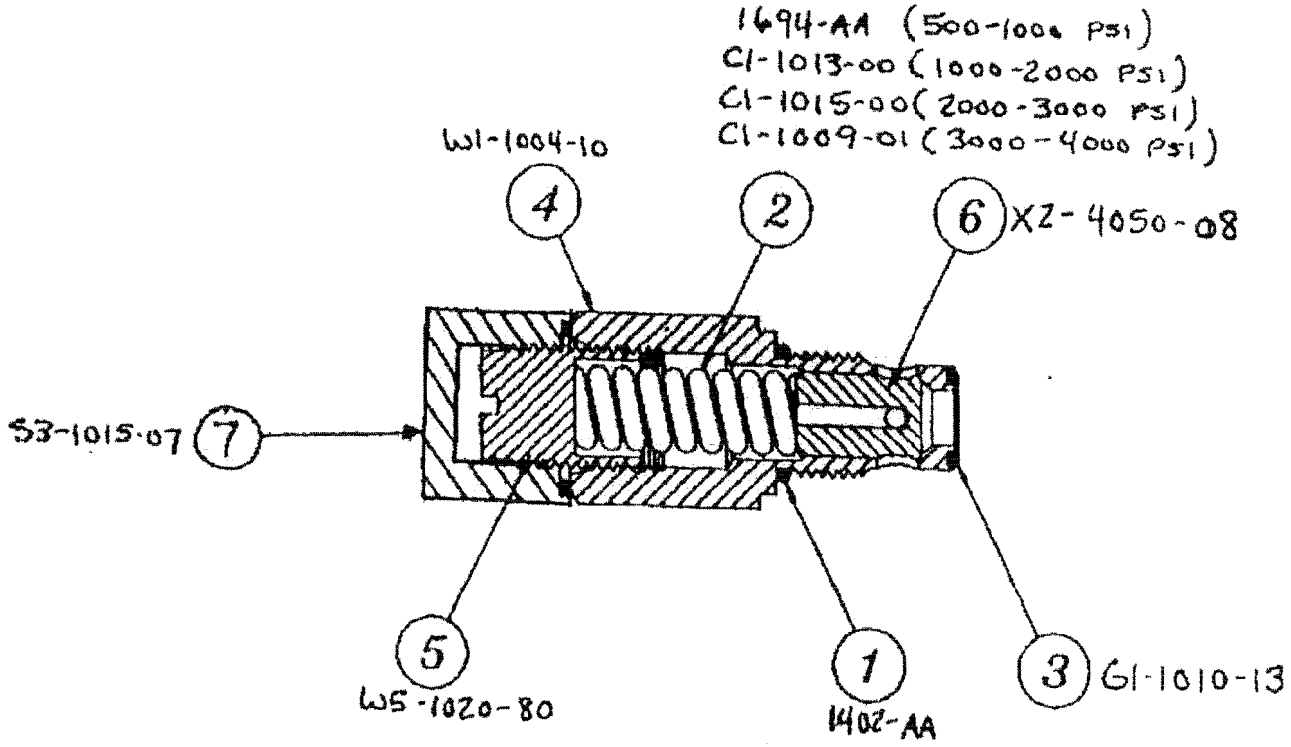




- KIT INCLUDES 4 COLOR-CODED RELIEF SPRINGS AS FOLLOWS: BLUE (500-1000 PSI)[34.5-69 BAR], GREEN (1000-2000 PSI)[69-138 BAR], RED (2000-3000 PSI) [138-207 BAR], BLACK (3000-4000 PSI)[207-276 BAR].
- OPTIONAL: (4000-5000 PSI)[276-345 BAR] RELIEF VALVE KIT AVAILABLE, ORDER PART NO. K-175.
- OPTIONAL: ORDER JF-0048 SPRING LOCATOR WHEN USING THE BLUE (500-1000 PSI)[34.5-69 BAR] SPRING.

CHANGE				TITLE	SCALE	REV.
ADDDED OPTION NOTES. (REF: ECO# 970718B)				RELIEF VALVE KIT	NONE	E
DRAWN	DATE	CHECK	DATE		PART NO.	
MM	6-AUG-97		10-15-97		KC08	

PART #444496



PART NUMBER [redacted]	THIS PRINT IS LOANED SUBJECT TO RECALL AT ANY TIME AND WITH THE UNDERSTANDING THAT IT WILL NOT BE USED IN ANY WAY DETRIMENTAL TO THE INTERESTS OF FENNER FLUID POWER, INC.			
	DRAWN [redacted]	DATE [redacted]	CHECKED [redacted]	DATE [redacted]
	USED ON			
	MT. FINISH			
	MATERIAL PER B/M			
	SUPERCEDES	SUPERCEDED BY		

Barry Gilmore

TITLE PLUNGER RELIEF ASSEMBLY

SCALE NONE | DRAWING NO. V-7 [redacted] | REV A

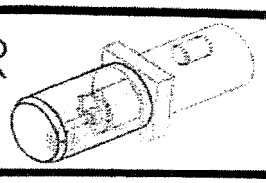
Fenner Fluid Power

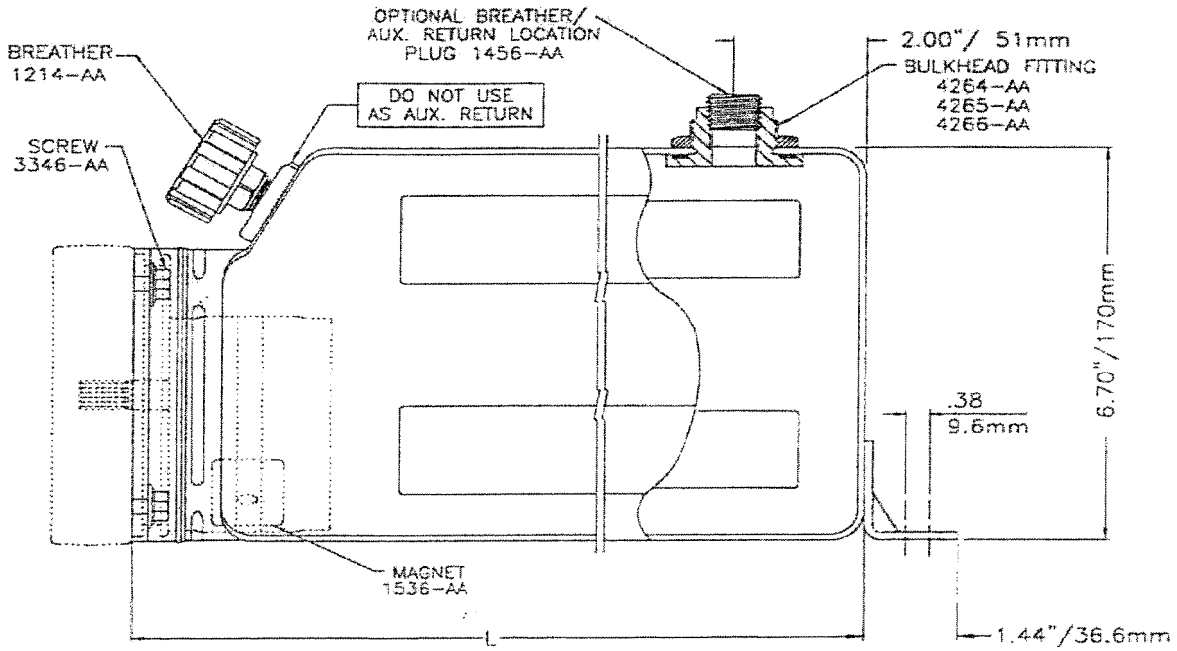
5885 11TH STREET
ROCKFORD, IL. 61109 U.S.A.

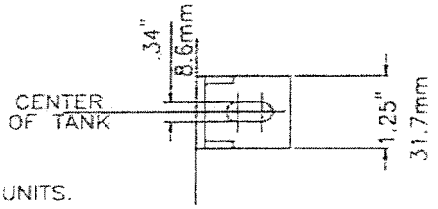
ASHTON ROAD
ROMFORD, RM3 8UA. ENGLAND

Fenner Fluid Power

DISTRIBUTOR POWER UNIT PROGRAM







- FOOT INCLUDED ON 1.5 GAL. AND LARGER.
- SHIMMING MAY BE REQUIRED AT INSTALLATION.
- DO NOT USE KR50 OR KR55 WITH DUPLEX PUMP UNITS.

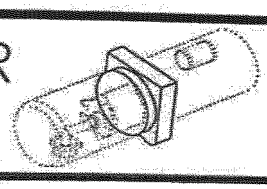
KIT NO.	NOMINAL CAPACITY (GALS.)	TANK LENGTH (L)		USEABLE OIL CAPACITY			
				VERTICAL		HORIZONTAL	
		mm	IN.	LITRE	CUBIC IN.	LITRE	CUBIC IN.
KR50	1.0	190.5	7.50	1.9	120	3.1	186
KR55	1.2	228.6	9.00	2.9	180	3.8	230
KR51	1.5	279.4	11.00	4.3	260	4.7	286
→ KR52	2.0	330.2	13.00	5.6	340	5.6	345
KR56	2.5	381.0	15.00	6.9	420	6.6	400
KR53	3.0	508.0	20.00	10.2	620	6.8	540
KR54	4.0	660.4	26.00	14.1	860	11.7	715

CHANGE	TITLE	SCALE	REV
REM'D FITTING 4191-AA (REF: ECO#970903A)	RESERVOIR PLASTIC 6.7"[170mm] OFFSET	NONE	F

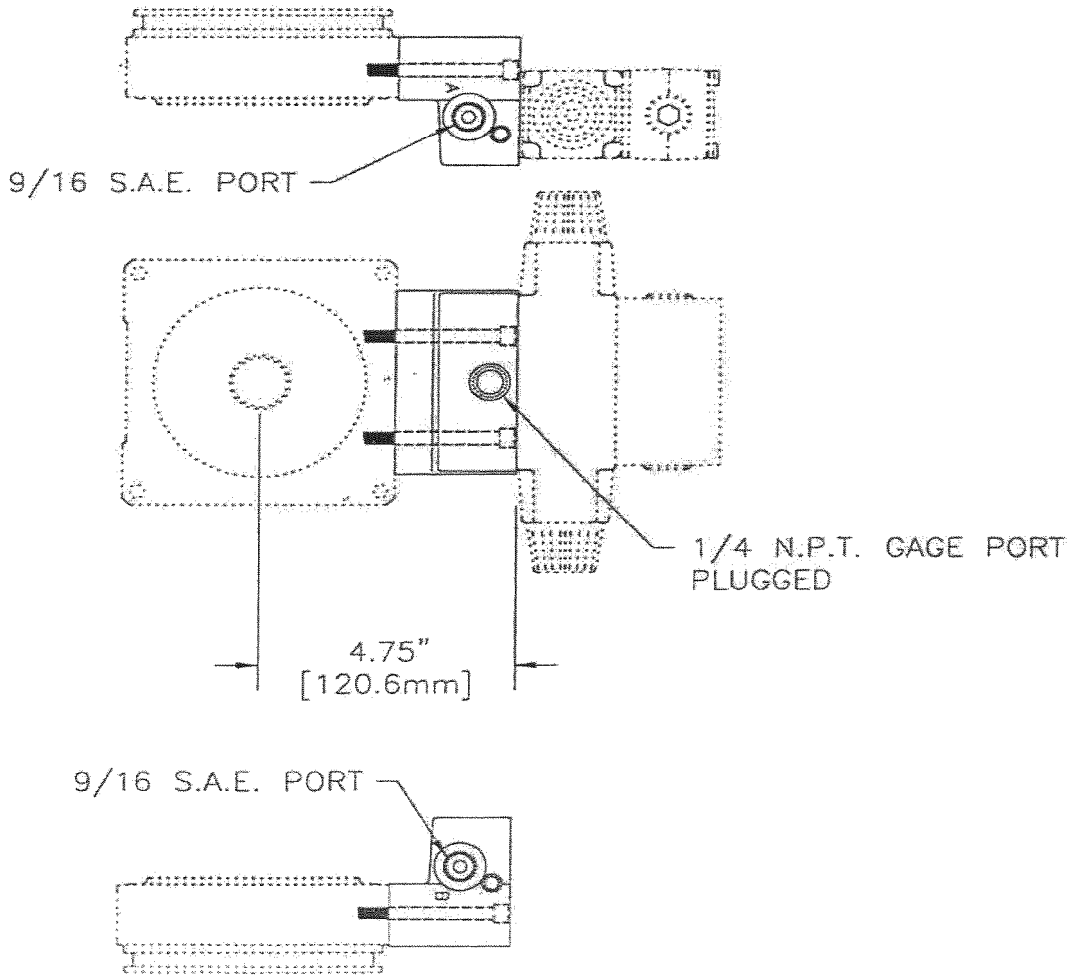
DRAWN	DATE	CHECK	DATE	PART NO.
MM	08-SEP-97		11-5-97	KR5_

Fenner Fluid Power

DISTRIBUTOR POWER UNIT PROGRAM



- KIT INCLUDES ALL SEALS AND MOUNTING HARDWARE.
- CETOP VALVE NOT INCLUDED.



CHANGE	TITLE	SCALE	REV.
ADD METRIC DIMS.	SINGLE MANIFOLD BLOCK FOR CETOP 3-VALVE S.A.E. PORTS	NONE	B

DRAWN	DATE	CHECK	DATE	PART NO.
GLC	24-JUL-95		10-15-97	KB11

TYPICAL MODEL CODES AND RELATED LITERATURE

DG4V-3(S) -** * (L) – (**) – (V) M – (S *) - ***** (L) - * * - 60 – (EN ***) – (P ** - A ** - B ** - T **)

[1] [2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13]

[1] Standard or High Performance

[2] Spool Type

[3] Spool Spring Arrangement (8 Options)

[4] Manual Override Option

[5] Solenoid Energization Identy

[7] Spool Indicator Switch (5 options)

[6] Solenoid Type Connections (10 configurations)

[8] Indicator Lights

[9] Coil Rating (10 AC and DC options

[10] Port T Rating (4 pressure levels)

[11] Design Number, 60 Series

[12] Special Features (EN numbers as required)

[13] Port Restrictor Plugs

Features within brackets ( ) are optional All other features must be specified when ordering.

For more information on these directional control valves, refer to GB-C-2015.

Solenoid Operated
Soft Shift
DG4V-3S-2A208-VM-FT-GH5-60

Hydraulically Operated
DG3V-3-2A-T-P1-7-S-60

Lever Operated
DG17V-3-2A-60

Air Operated
DG-18V-3-2A-P2-V-T-60

CAM Operated
DG20V-3-2A-60

Plunger Operated
DG21V-3-A(L)-2-60

****DG4V3S-8C-VN-FW-B5-60-EN21 is the valve that will be supplied with your power unit.**

Installation Dimensions

Models for use with ISO 4400 (DIN 43650) connectors

3rd angle projection

Double solenoid models ▲
DG4V-3(S)-*C-**-(V)M-U-**-60
DG4V-3(S)-*N-**-(V)M-U-**-60

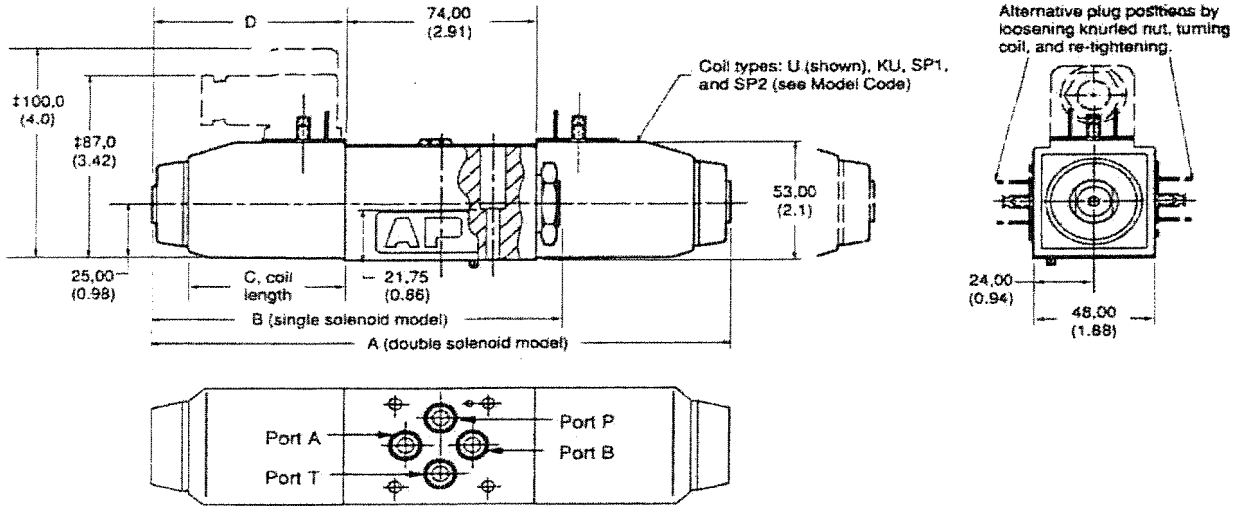
Single solenoid models ▲
DG4V-3(S)-*A(-**)■
DG4V-3(S)-*B(-**)■
DG4V-3(S)-8BL(-**)
DG3V-3(S)-*F■

As shown

DG4V-3(S)-*AL(-**)■
DG4V-3(S)-*BL(-**)■
DG4V-3(S)-8B(-**)
DG4V-3(S)-*FL(-**)■

Solenoid and end cap interchanged

Dim mm (in.)



■ *Not applicable to type "8" spool.*
▲ *For solenoid identities see table on page 16.*
‡ *Can vary dependent on source of plug.*

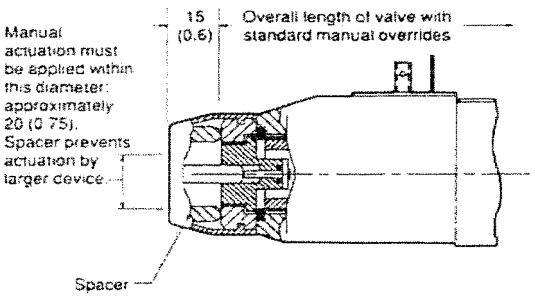
Model type	AC or DC	A Dim.	B Dim.	C Dim.	D Dim.
All	DC ⎓	220 (8.66)	156 (6.14)	61 (2.5)	73 (2.87)
DG4V-3	AC ~	200 (7.87)	146 (5.75)	51 (2.1)	63 (2.48)
DG4V-3S	AC ~	200 (7.87)	146 (5.75)	45 (1.7)	63 (2.48)

Water-resistant manual override on solenoid

DG4V-3(S)-****(L)-H-(V)M-**-**-60

Application

General use where finger operation is required (standard manual overrides cannot be operated without using small tool).



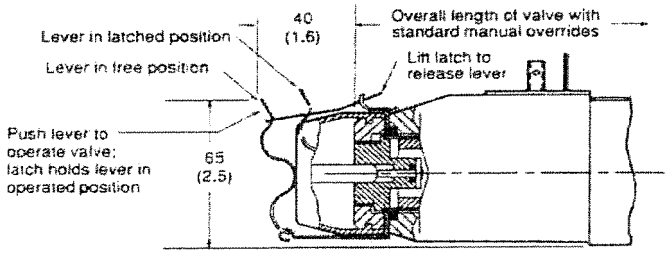
Note:
"H" feature is not field convertible from other models; specify with order.

Latching manual override on solenoid

DG4V-3-****(L)-Y-(V)M-**-**-60
DG4V-3S-****(L)-Y-(V)M-**-**-60, DC coil models only

Application

Stainless steel lever/latch mechanism and water-resistant seal make this feature ideal for vehicle-mounted and exposed applications requiring emergency selection of valve for a period of time in the event of electrical failure.



Notes:
1. *Opposite solenoid (on "C" and "N" double solenoid models) should not be energized while the valve is latched in selected position; AC solenoid coils will burn out under this improper usage.*
2. *"Y" feature is field-convertible from "H" type manual override (omitting spacer), but is not field-convertible from other models.*

Spare parts data

Refer to service drawing I–3886–S for spare parts and kit information.

Seal kits

For valves with spool indicator switch, model types DG4V-3-*A---M-S*---60 ..... kit no. 859049
For other models seal kits vary according to type of coil fitted:
For "U" type coil ..... kit no. 858995
For "F" type coil ..... kit no. 858996

Note: Each seal kit covers a variety of models and may have redundant seals for a particular model.

Solenoid Coils

AC coils

Code	Voltage/ frequency	Standard performance "U" type	Standard performance "F" type	High performance "U" type	High performance "F" type
Full power coils:					
A	110V/50 Hz	02-101725	02-101730	507825	508166
B	110/120V/50/60 Hz	02-101726	02-101731	507833	508169
C	220V/50 Hz	02-101727	02-101732	507826	508167
D	220/240V/50/60 Hz	02-101728	02-101733	507834	508170
Low power coils:					
BL	110/120V/50/60 Hz	N/A	N/A	598562	698563
DL	220/240V/50/60 Hz	N/A	N/A	866455	866457

DC coils *(Standard and high performance)*

Code	Voltage	"U" type	"F" type	"SP1" type	"SP2" type	"KU" type
Full power coils:						
G	12V	507847	508172	02–111246	02-111166	02–140394
H	24V	507848	508173	02–111248	02-111168	02–140395
Low power coils:						
GL	12V	507855	508175	N/A	N/A	N/A
HL	24V	507852	508174	N/A	N/A	N/A

Mass, approx. kg (lb)

DG4V-3 and DG4V-3S (DC)	"U" coils	"F" coils
Single sol. valve	1,6 (3.5)	1,8 (4.0)
Double sol. valve	2,2 (4.8)	2,3 (5.0)
DG4V-3 and DG4V-3S (AC)	"U" coils	"F" coils
Single sol. valve	1,5 (3.3)	1,6 (3.5)
Double sol. valve	1,8 (4.0)	2,0 (4.4)
Single sol. valve w/ position switch	2,0 (4.4)	2,0 (4.4)

Mounting Attitude

No restrictions except for no-spring, detented models DG4V-3-*N and DG4V-3S-*N which should be mounted with the spool axis horizontal. These model types may be affected by severe vibration or shock, especially if a solenoid is not held energized.

Temperature Limits

Ambient range .... -20°C to 70°C
(-4°F to +158°F)

Fluid Temperature

Fluid Temp.	Mineral oil	Water containing
Minimum	-20°C (-4°F)	+10°C (+50°F)
Maximum*	+70°C (+158°F)	+54°C (+129°F)

** To obtain optimum service life from both fluid and hydraulic system, 65° C (150° F) is the recommended maximum fluid temperature, except for water-containing fluids.*

For synthetic fluids, consult fluid manufacturer or Vickers representative where limits are outside those for mineral oil.

Whatever the actual temperature range, ensure that fluid viscosities stay within the limits specified in "Hydraulic Fluids".

Fluid Cleanliness

Proper fluid condition is essential for long and satisfactory life of hydraulic components and systems. Hydraulic fluid must have the correct balance of cleanliness, materials and additives for protection against wear of components, elevated viscosity and inclusion of air.

Essential information on the correct methods for treating hydraulic fluid is included in Vickers publication 561;"Vickers Guide to Systemic Contamination Control," available from your local Vickers distributor or by contacting Vickers, Incorporated. Recommendations on filtration and the selection of products to control fluid condition are included in 561.

Recommended cleanliness levels, using petroleum oil under common conditions, are based on the highest fluid pressure levels in the system and are coded in the chart below. Fluids other than petroleum, severe service cycles or temperature extremes are cause for adjustment of these cleanliness codes. See Vickers publication 561 for exact details.

Vickers products, as any components, will operate with apparent satisfaction in fluids with higher cleanliness codes than those described. Other manufacturers will often recommend levels above those specified.

Experience has shown, however, that life of any hydraulic components is shortened in fluids with higher cleanliness codes than those listed below. These codes have been proven to provide a long trouble-free service life for the products shown, regardless of the manufacturer.

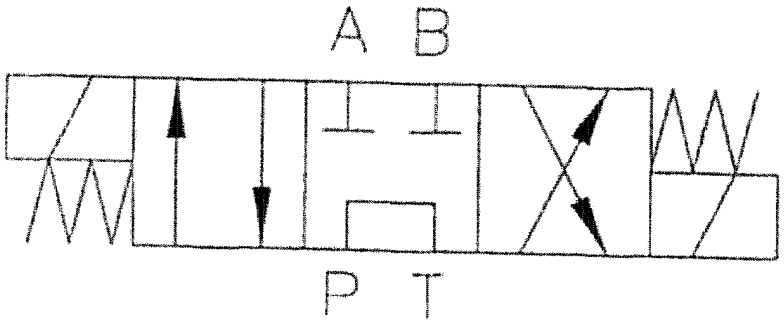
Fire resistant fluids usually have higher specific gravities than oil. The specific gravity of a fluid may be obtained from its producer.

	System Pressure Level bar (psi)		
Product	**<70 (<2000)**	**70–207 (2000–3000)**	**207+ (3000+)**
Vane pumps, fixed	20/18/15	19/17/14	18/16/13
Vane pumps, variable	18/16/14	17/15/13	
Piston pumps, fixed	19/17/15	18/16/14	17/15/13
Piston pumps, variable	18/16/14	17/15/13	16/14/12
Directional valves	20/18/15	20/18/15	19/17/14
Proportional valves	17/15/12	17/15/12	15/13/11
Servo valves	16/14/11	16/14/11	15/13/10
Pressure/Flow controls	19/17/14	19/17/14	19/17/14
Cylinders	20/18/15	20/18/15	20/18/15
Vane motors	20/18/15	19/17/14	18/16/13
Axial piston motors	19/17/14	18/16/13	17/15/12

Ordering Procedure

When placing an order, please specify full model designations of valves, subplates and kits. Refer to relevant "Model Code" sections.

SCHEMATIC REPRESENTATION OF VICKERS DIRECTIONAL CONTROL VALVE VICKERS P/N: DG4V3S-8C-VM-U1-B5-60-EN21



Filtration

Return or Suction Spin-On Filter

SP07, SP15, SP16, SP25 Series

Specifications

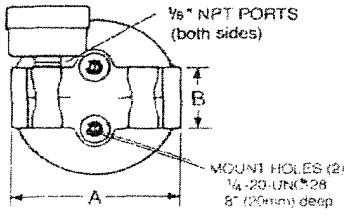
- 200 PSI working pressure
- Flows up to 20 GPM for return and 5 GPM for suction line applications
- For use with petroleum and water based fluids; for other fluids – consult factory
- Operating temperature –22°F to +250°F (–30°C to +121°C)
- Aluminum casting and Buna-N seals

Options

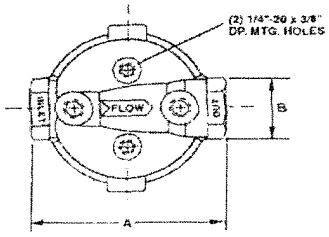
- Beta-3 and Beta-10 Absolute elements
- Extra capacity 10 or 25 micron nominal cellulose elements
- 10 micron water absorbing elements
- 140 micron stainless wire mesh elements
- $^1/_4$", $^3/_8$", $^1/_2$", $^3/_4$", 1" NPT and $^9/_{16}$", $1^1/_{16}$" SAE ports
- Visual or electrical indicators
- **Private labeling of elements available – consult factory**

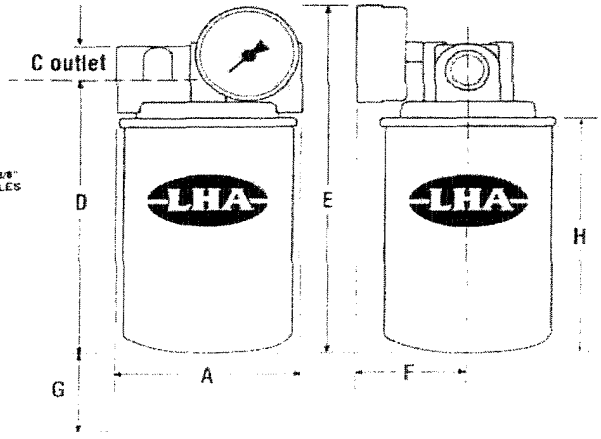
Dimensional Details

SP15 / 16 /25



SP07





G = Element removal clearance

Filter Series		A	B	C	D	E	F	G	H	Port Size
SP07	in.	3.05	1.50	0.56	3.94	5.75	N/A	0.04	3.38	See Pg. 1.02 for port options
	mm.	77.5	38.1	14.2	100	146	N/A	10.2	85.9	–
SP15	in.	3.74	1.48	0.75	6.19	7.61	2.30	0.79	5.06	See Pg. 1.02 for port options
	mm.	95.0	37.6	19.0	157	193	59.5	20.0	128	–
SP16	in.	3.74	1.48	0.75	6.39	7.63	2.30	0.79	5.84	See Pg. 1.02 for port options
	mm.	95.0	37.6	19.0	162	193	59.5	20.0	148	–
SP25	in.	3.74	1.48	0.75	9.50	10.9	2.30	0.79	8.66	See Pg. 1.02 for port options
	mm.	95.0	37.6	19.0	241	277	59.5	20.0	220	–

Filtration

Return or Suction Spin-On Filter

SP07, SP15, SP16, SP25 Series

FILTRATION

Ordering Information

SP15 N A G N O

Series	
SP07	UNF Post
SP15	UNF Post
SP16	BSP Post
SP25	UNF Post

	Port Type	Series
G	1/4" NPT	07
I	3/8" NPT	07
J	9/16"-18 SAE	07
K	1/2" NPT	15, 25
N	3/4" NPT	15, 16, 25
P	1" NPT	15, 25
S	1 1/16"-12 SAE	15, 25

Code	Element	Series
A	10 Micron Nominal Cellulose	All
B	25 Micron Nominal Cellulose	07, 15, 25
H	10 Micron Water Absorbing	15
J	Beta-3 Absolute Synthetic	15, 25
R	Beta-10 Absolute Synthetic	15, 25
W	140 Micron Absolute Stainless Wire Mesh	15

	Indicator Location	Series
0	None	All
1	Return	15, 16, 25
2	Suction	15, 16, 25
3	Suction & Return	15, 16, 25
4	Top Return	07
5	Top Suction	07

	Indicator	Series
EP	Electrical Return	All
EV	Electrical Suction	All
N	None	All
V	Visual	All

	Bypass Valve Setting	Series
C	18 PSI	07
D	Blocked Bypass	All
E	2 1/2 PSI	15, 16, 25
G	15 PSI	15, 16, 25
H	25 PSI	All

Replacement Elements

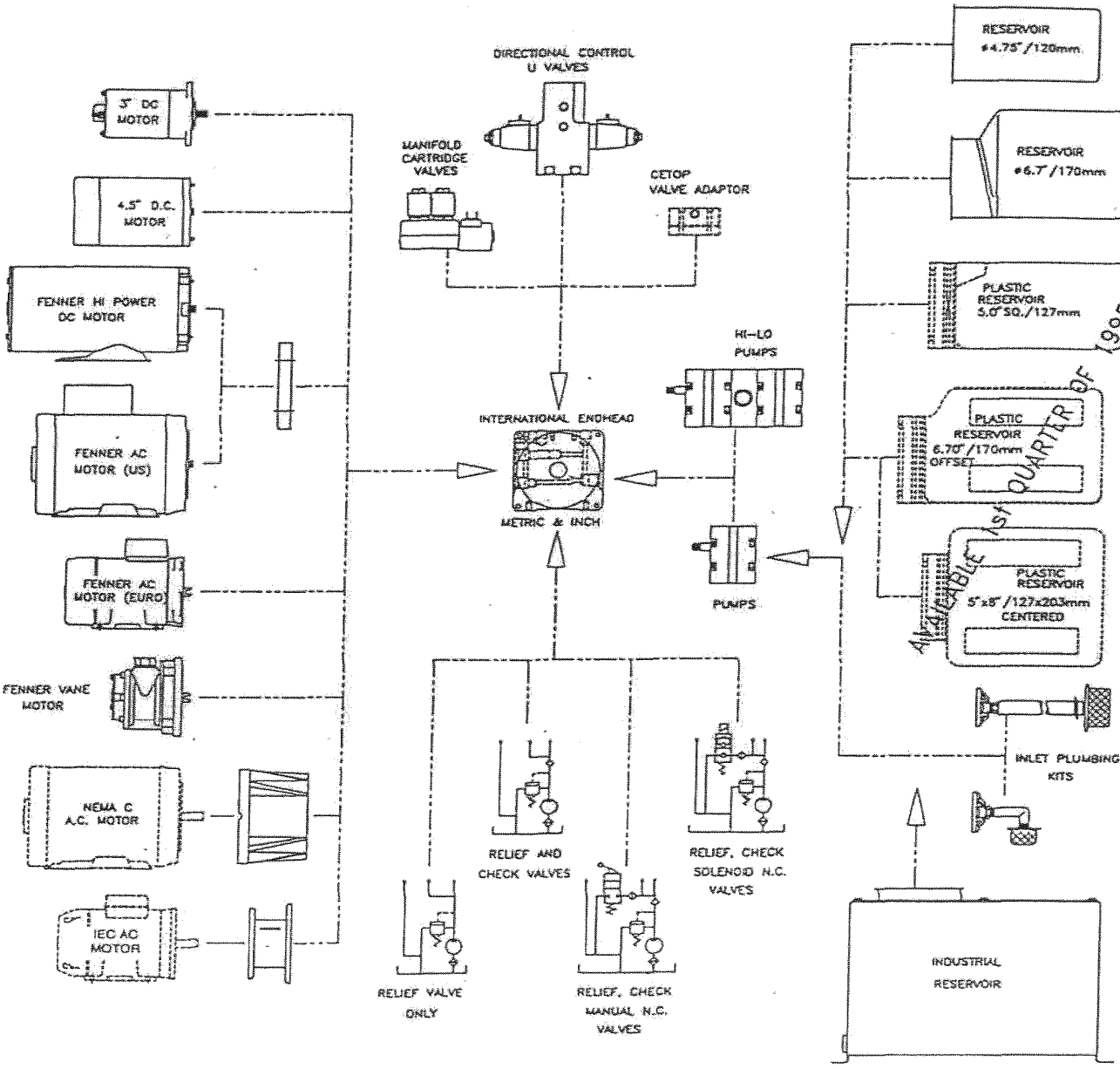
Part Number	Code	Filtration Area in²	Filtration Area cm²	Element Thread
SPE-07-10-D	A	117	755	3/4" UNF
SPE-07-10-C	A	117	755	3/4" UNF
SPE-07-10-H	A	117	755	3/4" UNF
SPE-07-25-D	B	117	755	3/4" UNF
SPE-07-25-C	B	117	755	3/4" UNF
SPE-07-25-H	B	117	755	3/4" UNF
SPE-15-10	A	547	3529	1"-12 UNF
SPE-15-25	B	547	3529	1"-12 UNF
SPE-15-BTA-3	J	391	2522	1"-12 UNF
SPE-15-BTA-10	R	366	2361	1"-12 UNF
SPE-15-H-10	H	547	3529	1"-12 UNF
SPE-15-140W	W	90	580	3/4" UNF
SPE-16-10	A	455	2938	3/4" BSP
SPE-25-10	A	947	6110	1"-12 UNF
SPE-25-25	B	947	6110	1"-12 UNF

Replacement Indicators

Part No.	Description	Type
EL-P-1	Return Indicator	Electrical
EL-V-2	Suction Indicator	Electrical
SP-15P	Return Indicator - numeric scale	Visual
SP-15P-1	Return Indicator - 15 PSI color coded	Visual
SP-15P-2	Return Indicator - 25 PSI color coded	Visual
SP-15V	Suction Indicator	Visual

For Pressure Drop Curve Data See Page 1.16
For Filter Indicator Specifications See Page 1.20

OPTIONS CHART



MOTORS	PUMPS	ENDHEAD	INTEGRAL VALVING	RESERVOIRS AND PLUMBING	MANIFOLD VALVES	ELECTRICAL ACCESSORIES
KM --	KP -- KU -	KN1 --	KC -- KFC -	KR -- KH KV	KB -- KCV - KDV -	KG -- KS -

2

PUMPS Displacements		
KP08	***0.049 cu.in/rev.***	***(0.8 cc/rev.)*** ←
KP10	0.061 cu.in/rev.	(1.0 cc/rev.)
KP12	0.073 cu.in/rev.	(1.2 cc/rev.)
KP16	0.098 cu.in/rev.	(1.6 cc/rev.)
KP20	0.122 cu.in/rev.	(2.0 cc/rev.)
KP25	0.153 cu.in/rev.	(2.5 cc/rev.)
KP31	0.189 cu.in/rev.	(3.1 cc/rev.)
KP40	0.244 cu.in/rev.	(4.0 cc/rev.)
KP50	0.305 cu.in/rev.	(5.0 cc/rev.)
KP63	0.384 cu.in/rev.	(6.3 cc/rev.)
KP80	0.488 cu.in/rev.	(8.0 cc/rev.)

UNLOAD VALVE (Optional)		
	Unload Setting	Adjustment Range
KU2	300 psi (20 bar)	300-450 psi (20-30 bar)
KU4	600 psi (40 bar)	500-1000 psi (20-30 bar)

3

ENDHEAD	
KN10	G3/8 Pressure & Return Ports
KN11	***3/8 NPT Pressure & Return Ports*** ←
KN12	9/16 SAE Pressure & Return Ports (Manifold Valve cannot be utilised)

4

INTEGRAL VALVES	
KC01*	Relief, Check & Sol. Rel. Kit
KC03	Relief, Check & Manual Rel. Kit
KC05*	Relief, Check & Manual Rel. Kit with Microswitch
KC07	***Relief & Check Kit*** ←
KC08	Relief Kit
KC14	*Relief, Check & Pneumatic Rel. Valve Kit*
KC15	Relief, Check & Manual Rel. without Switch
KC18	Relief, Check & Level Rel. Valve Kit
	**Add Suffix*
	C = 12V DC Stud F = 24VDC Stud
	H = 230V AC Din J = 115V AC Din
	Other Options Available - Consult Fenner

5

RESERVOIR	Nominal Capacity US Gals.	(hrs)	Nominal Capacity US Gals.	(hrs)	Nominal Capacity US Gals.	(hrs)
KR12	0.50	(1.90)	90	(1.4)	85	(1.3)
KR14	0.75	(2.85)	135	(2.1)	145	(2.3)
KR15	1.00	(3.80)	170	(2.7)	200	(3.2)
KR40	1.00	(3.80)	170	(2.7)	100	(1.5)
KR45	1.25	(4.75)	200	(3.2)	160	(2.4)
KR41	1.50	(5.70)	270	(4.2)	220	(3.8)
KR42	2.00	(7.60)	360	(5.6)	340	(5.4)
KR46	2.50	(9.50)	390	(6.4)	380	(6.2)
KR43	3.00	(11.40)	500	(8.2)	520	(8.5)
KR44	4.00	(15.20)	600	(9.8)	650	(10.6)

Note: If accessories are needed, please add part number(s) to the end of order.

6

PLUMBING	
KH	Horizontal
KV	***Vertical***

These plumbing kits are rated for 3 gpm (11.4 l/min) maximum.

For flows higher than 3 gpm (11.4 l/min) order a 1413-AA Filter.

INTEGRAL VALVES			
C17	Double Pilot Operated Check Valve Kit Used on KDV1, KDV2, KDV3 & KDV4. Directional Control Valves	KFC2	Flow Control 0.5 gpm (1.9 l/min)
		KFC4	Flow Control 1.0 gpm (3.8 l/min)
		KFC6	Flow Control 1.5 gpm (5.7 l/min)
KB10	Single CETOP 3 Manifold (BSPP Ports)	KFC8	Flow Control 2.0 gpm (7.6 l/min)
KB11	***Single CETOP 3 Manifold (S.A.E. Ports)***	KG11	Cont. Handset for Single-Acting Unit
KCV1	12V DC 2P4W Single Sol. Dir. Cont. Valve	KG12	Cont. Handset for 2P Double-Acting Unit
KDV1	12V DC 3P4W Double Sol. Dir. Cont. Bottom Valve	KG13	Cont. Handset for 3P Double-Acting Unit
		KS1	12V Internal Ground Single Terminal
KDV4	12V DC 3P4W Double Sol. Dir. Cont. Valve	KS2	24V Internal Ground Single Terminal
		KS3	12V External Ground 2 Terminals
		KS4	24V External Ground 2 Terminals

NOTE: **When using KCV1, KDV1, KDV2, KDV3 or KDV4 with any KR4N Series Reservoir, please add a "K-29" Valve Spacer Block**

Berendsen
Fluid Power Ltd.

Customer Name: TROJAN TECHNOLOGIES INC.

Project Title: Fenner Power Unit & Filtration Package

B.F.P. Job Number: F97-0003A

Sales Branch: 105 Midpark Road
Unit 1 & 2
London, Ontario
N6N 1B2
Tel: (519) 681-3350
Fax: (519) 681-2196

Berendsen Fluid Power

ACCESSORIES	ANCHOR	Port Flanges
	BEAR	Pressure Switches
	HEDLAND	Flow Meters
	HYDRO-CRAFT	Clamping Devices
	LAKE	Flow Meters
	LHA	Gauges, Reservoir Accessories
	MAGNALOY	Couplings
	MARSH	Gauges
	TELEDYNE	Gauges
ACCUMULATORS	KOCSIS	*Bladder & Piston Type*
	OIL AIR	Bladder Type, Piston Type
	TOBUL	Piston Type
	VICKERS	Bladder Type
BRAKES	MICO	Failsafe, Wet & Dry, Brake System Components
CLUTCHES	PITTS	*Hydraulic & Industrial, Electro-Magnetic*
COOLERS	BLISSFIELD	Air-Oil, Water-Oil
	HAYDEN	Air-Oil, Water-Oil
	THERMAL TRANSFER	Air-Oil, Water-Oil
	VICKERS	Air-Oil, Water-Oil
CYLINDERS	CROSS	Agricultural
	HYDRO-LINE	NFPA Standard, Custom Hydraulic, Pneumatic, Agricultural
	PRINCE	Agricultural
	VICKERS T-J	NFPA Standard, Modified Hydraulic, Pneumatic, Agricultural
ELECTRONICS	PROPORTION AIR	*Electronic Pressure & Volume Controls*
	VICKERS	Positional Feedback Devices, Controllers, Amplifiers, Servo & Proportional Valves
FILTERS	FLOW-EZY	Low Pressure
	GRESEN	Low Pressure Mobile Cartridge Type
	LHA	Low Pressure
	TELEDYNE	Strainers
	VICKERS	Proactive Maintenance Products, Low, Medium, High Pressure Filters, Fluid Monitoring
FLOW DIVIDERS	BRAND	Mobile Spool Type
	DELTA	Gear Type
	FENNER	Low Flow Gear Type
	GRESEN	Mobile Spool Type
	PERMCO	Gear Type
	VICKERS	Spool Type
GEAR BOXES AND DRIVES	AUBURN GEAR	Shaft, Wheel, *Planetary Drives*
	HECO	Planetary Speed Reducers
	HUB CITY/FEDERAL	Pump Drives
	TRANSMITTAL BONFIGLIOLI	Planetary Gear Boxes
	ZERO-MAX HELLAND	Overhung Load Adapters
HYDROSTATIC DRIVES	SAUER-SUNDSTRAND	*Light, Medium & Heavy Duty*
	VICKERS	Medium Duty
MANIFOLDS	BERENDSEN	Custom Manifolds
	DAMAN	Bar Stock, Parallel & Series
	LHA	Bar Stock, Parallel & Series
	TELEDYNE	*Press Air Manifolds*
	VICKERS	*Screw In, DIN Slip In Logic & Custom*
MOTORS	CROSS	Gear Type
	FENNER	Vane Type Air
	GRESEN	Gear Type
	KYB	Radial Piston
	PERMCO	*Gear Type*
	ROSS	Geroler, Power Steering
	SAUER-SUNDSTRAND	Gear, Piston, Hydrostatic
	VICKERS	Piston, Vane

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Winnipeg, MB .(204) 786-7436
Fax .....(204) 772-5082

Locations Continued on other side

Berendsen Fluid Power

POWER UNITS	**BERENDSEN**	Custom Design
	FENNER	AC/DC Units
	VICKERS	Standard, Custom
PUMPS	**CROSS**	Gear Type
	FENNER	Gear Type
	PERMCO	Gear Type
	PRINCE	PTO Gear Type
	SAUER-SUNDSTRAND	Gear, Piston, Hydrostatic
	TELEDYNE	Axial Piston, Hand Pumps
	VICKERS	Piston, Vane
SERVO VALVES	**SAUER-SUNDSTRAND**	Pump Mounted Controls
	VICKERS	High Performance
SWITCHES	**BARKSDALE**	Pressure, Level, Temperature
SYSTEM MONITORING	**UCC**	Contamination, Flow, Pressure, Temperature
	VICKERS	Contamination, Flow, Pressure, Temperature, Proactive Maintenance Products
TRANSFER PUMPS	**BERENDSEN**	Filter Transfer
	LHA	Fluid Transfer
	MICO	Fluid Transfer
	VICKERS	Filter Transfer
VALVES	**AAA**	Compressed Air or Gas Service Valves
	BRAND	Directional, Flow, Pressure
	CROSS	Directional, Flow, Pressure, Mobile
	DOUBLE A	Directional, Flow, Pressure
	FPS	Directional
	GRESEN	Directional, Mobile, Monoblock, Sectional
	LHA	Ball, Check, Gate, Needle
	MODULAR (Vickers)	Cartridge Valves
	OLMSTED	Custom Design, Prefill
	PARKER MANATROL	Check, Flow, Needle
	PRINCE	Directional, Flow, Pressure
	PROPORTION AIR	Electronic, Pressure & Volume Controls
	SAUER-SUNDSTRAND	Solenoid & Proportional
	TELEDYNE	Cartridge, Directional, Pressure
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Berendsen
Fluid Power

Warning:

IMPROPER OPERATION OF THIS HYDRAULIC SYSTEM CAN CAUSE INJURY TO PERSONNEL OR DAMAGE TO MACHINERY.

PLEASE READ CAREFULLY!

Start-Up Procedure

All Berendsen Fluid Power hydraulic units are thoroughly tested at the completion of assembly. The units are tested at the design flow and pressure of the unit and a copy of the test report is included with this manual. Berendsen Fluid Power hydraulic units are assembled from components that are sized and matched to work together as a total system. Replacement of any component in the system with a component that is not on the Berendsen Fluid Power parts list may result in damage to the machine and injury to personnel, as well as void any warranties.

1.0 General

Regular maintenance is required to keep a Berendsen Fluid Power hydraulic power unit operating. The most critical time in a hydraulic system's life is at the time of installation. Dirt or contaminants in a hydraulic system will greatly reduce its useful life. Keeping the system free of contaminants during installation is extremely critical.

2.0 Plumbing

After fabrication of tubes and hoses, they should be flushed out with oil or solvent to remove foreign matter. Contaminants in a new system typically come from the installation of pipe, hose and tubing. **KEEP THE INSTALLATION CLEAN!!!!**

3.0 Fluid

Fill the reservoir to the operating level with the proper grade of hydraulic fluid (refer to the nameplate data). If your system has an accumulator, **DO NOT** top off the oil level after the system has been started. The accumulator will store oil in it and cause the level of the reservoir to drop. The oil level should therefore be checked after the system is cycled and the accumulator is discharged. Any oil added to the system should be pre-filtered to an ISO standard level of 18/16/14 or better. Use only the recommended grade of oil, or an equivalent.

4.0 Pumps

If your system has a piston pump (or pumps), the case of each pump must be filled with oil that has been pre-filtered as described above before the system can be started. A piston pump will have a small hose or tube connected from the highest point of the pump back to the reservoir. Disconnect this drain line from the pump and fill the case with oil. If the pump is started without oil in the case, the pump may be damaged. Some pumps can only be operated in one direction. The pump will have an arrow on it, or near it, to indicate the direction of rotation. If the unit has a shut off valve in the suction line, open the valve now.

4.1 After the motor has been wired, jog (start and stop) the motor to check that the pump is rotating in theproper direction, as indicated by the arrow.

5.0 Accumulators

If your system is equipped with an accumulator, ensure that it has been properly pre-charged to the correct pressure. If the label on the accumulator or the schematic does not have this information on it, consult your local Berendsen Fluid Power Branch. Dry nitrogen is the most commonly used gas to charge an accumulator. **Caution: Never use anything but Nitrogen (N2) to precharge an accumulator.** Starting a system with a bag or bladder type accumulator that has not been precharged will cause damage to the bladder.

Warning:

Accumulator systems may have fluid stored under pressure in them, even if the pump is not running. Before working on a system with an accumulator, make certain that the stored fluid has been dumped back to the reservoir. If the controls are operated, unexpected movement of the machine members may occur, causing injury to personnel or damage to the machine.

6.0 Open Loop System Flushing

Warning:

Do not disconnect any line while the motor is running or the system is under pressure.

6.1 To remove contaminants in the installed plumbing, you **must** loop the system. A simple example of this is illustrated in Figure #1 and Figure #2. Figure #1 is a system with one directional valve and relief. Figure #2 shows how to LOOP your system. If you have ordered your system without a return filter, install one in the return line for a few days and then remove it, if you wish.

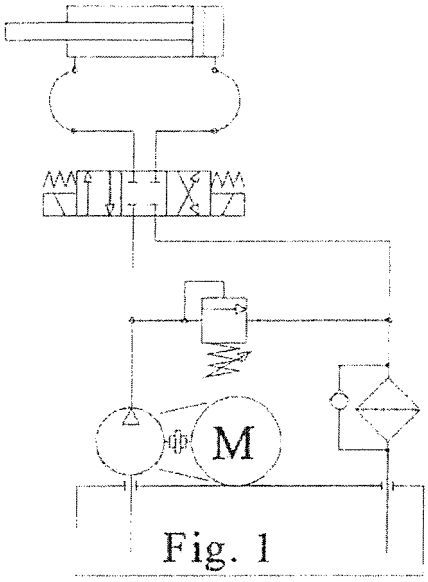


Fig. 1

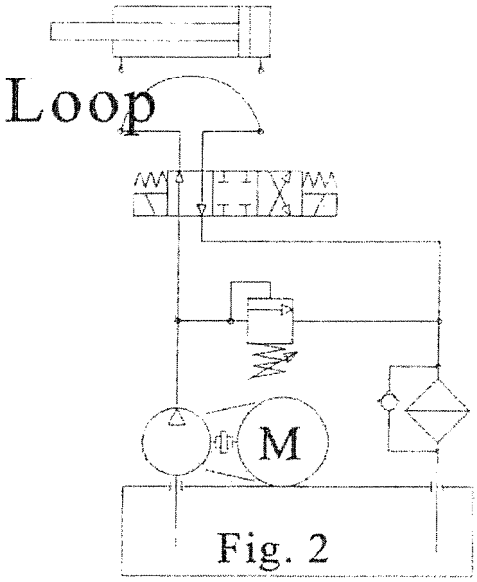


Fig. 2

6.2 Install the hose as illustrated in Figure #2. Make sure the hose you use is sized for full pump flow. The hose should be installed as close to the cylinder or motor as possible. Loop only one actuator at a time. If there is more than one actuator in your system, disconnect and plug the ports on the actuator branches that you are not flushing.

6.3 For the flushing to be effective, flow from the power unit must go through each branch of the system. The more flow you can get through the plumbing at one time, the better. If your system has a backup pump and motor, open the necessary valves to include the flow from that pump when you complete flushing the primary circuit.

Warning:

It is important to ensure that trapped air in the system is properly bled off. Some pumps will not prime if air is trapped in the system. Also, trapped air in the system can become compressed when the system is started, causing sudden movements of the machine, resulting in injury or damage.

If the flushing procedures are performed properly, the air in the system will be displaced.

6.4 Check that Step #5.0 has been completed. Shift the directional valve that is controlling the branch of the circuit with the loop. Start the motor(s) and pump(s). Check the pressure of the system at the pump. It should be below th system setting at this point.

6.5 Repeat Steps 6.1 through 6.3 for each branch of the system. Each branch should be flushed for a minimum of 30 minutes. Ensure enough filter elements are on-hand when flushing is started. The initial cleanliness of the installation and the filter element rating will determine the number of filter elements used. The entire system must be flushed until the appropriate ISO cleanliness code is achieved.

Warning:

Electrical power must be off , the system not under pressure and the accumulator discharged before disconnecting or reconnecting any components in the system.

6.6 Reconnect all actuators in the system and check for leaks.

Troubleshooting

Warning:

Electrical power must be off and the system not under pressure before beginning the following procedures.

1.0 Pump fails to rotate

1.1 Check that the electric motor is properly wired and that the voltageand hertz are correct for that motor.

1.2 With the power off, manually rotate the electric motor to see if movement is free. You should slide the motor and pump coupling apart so they are not engaged in order to do this.

1.3 Check the pump for free rotation at the same time you check the motor. Some piston pumps and gear pumps may seem tight or hard to turn. This is normal.

1.4 If the motor or the pump will not turn, disassembly may be necessary to determine the cause. This work should be done only by qualified personnel. If the system is under warranty, contact Berendsen Fluid Power before proceeding.

2.0 Pump delivery abnormally low

2.1 Check the oil level in the reservoir to ensure that it adequately covers the suction strainer.

2.2 Check for suction air leaks or a clogged suction strainer.

2.3 Check the prime mover to ensure that it is operating at rated speed. Lower than normal speed can be caused by a motor "single-phasing" due to a wiring defect or a bad fuse.

2.4 Check that the relief valve setting is not set too low.

2.5 Check the oil temperature. If the oil temperature is higher than that on the nameplate, the oil will thin out and the efficiency of the pump will be decreased.

3.0 Excessive pump noise

3.1 Hammer, gurgle, or rattle noises are usually the result of a starved suction or air leak in the pump suction line.

3.2 Chattering may be caused by air in the lines, a defective relief valve or a starved suction line.

3.3 To correct (3.1) and (3.2)

Ensure the oil in the reservoir is well above the suction strainer.

Ensure that the suction filter or strainer is free of contaminants.

Ensure that all the connections in the suction lines are tight and that none of the plumbing is damaged.

4.0 Oil overheating

4.1 Check the system relief valve for proper setting. If the relief is set too low, it will cause the system to overheat.

4.2 Check the flow controls in the system. If a flow control is set too low, this will also cause heat.

4.3 If you have a hydraulic motor in the system with a flow control before the motor and it is set too low (to slow the motor), the motor may be sized incorrectly for theapplication.

5.0 Additional Help

If you need additional help with a problem, technical assistance may be obtained by calling 1 (800) 905- BEAR. Many problems may be corrected over the phone, if this does not get you up and running, Berendsen Fluid Power has Field Service Technicians on call to assist you.

Maintenance

The best maintenance for a hydraulic system is filtration. If your system has a suction filter or strainer, it should be checked for cleanliness every 15 to 30 days.

When adding new oil to the system, only oil that has been pre-filtered to at least an ISO standard level of 18/16/14 should be used.

Check the filters in the system once a week. Most of the filters used have some type of indicator on them to tell you when the filter element is getting close to the by-pass setting. Once the filter goes into the by-pass mode, the system is unprotected and damage to the system can occur.

Berendsen Fluid Power has included a filter and oil log in the back of this manual. With this log, you can track the usage of filter elements and the cleanliness of your oil. After a time, you will be able to schedule the filter element changes of your system.

Oil samples should be taken every 3 to 6 months. After the oil is tested, the report can tell you if a component in your system is wearing and you can take corrective action.

Check the system for overheating. High temperatures will reduce the life of the seals in the system and cause leaks. It will also reduce the life of the components in the system.

Temperature changes of the oil in the reservoir cause a certain amount of moisture condensation which over a period of time, will result in a build up of water at the bottom of the reservoir. This water should be drawn off a 6 month intervals or as required.

At the same time (every 6 months), the reservoir should be drained and inspected for silt or sludge. The cleanout doors should be removed and the reservoir cleaned by hand with a solvent or light oil.

Filter Log

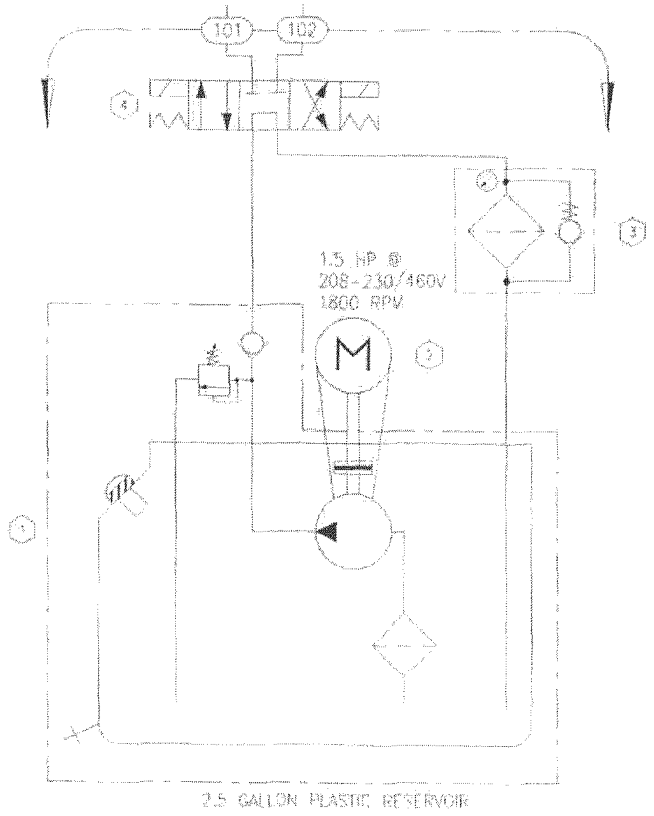
Pressure Filter Element Number _____

Return Filter Element Number _____

Suction Filter Element Number _____

Oil Type and Number _____

Date of Element Change	Filter Changed	Oil Sample Taken
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No
	(P) (R) (S)	Yes No



4	1	DG4V-3S-8C-V-M-FW-B5-61-ENC1 DIRECTIONAL CONTROL VALVE	VICKERS
3	1	SPTEB'GNR RETURN FILTER	LHA
	1	SPE-15-25 REPLACEMENT ELEMENT	LHA
2	1	KMC16 1 HP @ 3600 RPM, 115V ELECTRIC MOTOR	FENNER
1	1	FENNER POWER PAK CONSISTING OF	FENNER
	1	V8709B5ADA ALUMINUM SUBPLATE	U.F.P.
	1	1538-AA MAGNET	FENNER
	1	8080-CC PLASTIC BREATHER	FENNER
	1	8400-5-4-0 STRAIGHT ADAPTER	FENNER
	1	KV VERT. PLUMBING KIT	FENNER
	1	3531-AC 2.5 GALLON RESERVOIR	FENNER
	1	KC07 RELIEF & CHECK KIT	FENNER
	1	V-7 RELIEF VALVE	FENNER
	1	RH11 ENDHEAD	FENNER
	1	KP16 PUMP	FENNER

PORT CHART

PORT No	CONNECTION TYPE
—	—
—	—

Berendsen Fluid Power Ltd.

TROJAN TECHNOLOGIES INC.
FENNER POWER UNIT
F97-0003

DRAWN BY	SIZE	DATE	DWG NO.	SHEET NO.	REV
A.SITARU	A	05 APR '98	F970003AHA	1 OF 1	A
APPROVED BY J.GENIER	SCALE NTS	DR. AW32/46	MOTOR 120VAC	OPERATING TEMPERATURE 140F	

FILTER ELEMENTS

The filters supplied on this power unit were chosen specifically for this application. Substituting less expensive and subsequently less efficient replacement elements will void all warranties and may harm certain components.

Factors such as:

- **operating temperature**
- **duty cycle**
- **fluid type**
- **type of valving**
  (servo valves, proportional valves, etc.)

all played a major part in the selection of filtration components installed on this unit. Use only the replacement elements shown in this manual. Always replace elements as soon as indicators are activated.

PART NUMBERS

Replacement element part numbers are found on the schematic drawing and/or the filter housing or bowl. Also, the numbers are found in the spare parts section of this manual.

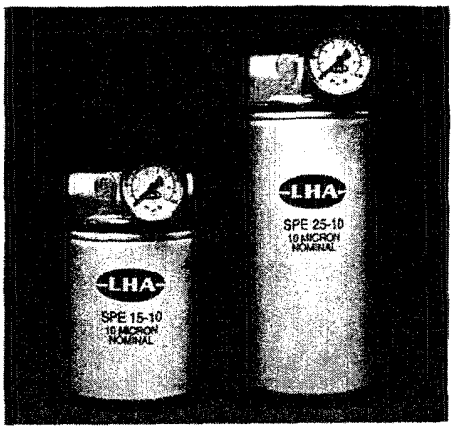
DO NOT SUBSTITUTE ELEMENTS

Return or Suction Spin-On Filter

SP07, SP15, SP16, SP25 Series

Specifications

- 200 PSI working pressure
- Flows up to 20 GPM for return and 5 GPM for suction line applications
- For use with petroleum and water based fluids; for other fluids – consult factory
- Operating temperature –22°F to +250°F (–30°C to +121°C)
- Aluminum casting and Buna-N seals

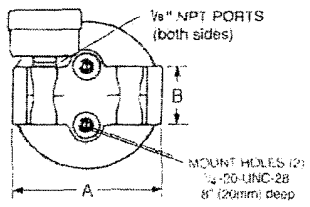


Options

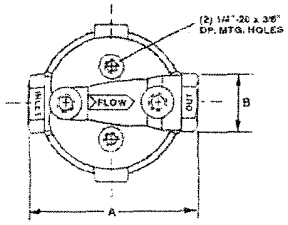
- Beta-3 and Beta-10 Absolute elements
- Extra capacity 10 or 25 micron nominal cellulose elements
- 10 micron water absorbing elements
- 140 micron stainless wire mesh elements
- 1/4", 3/8", 1/2", 3/4", 1" NPT and 9/16", 1 1/16" SAE ports
- Visual or electrical indicators
- **Private labeling of elements available – consult factory**

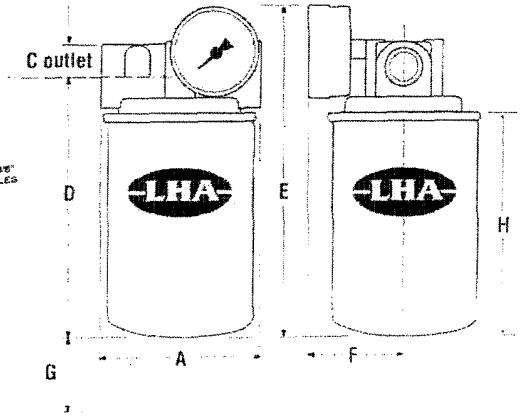
Dimensional Details

SP15 / 16 /25



SP07





G = Element removal clearance

Filter Series		A	B	C	D	E	F	G	H	Port Size
SP07	in.	3.05	1.50	0.56	3.94	5.75	N/A	0.04	3.38	See Pg. 1.02 for port options
	mm.	77.5	38.1	14.2	100	146	N/A	10.2	85.9	–
SP15	in.	3.74	1.48	0.75	6.19	7.61	2.30	0.79	5.06	See Pg. 1.02 for port options
	mm.	95.0	37.6	19.0	157	193	59.5	20.0	128	–
SP16	in.	3.74	1.48	0.75	6.39	7.63	2.30	0.79	5.84	See Pg. 1.02 for port options
	mm.	95.0	37.6	19.0	162	193	59.5	20.0	148	–
SP25	in.	3.74	1.48	0.75	9.50	10.9	2.30	0.79	8.66	See Pg. 1.02 for port options
	mm.	95.0	37.6	19.0	241	277	59.5	20.0	220	–

Return or Suction Spin-On Filter

SP07, SP15, SP16, SP25 Series

Ordering Information

SP15 N A G N O

Series	
SP07	UNF Post
SP15	UNF Post
SP16	BSP Post
SP25	UNF Post

	Port Type	Series
G	1/4" NPT	07
I	3/8" NPT	07
J	9/16"-18 SAE	07
K	1/2" NPT	15, 25
N	3/4" NPT	15, 16, 25
P	1" NPT	15, 25
S	1 1/16"-12 SAE	15, 25

Code	Element	Series
A	10 Micron Nominal Cellulose	All
B	25 Micron Nominal Cellulose	07, 15, 25
H	10 Micron Water Absorbing	15
J	Beta-3 Absolute Synthetic	15, 25
R	Beta-10 Absolute Synthetic	15, 25
W	140 Micron Absolute Stainless Wire Mesh	15

	Indicator Location	Series
0	None	All
1	Return	15, 16, 25
2	Suction	15, 16, 25
3	Suction & Return	15, 16, 25
4	Top Return	07
5	Top Suction	07

	Indicator	Series
EP	Electrical Return	All
EV	Electrical Suction	All
N	None	All
V	Visual	All

	Bypass Valve Setting	Series
C	18 PSI	07
D	Blocked Bypass	All
E	2 1/2 PSI	15, 16, 25
G	15 PSI	15, 16, 25
H	25 PSI	All

Replacement Elements

Part Number	Code	Filtration Area in²	Filtration Area cm²	Element Thread
SPE-07-10-D	A	117	755	3/4" UNF
SPE-07-10-C	A	117	755	3/4" UNF
SPE-07-10-H	A	117	755	3/4" UNF
SPE-07-25-D	B	117	755	3/4" UNF
SPE-07-25-C	B	117	755	3/4" UNF
SPE-07-25-H	B	117	755	3/4" UNF
SPE-15-10	A	547	3529	1"-12 UNF
SPE-15-25	B	547	3529	1"-12 UNF
SPE-15-BTA-3	J	391	2522	1"-12 UNF
SPE-15-BTA-10	R	366	2361	1"-12 UNF
SPE-15-H-10	H	547	3529	1"-12 UNF
SPE-15-140W	W	90	580	3/4" UNF
SPE-16-10	A	455	2938	3/4" BSP
SPE-25-10	A	947	6110	1"-12 UNF
SPE-25-25	B	947	6110	1"-12 UNF

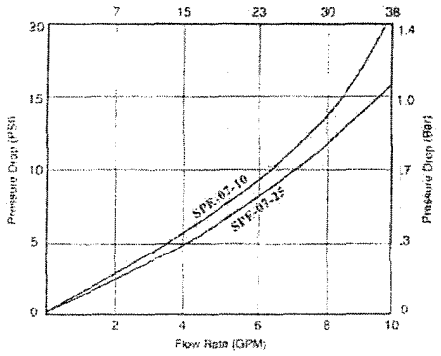
Replacement Indicators

Part No.	Description	Type
EL-P-1	Return Indicator	Electrical
EL-V-2	Suction Indicator	Electrical
SP-15P	Return Indicator - numeric scale	Visual
SP-15P-1	Return Indicator - 15 PSI color coded	Visual
SP-15P-2	Return Indicator - 25 PSI color coded	Visual
SP-15V	Suction Indicator	Visual

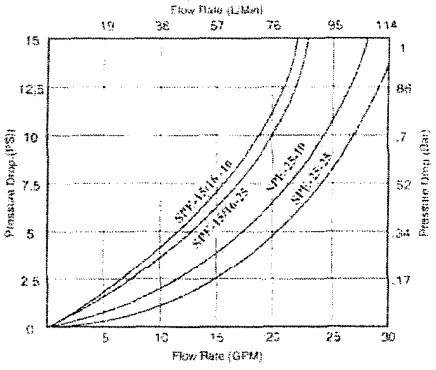
For Pressure Drop Curve Data See Page 1.16
For Filter Indicator Specifications See Page 1.20

Pressure Drop Information

SP07



SP15/SP16/SP25



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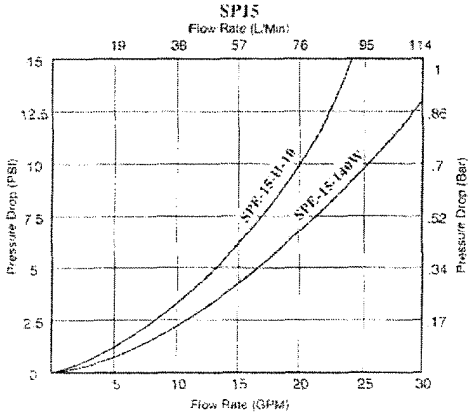
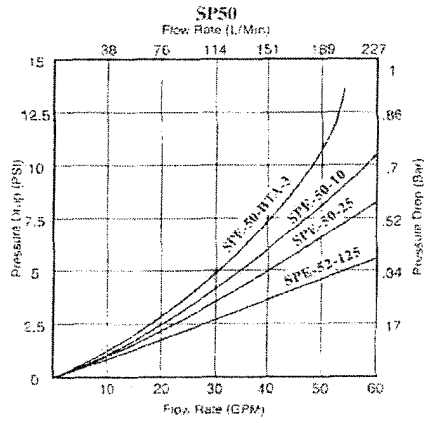
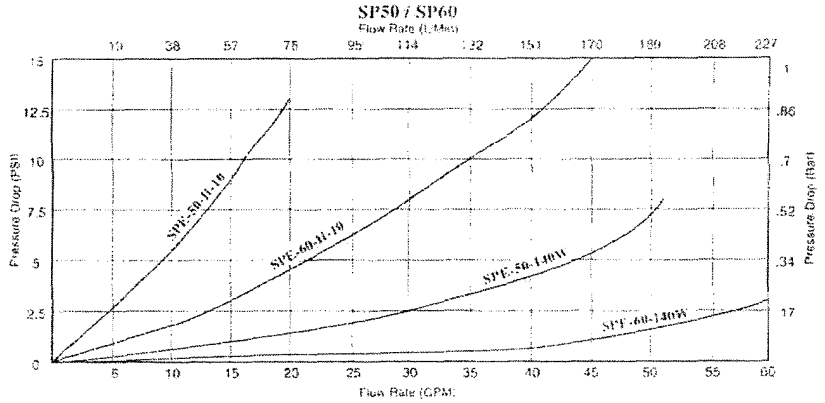


SP50



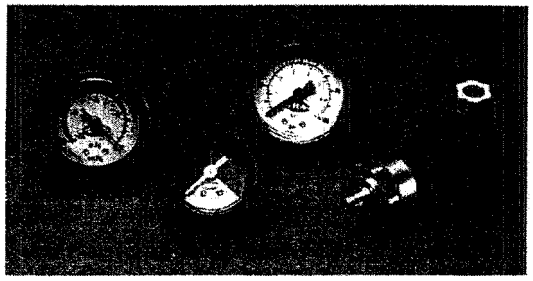
SP50 / SP60



Indicators Visual and Electrical

Visual Indicators

- Easy to read indicators for suction or return filters
- Built in snubber to minimize damage caused by pressure surges
- Accuracy ± 2% full scale
- ⅛" -27 NPTF threads
- Compatible with petroleum and mineral based fluids

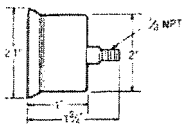


Ordering Information

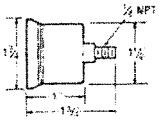
Part No.	Pressure Range	Function
PD-V-1	15 PSI Pop-up indicator	Return
PD-V-2	25 PSI Pop-up indicator	Return
SP-15P	0 to 100 PSI Numeric Scale	Return
SP-15P-1	0 to 100 PSI Color Coded (15 PSI)	Return
SP-15P-2	0 to 100 PSI Color Coded (25 PSI)	Return
SP-15V	0 to –20 Hg	Return
TI-15P	0 to 30 PSI Color Coded (15 PSI)	Suction

Dimensional Details

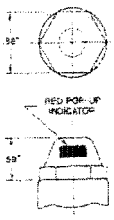
SP-15



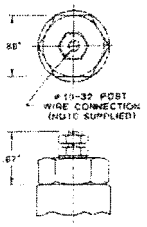
TI-15P



PD-V-1, 2

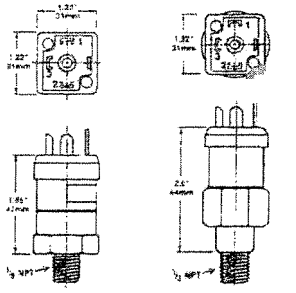


ED-P-1, 2



EL-P-1 EL-V-2

#1 Common #2 Normally Closed #3 Normally Open



Adjustment screw located in center of elec. prongs

Pressure and Vacuum Switches

Specifications	EL-P-1	EL-V-2
Electrical	7 AMP 12V DC or 125/250V AC	7 AMP 12V DC or 125/250V AC
Protection	DIN 43650 IP65	DIN 43650 IP65
Temperature Range	–40°F to +180°F (–40°C to +80°C) Ambient & Medium	–40°F to +180°F (–40°C to +80°C) Ambient & Medium
Diaphragm material	Epichlorohydrin standard	Epichloronydrin standard
Housing material	Zinc plated steel standard	Aluminum AL2024
Maximum overpressure	350 PSI (25 Bar) 6:1 safety factor	350 PSI (25 Bar)
Hysteresis	20%	25%
Maximum Pressure	350 PSI (25 Bar)	350 PSI (25 Bar)
Wetted Area Material	Elastomer & zinc plated steel brass	Elastomer & anodized aluminum 316SS optional
Repeatability	±2% at 70°F (20°C) Ambient temperature	±2% at 70°F (20°C) Ambient temperature
Hirschmann connector with strain relief		

Ordering Information

Part No.	Pressure Range	Function
EL-P-1*	5 to 35 PSI Field Adj.	Return
EL-V-2*	–5 to –30 in. Hg Field Adj.	Suction
ED-P-1	15 PSI Differential	Return
ED-P-2	25 PSI Differential	Return

* NOT PRESET: Setting adjustable for desired application

EL-P and EL-V Instructions

1. Remove DIN adaptor
2. Remove small brass screw
3. Using 1/16" allen wrench adjust clockwise to increase set point/ counter-clockwise to decrease set point
4. Reverse 1 & 2 for re-assembly

VICKERS

Logical Troubleshooting in Hydraulic Systems

Logical troubleshooting in hydraulic systems

Compiled by S.C. Skinner

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Warning

"Logical troubleshooting in Hydraulic Systems" *is intended as a guide to systematic fault findings in a hydraulic system. Vickers Systems (to the extent permitted by law) accept no liability for loss or damage suffered as a result of the use of this guide.*
If in doubt always refer to the original equipment manufacturer.
Refer at all times to the "safety procedure" on pages 3 and 39.

INTRODUCTION

It would be a virtually impossible task to try to document the cause and remedy of every possible fault that could occur on even the simplest hydraulic system. For this reason it is necessary to adopt a logical approach to troubleshooting, in order to locate a fault as quickly and accurately as possible. Down time on modern production machinery is very expensive, so an hour saved in locating a problem may make hundreds, or sometimes thousands, of pounds worth of saving in lost production.

Inevitably, hydraulic systems are becoming more and more complex as methods of controlling machines become increasingly sophisticated. The last ten years has seen rapid technological advances in the components used in many hydraulic systems, and it is vital that equipment, or machine manufacturer's service information or 'software' keeps pace with the actual hardware being used.

It is probably true to say that there is still a general lack of understanding of Hydraulics in some areas of industry, and in reality, the job of a hydraulic maintenance engineer is now a specialised occupation with many similarities to that of an instrument or electrical engineer.

The object of this book is to provide procedure for a logical approach to troubleshooting, which can be extended when necessary to cover specific machines in all areas of industry. The fundamentals around which this procedure is developed, ie. The control of flow, pressure and direction of flow, applies equally as well to a rolling mill in a steelworks or a winch drive on a trawler.

1. The hit and miss approach.

THE HIT AND MISS APPROACH

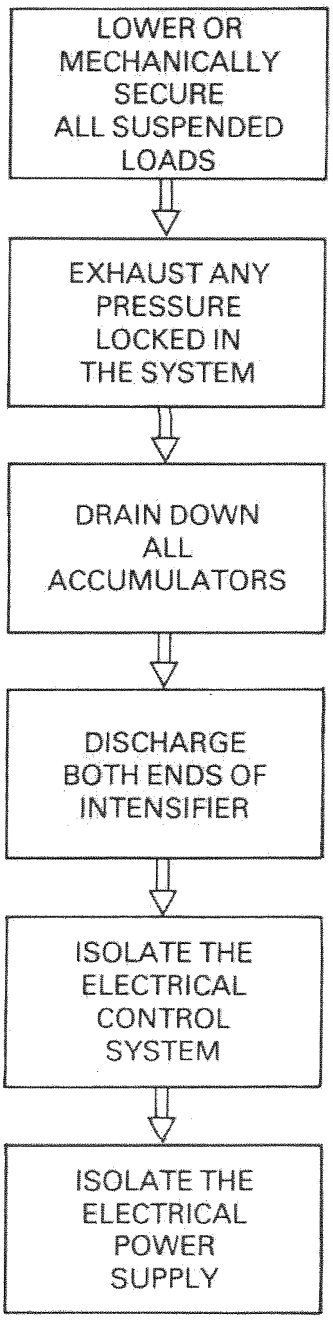
The only alternative to a logical troubleshooting method is the 'hit and miss' approach, where units are changed at random until the failed component is located. Eventually the problem may be found, but on all but the simplest of systems this method proves to be expensive in terms of time and money. It is usually the case that a large number of perfectly servicable units are changed before the right one is found.

As with all troubleshooting techniques, knowledge of components and their function in a system is vitally important. It is probably fair to say that when all the components of a hydraulic system have been identified, their function determined, and the operation of the system as a whole understood, the troubleshooter has gone 51% of the way towards finding the problem. It is important therefore, that to make use of this book effectively, a good understanding of the basic principles of hydraulics together with a knowledge of the operation and application of hydraulic components should first be obtained.

SHUTTING DOWN MACHINES

Whenever servicing work is carried out on a hydraulic system, the overriding consideration should be one of safety; to the maintenance engineer himself, his colleagues, and the machine operators. Although safe working practices rely largely on common sense it is very easy to overlook a potential hazard in the stress of a breakdown situation. Maintenance personnel should therefore discipline themselves to go through a set procedure before commencing any work on a hydraulic system. Because hydraulic fluid is only slightly compressible when compared with gas, only a relatively small amount of expansion has to take place to release the static pressure: however, where compressed gas can be present in a hydraulic system, either through ineffective bleeding, or where an

2.Safety procedure for shutting down machines.



accumulator is fitted, extra care must be taken to release the pressure gradually.

LINE SERVICE

When adopting service or trouble-shooting procedures, it is useful to define three distinct areas, similar to those used in the armed forces, ie. first, second and third line service.

First Line

Service or troubleshooting carried out on the machine itself and resulting in the failed component being identified and repaired whilst still in situ, or replaced.

Second Line

Investigation and repair of a failed or suspect component away from the machine, possibly in a user's own workshop.

Third Line

Investigation, overhaul and re-test of a component carried out at the maker's factory or service depot.

It should be the responsibility of the maintenance manager to decide where the dividing line is drawn between each area for his particular equipment. For example, if a pump fails on a system it may be possible to repair the unit whilst still on the machine ie. first line service. In another case it may be necessary to replace the unit with a new one sending the failed pump to a workshop or second line area where a decision can be made either to repair, return to manufacturer (third line), or if the unit has reached the end of it's useful life, to scrap it. Obviously several factors will affect this decision, such as spares availability, time factors etc. but wherever the line is drawn, the procedure should be clearly defined for the benefit of maintenance personnel.

This book is confined to the first line area ie. working from a fault to the failed component. Second line service information can be found in other Vickers publications together with details of specialist test equipment.

CHECKING FAULTS

The troubleshooting procedure in this book will endeavour to answer the following questions:

What Do I Check?

Which things can be measured in a hydraulic system that will indicate where the problem lies? A doctor will very often check a patient's heartbeat and temperature when making a diagnosis, to what do these correspond in a hydraulic system?

What Do I Check With?

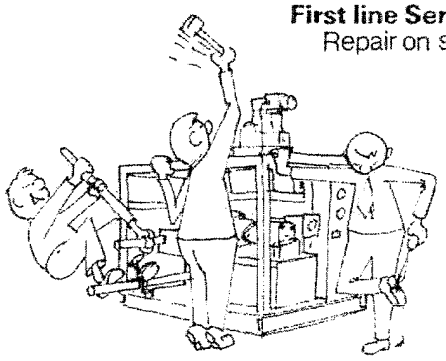
Knowing what to check, it is then necessary to determine any special instruments or equipment that will be required (corresponding to the doctor's stethoscope and thermometer).

Where Do I Check?

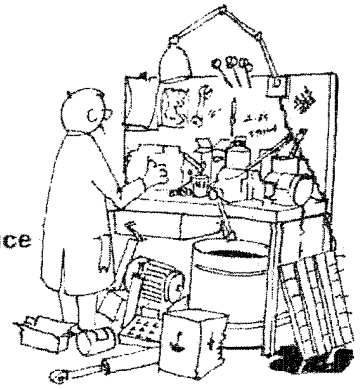
Whereabouts in a hydraulic system is it necessary to carry out the checks and which should be done first? As mentioned, a doctor will very often check a patient's heartbeat ie. the human pump; should the hydraulic pump be checked first?

3. Line service.

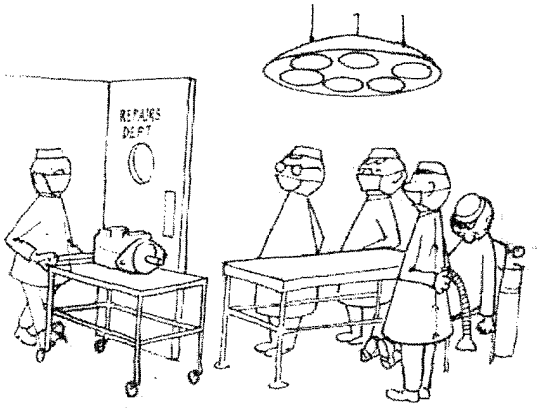
First line Service
Repair on site



Second line Service
Repair in workshop



Third line Service
Manufacturers repair service



What Do I Expect to Read?

Having taken a measurement at a certain point in a system, it is obviously necessary to know what the correct reading should be in order to draw conclusions if the reading is any different from normal. Again a doctor knows that the body temperature should be 37°C so if there is any variation a diagnosis can be made.

What Do I Check?

A hydraulic system is a means of transmitting and controlling power. Mechanical power is a function of force multiplied by distance moved per second or force x velocity. If a hydraulic actuator is considered as a device to convert hydraulic power to mechanical power, then the force (or torque) exerted by the actuator is governed by the applied *Pressure* and the velocity (or angular velocity) is governed by the *Flow* rate. It follows therefore that *Flow* and *Pressure* are two basic elements of a hydraulic system that control the power output. In engineering terms, velocity usually implies both speed and direction, speed, as discussed being controlled by flow rate and the direction of the actuator movement being controlled by the *Direction* of flow.

The three factors therefore that transmit and control power in a hydraulic system are:

Flow
Pressure
and *Direction* of flow

and it follows that in order to assess the performance of a hydraulic system one or more of these factors will have to be checked. In order to decide which, it is necessary to obtain the full facts of the problem.

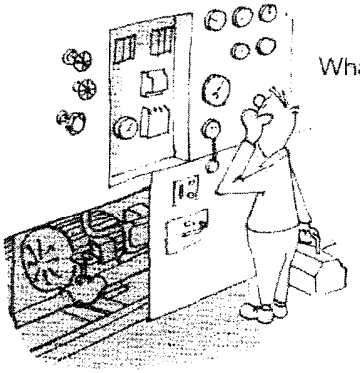
Very often when a problem is reported on a machine, it is described in vague terms such as "lack of power". As previously mentioned, power is a function of both force and velocity and it is necessary to define the problem in terms of one or the other. In practice, relevant questions must be asked in order to determine exactly what the problem is ie. when lack of power is reported does it mean that the actuator is moving too slowly, or is it not giving the required force or torque?

Having defined the problem as one of *Speed, Force (Torque)* or *Direction* it is now possible to define the hydraulic problem as one of *Flow, Pressure* or *Direction*.

Although the troubleshooting procedure is based upon checking flow, pressure and direction, there are other aspects of a system which can be measured both as an aid to locating a failed component and also to determine the reasons for a component failure. Such properties are:

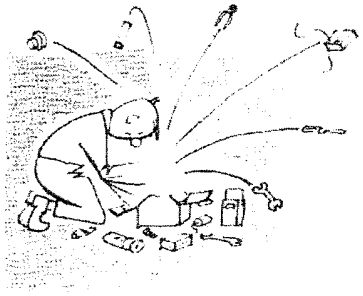
- *Negative pressure (vacuum),* especially in the area of the pump inlet to check for problems in the suction line.
- *Temperature,* generally when one component or part of a system is hotter than the rest, it is a good indication that flow is taking place

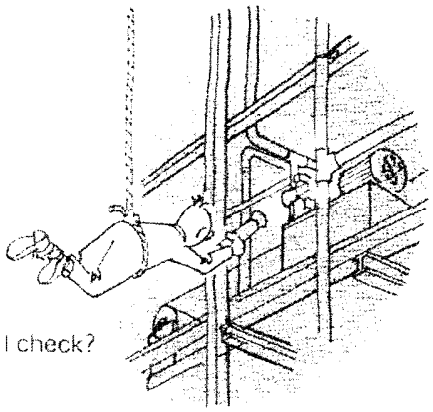
4. Checking faults.



What do I check?

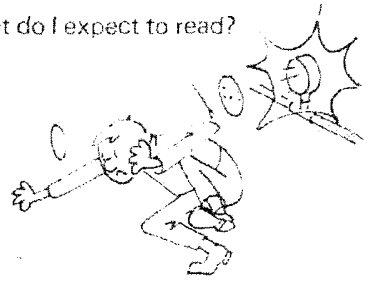
What do I check with?





Where do I check?

What do I expect to read?



– *Noise,*
when checked on a regular or routine basis is a good indicator of pump condition.

– *Contamination level,*
when repeated problems occur the cleanliness of the fluid should always be checked to determine the cause of the failures.

INSTRUMENTATION PRINCIPLES AND MEASURING INSTRUMENTS

What Do I Check With?

When an electrician checks an electrical circuit, he usually has available a meter that will measure electric current and voltage. In a hydraulic system the voltage corresponds to the pressure, and is usually measured with a pressure gauge, the current corresponds to the flow and is usually measured with a flow meter. Although the electricians meter will measure positive or negative voltage, if the hydraulic engineer wishes to measure a negative pressure ie. vacuum, then a separate instrument is required namely a vacuum gauge.

Apart from the basic requirements of a pressure gauge, vacuum gauge and flow meter, there are several other instruments that can prove useful to the hydraulic engineer ie:

– *Pressure Transducer and Recorder.*
If the pressure in a system needs to be measured to an accuracy greater than that which can be obtained with a pressure gauge, or if transient pressure peaks or shocks need to be measured then a pressure transducer can be used which produces a varying voltage according to the pressure applied.

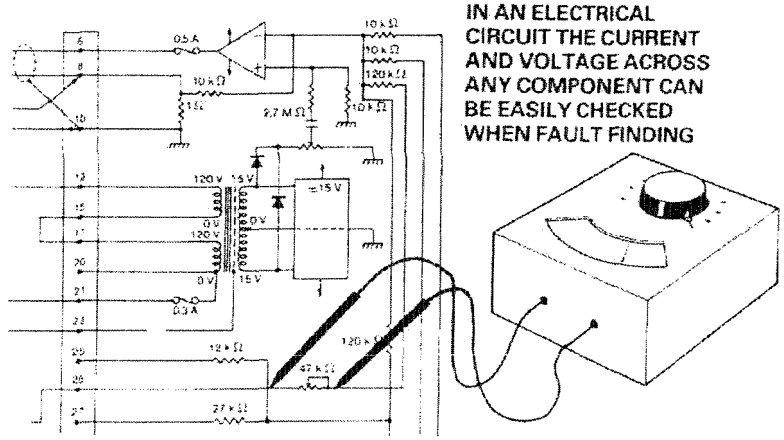
– *Measuring Jar and Stopwatch*
For measuring very small flows such as leakage a graduated jar and watch may be used. This can very often give a more accurate reading than a flow meter working at the bottom of it's range.

– *Temperature Gauge or Thermometer*
To measure the general system temperature a temperature gauge can be immersed in the fluid reservoir (sometimes incorporated with the level gauge). Very often the temperature gauge incorporates a switch to give a warning if the fluid temperature is too low or too high.

– *Thermocouple*
Temperature can be measured locally in a system by means of a thermocouple. If one part of a system is very much hotter than the rest it is a good indication that power is being wasted (such as a leakage point).

– *Noise Meter*
Excessive noise is again a good indication of a fault in a system especially the pump. In the middle of a noisy factory it may be difficult to judge whether a pump is more noisy than usual, so a noise meter enables a comparison to be made between a suspect pump and a new pump.

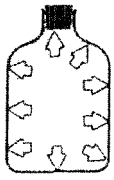
5. Instrumentation principles.



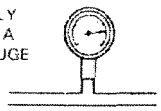
IN AN ELECTRICAL CIRCUIT THE CURRENT AND VOLTAGE ACROSS ANY COMPONENT CAN BE EASILY CHECKED WHEN FAULT FINDING

IN A HYDRAULIC SYSTEM:

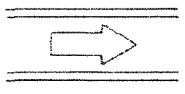
THE 'VOLTAGE' CORRESPONDS TO THE PRESSURE



AND IS USUALLY MEASURED BY A PRESSURE GAUGE



THE 'CURRENT' CORRESPONDS TO THE FLOW



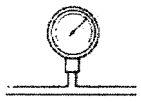
AND IS USUALLY MEASURED BY A FLOW METER

– *Particle Counter*
The condition of the system fluid from a contamination point of view is obviously a major factor in the life and performance of a system. In trying to determine the reasons for a component failure it may be necessary therefore to measure the cleanliness of the fluid. Although equipment may not be available on site to check the fluid, such a service is offered by most of the major fluid suppliers and filter manufacturers.

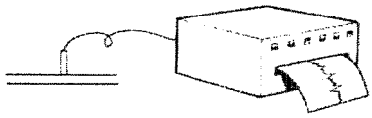
Considering the two basic requirements of pressure/vacuum gauges and flow meters, thought should now be given on how they are to be connected into the system, bearing in mind the type of instrument concerned.

6. Measuring instruments.

SYSTEM PRESSURE IS USUALLY MEASURED WITH A PRESSURE GAUGE

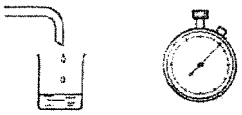


FOR VERY ACCURATE MEASUREMENT OF PRESSURE OR FOR MEASURING TRANSIENT PRESSURE SHOCKS, A PRESSURE TRANSDUCER AND RECORDER MAY BE USED.

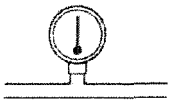


FLOW IS USUALLY MEASURED BY A FLOW METER WHICH CAN BE OF SEVERAL DIFFERENT TYPES

FOR VERY SMALL FLOWS (e.g. LEAKAGE) A MEASURING JAR AND STOPWATCH MAY BE USED

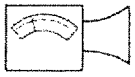


TEMPERATURE IS USUALLY MEASURED WITH A THERMOMETER OR TEMPERATURE GAUGE

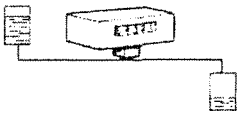


FOR CERTAIN APPLICATIONS A THERMOCOUPLE AND ELECTRICAL METER IS USED TO MEASURE TEMPERATURE

NOISE CAN BE MEASURED WITH A NOISE METER



FLUID CONTAMINATION CAN BE MEASURED BY A PARTICLE COUNTER



Pressure Gauges

Pressure gauges are usually of the Bourdon Tube type consisting of a curved tube attached to a pointer. When pressure is applied to the curved tube, it tends to straighten out, exactly as a garden hose does when the tap is turned on. As the tube straightens, the pointer is moved around the dial, indicating the applied pressure. Being a delicate instrument, it is necessary to protect the gauge as much as possible from pressure shocks in the system. Usually some form of snubber arrangement is fitted to the stem of the gauge, and the complete case may be filled with glycerine to damp down vibrations.

Pressure gauges are available in several different ranges and obviously a gauge must be chosen to suit the expected pressure reading (if in doubt as to what the pressure is likely to be, start with a high pressure gauge first). Most pressure gauges however tend to be more accurate around half scale deflection ie. a 0 – 100 bar gauge would be most accurate around pressures of 50 bar.

Pressure Gauge Installation

There are several ways of connecting a pressure gauge into a system as follows:

1. The gauge can be directly connected into the pipework by means of a 'tee' piece. Obviously the gauge will be subject to all the pressure shocks in the system so over a period of time the accuracy will inevitably drop off.

2. The gauge can be installed with an isolating valve so that the valve is only opened when a pressure reading needs to be taken and the gauge is normally isolated from shocks in the system.

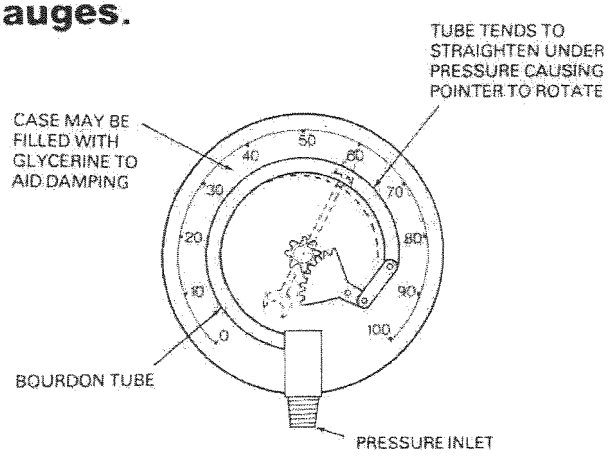
3. A venting isolation valve may also be used normally of the 'push-to-read' or 'twist-to-read' type which both isolates the gauge from the system and also vents the gauge to tank when the button is released.

4. A multi-station isolating valve allows the pressure to be read at six different points in the system using only one pressure gauge. The valve is also usually of the push-to-read type, venting the gauge when the button is released.

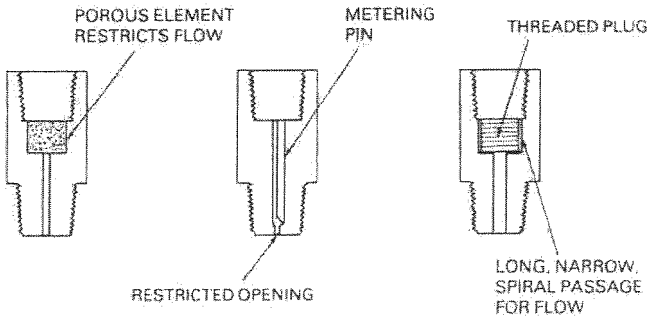
5. Most hydraulic units are provided with gauge points in inlet and outlet ports usually a screwed plug. If the system designer has not allowed for a gauge to be permanently installed in a part of the system it is usually possible to connect one in without having to disturb pipework etc. provided the gauge points can be identified.

6. Quick release, self sealing test points can be provided around the system (or even connected into unit gauge points) allowing the maintenance engineer to check pressure in the system with a portable gauge kept in his toolbox, fitted with the appropriate male probe. (By connecting the male probe to the test point without a pressure gauge, they can also be used for bleeding air from the system.)

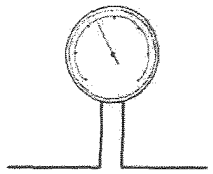
7. Pressure gauges.



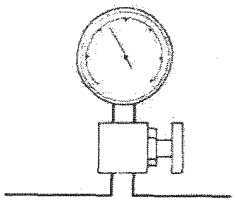
SNUBBER ARRANGEMENTS



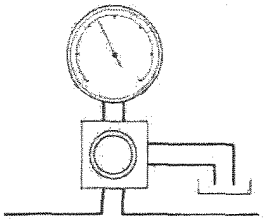
8. Pressure gauge installation.



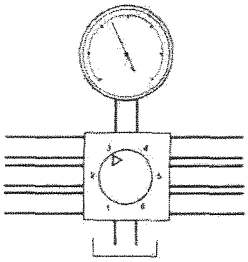
1 PRESSURE GAUGE PERMANENTLY INSTALLED IN PIPEWORK



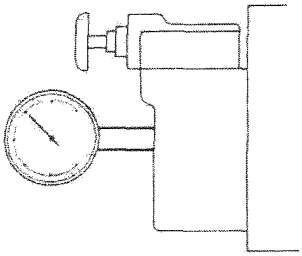
2 PRESSURE GAUGE INSTALLED WITH SHUT-OFF VALVE



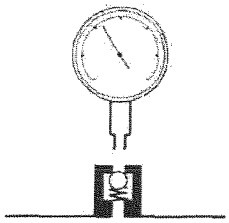
3 PRESSURE GAUGE INSTALLED WITH VENTING ISOLATION VALVE



4 PRESSURE GAUGE INSTALLED WITH MULTI-POINT SELECTOR VALVE



5 PRESSURE GAUGE PLUGGED INTO UNIT GAUGE POINT



6 PRESSURE GAUGE PLUGGED INTO SYSTEM TEST POINT

Flow Meter

Flow meters are available of several different types such as the float type or turbine type as illustrated in fig 9. In addition, test units are available which combine flow meter, pressure gauge and temperature gauge in one portable unit. In practice, flow meters are rarely connected into a system permanently since flow setting in a system is usually accomplished by measuring the speed of an actuator. When it is necessary to check flow in a system however, careful consideration should be given to the positioning of the flow meter in the system.

Flow Meter Installation

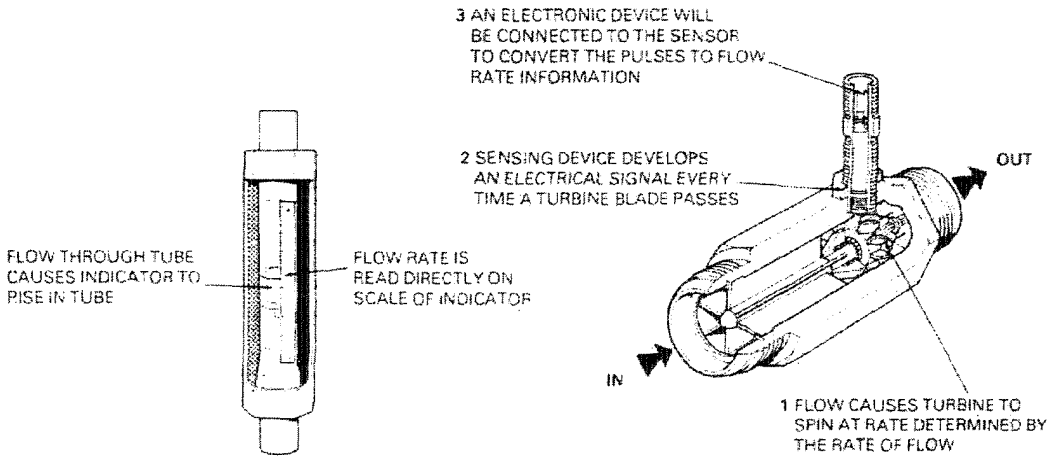
Flow meters may be installed in a hydraulic system to check while the machine is operating normally (on-line) or while the machine is shut down for maintenance purposes (off-line)

Fig. 11a illustrates a flow meter installed in the main flow line from the pump. By incorporating two 3-way valves in the line, a flow meter can be connected in to the system and the 3-way valves selected to divert flow through the meter. The meter used must obviously be capable of withstanding the full system pressure and flow. The meter reading will indicate the flow available to the system, but if the reading is less than specification it is not immediately apparent whether the pump is giving less flow than required or the relief valve is leaking a proportion of the pump flow to tank. If a problem is found however, the list of possible causes has been narrowed down to two units, and a check on the tank return line from the relief valve should then confirm which of the two units is at fault.

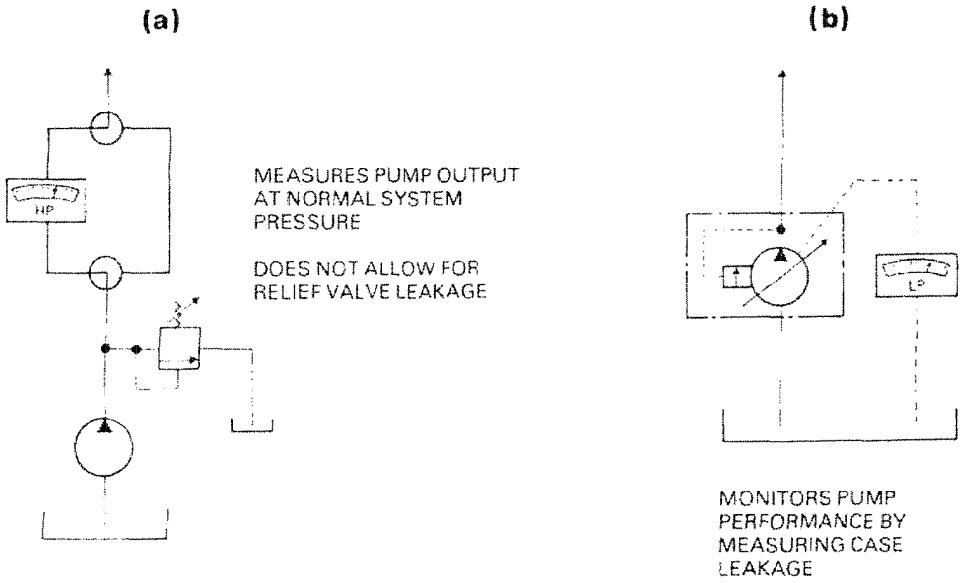
In the case of a variable pump, the pump output flow will only be that actually required by the system at any time. A good indication of pump performance however, can be obtained by measuring the internal leakage in the pump ie. measuring the case drain flow as indicated in fig. 11b. A certain amount of case leakage is inherent on brand new pumps (caused by design clearances, lubrication drillings etc.) so it will be necessary to compare the leakage actually measured with that for a pump within full specification. When measuring case leakage it is important that it is done under steady state conditions, ie. with the pump delivering a constant volume. The flow meter required will only have to withstand pump case pressure (normally around 0.3 bar) and very low flows so in fact a measuring jar and stopwatch may be used. It is important however that the drain line is NEVER allowed to be blocked off.

Fig. 12a illustrates a typical off-line arrangement. The addition of two shut-off valves in the system allows the system itself to be isolated and the pump flow diverted through the flow meter. Again a low pressure meter can be used since the pump flow is measured at low pressure although this may not give a true indication of the pump output at normal working

9. Flow meters.



11. Flow meter installation (on-line).



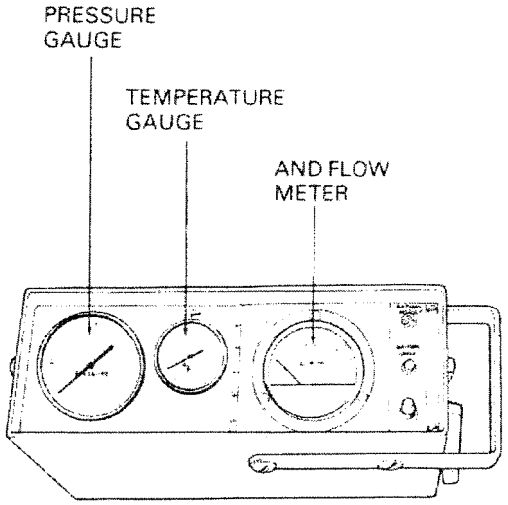
pressure. As mentioned previously, a flow deficiency could be caused by low pump output or relief valve leakage so a further check will be required if this is the case. It is possible to incorporate a restrictor in the flow meter line in order to develop pressure, in which case of course, a high pressure meter will be required.

If the output from the pump unit proves to be satisfactory, it may be necessary to connect flow meters into other areas of the system. Again the addition of isolating valves as illustrated in fig. 12b considerably simplifies the operation

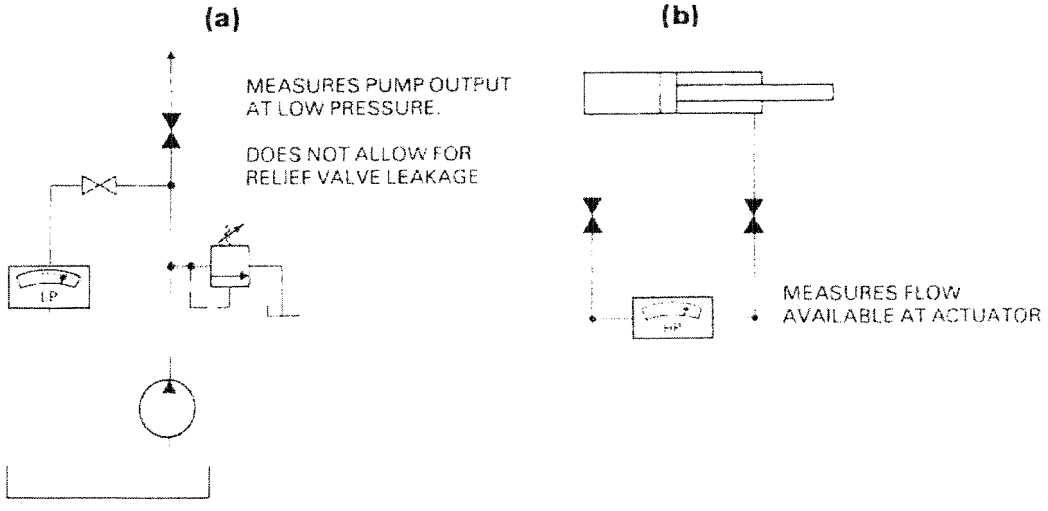
Whenever a flow meter is connected into a system, it is vital to ensure that the pump always has direct access to the relief valve, and the relief valve tank line is never allowed to be blocked off or unduly restricted.

10. Hydraulic test unit.

A HYDRAULIC TEST UNIT COMBINES



12. Flow meter installation (off-line).



Where Do I Check?
& What Do I Expect to Read?

When considering failures in a hydraulic system there can be two alternative starting points namely:

a. **Machine Malfunction –**
where a fault occurs in a hydraulic system causing a malfunction on the machine itself ie. an actuator fails to operate correctly.

b. **System Malfunction –**
where a fault occurs in the hydraulic system without necessarily affecting the machine performance in the short term, eg. excessive leakage, temperature etc.

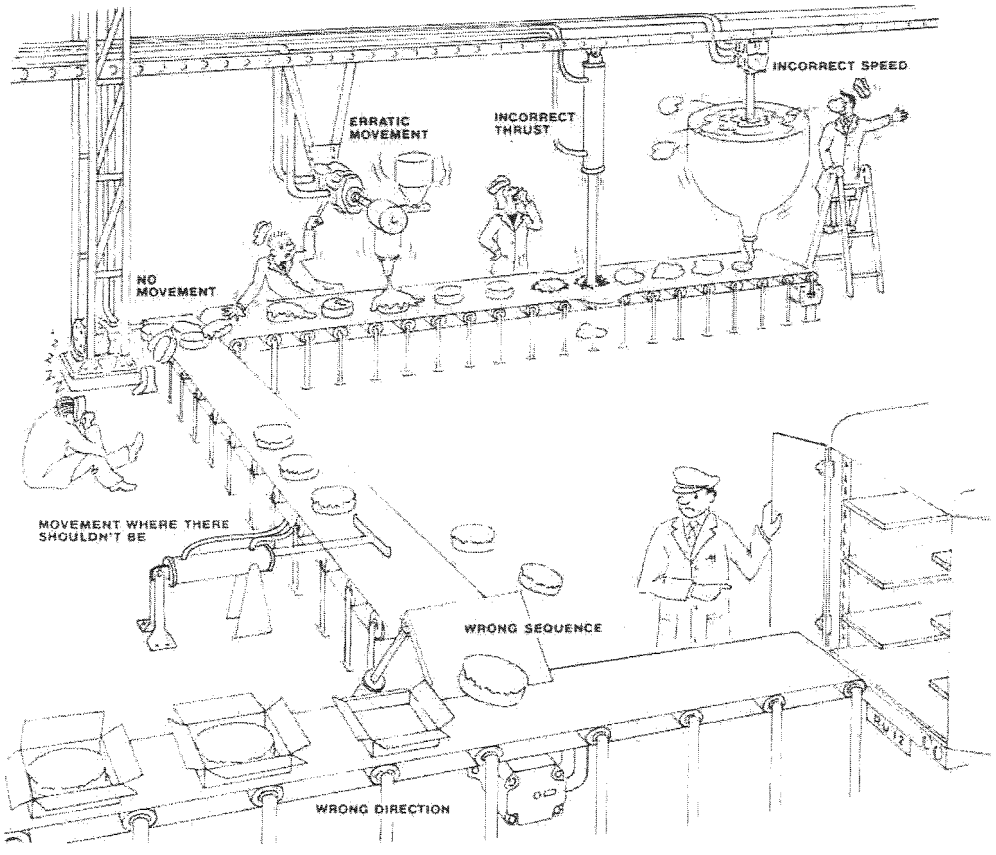
The two can of course occur together, for example a pump failure would result in the machine failing to operate correctly and would most likely be accompanied by an increase in noise level. Experience has shown that it is usually better to start at the fundamental problem and work through the checking procedure, using symptoms such as heat, noise, leakage etc. as clues.

Again common sense must prevail when working through this procedure, as some symptoms may point straight to the problem area. A fountain of oil gushing from a valve points immediately to the problem area, but some symptoms may not be so obvious. When a unit leaks flow from high to low pressure heat is usually generated locally in that part of the system, which may not be immediately obvious.

Whichever the starting point, certain questions should be answered before proceeding. When a problem is reported, it is important to gather as many facts together as possible. It could be that the same problem occured six months ago and is recorded somewhere on a log sheet or record card in which case a good deal of time can be saved. It should be ascertained whether any recent maintenance work or adjustments have been made to the system. The exact nature of the failure should be determined, was it a sudden or gradual breakdown, which parts of the machine have been affected and which have not? It may be difficult always to get the complete story, but an effort should be made to gather as much information as possible.

The philosophy of the trouble-shooting procedure is to start at the fundamental problem and determine which aspect of the hydraulic system is at fault; flow, pressure or direction. By consulting the circuit diagram, a list of

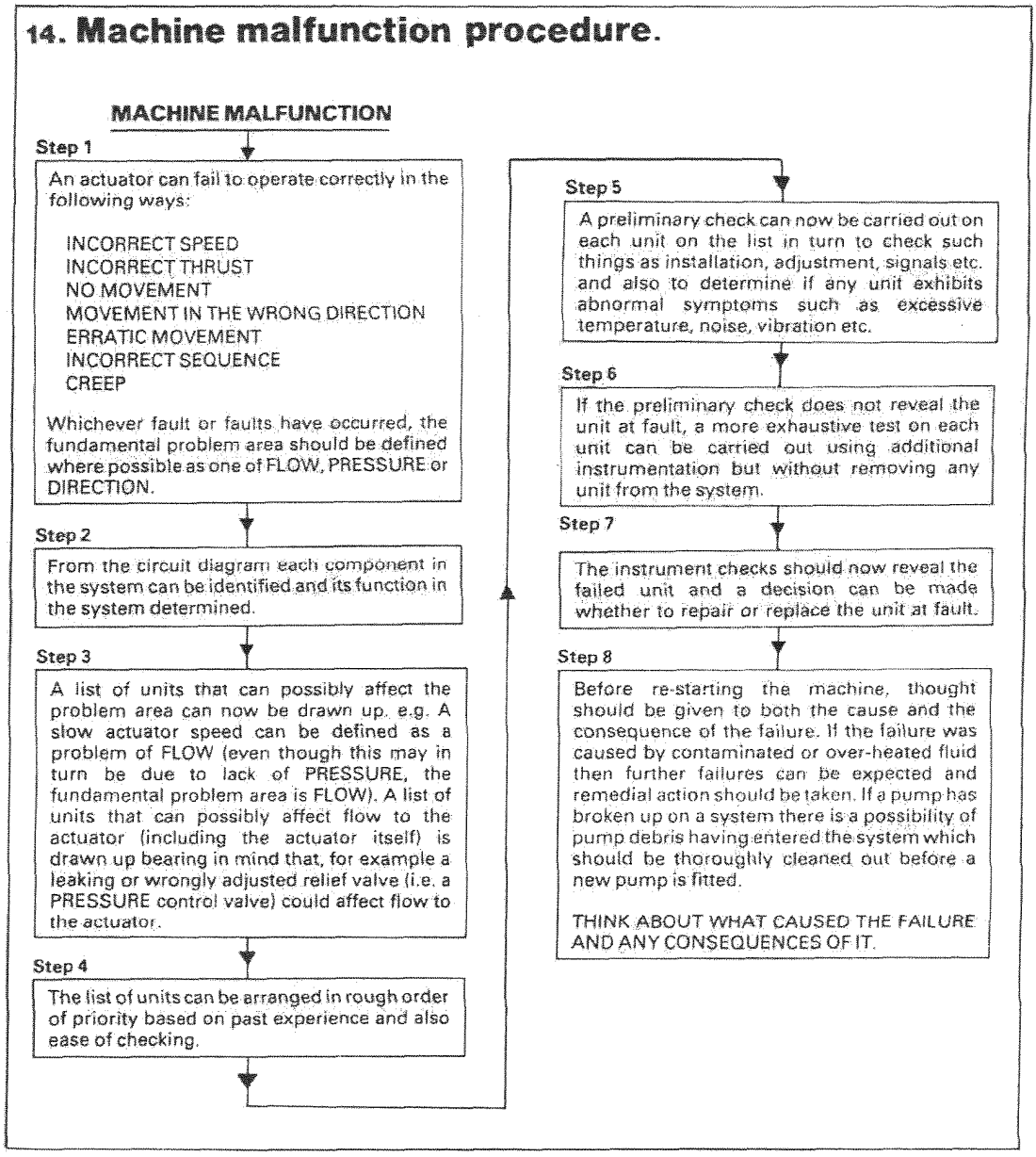
13. Machine faults.



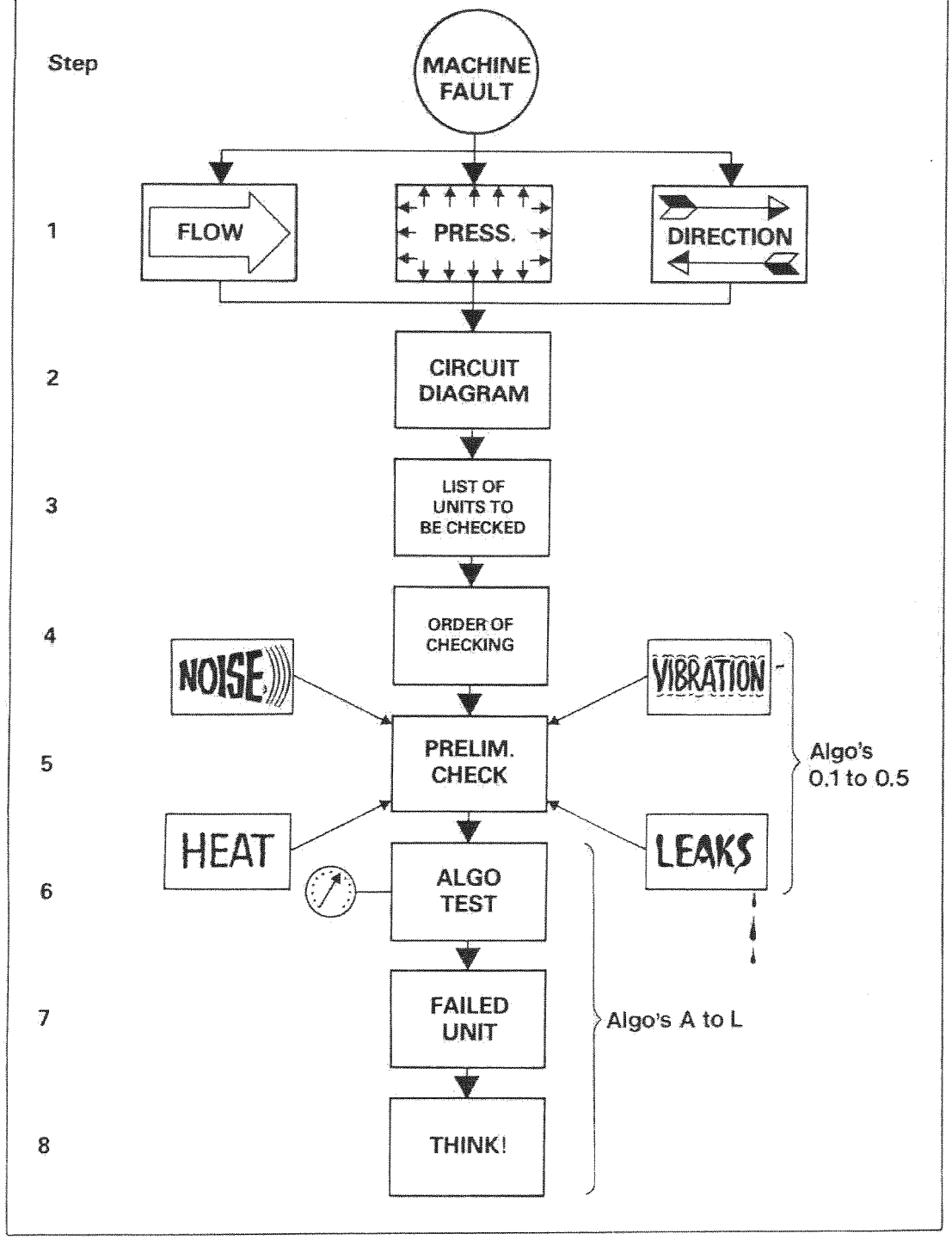
possible causes can be drawn up. The next stage is to then look for the obvious. It is perhaps human nature when faced with a challenging problem to search too deeply too quickly, in the process overlooking, what in hindsight, appears a very obvious solution. There are certain checks that can be carried out on a hydraulic system using the human senses of sight, touch and hearing and which can be carried out very quickly. If a rigid procedure is adopted each time it will ensure that no obvious or apparently trivial problem is overlooked. In practice very many problems will be solved at this stage without having to resort to additional instrumentation.

Only if this stage fails to reveal the problem is it necessary to resort to extra pressure gauges, flow meters etc. and again a logical approach should be adopted using the algorithm charts in this book.

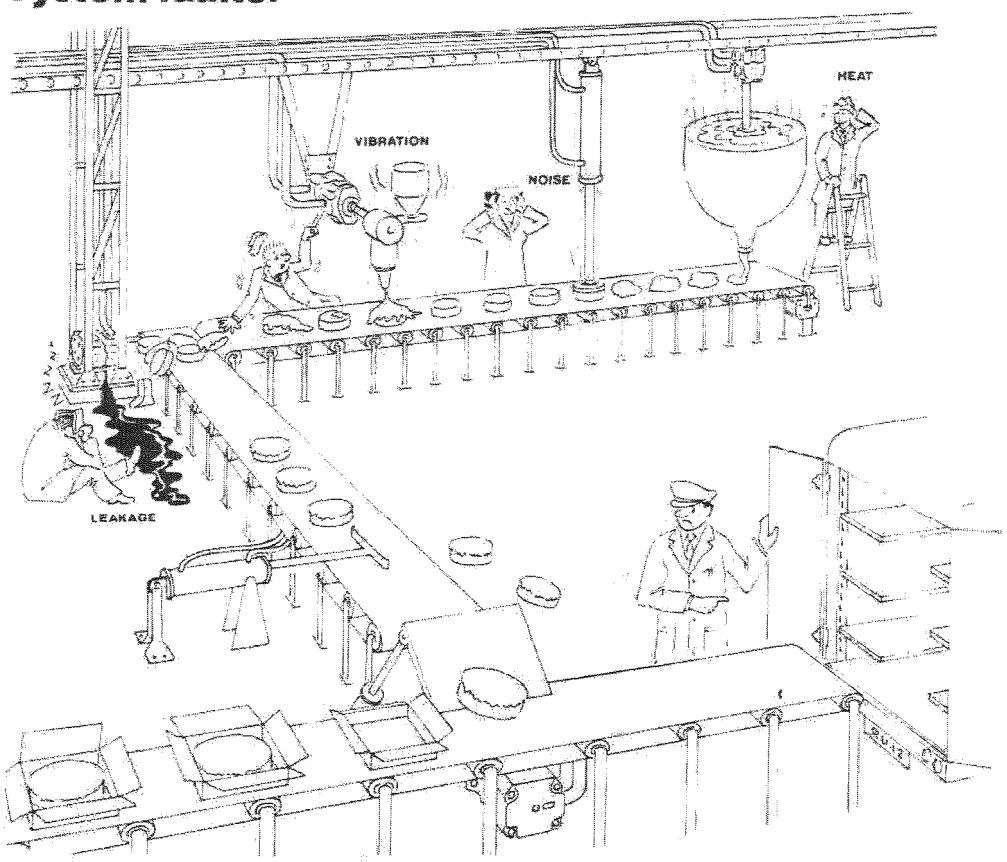
14. Machine malfunction procedure.



15. Machine faults.



16. System faults.



17. System malfunction

SYSTEM MALFUNCTION

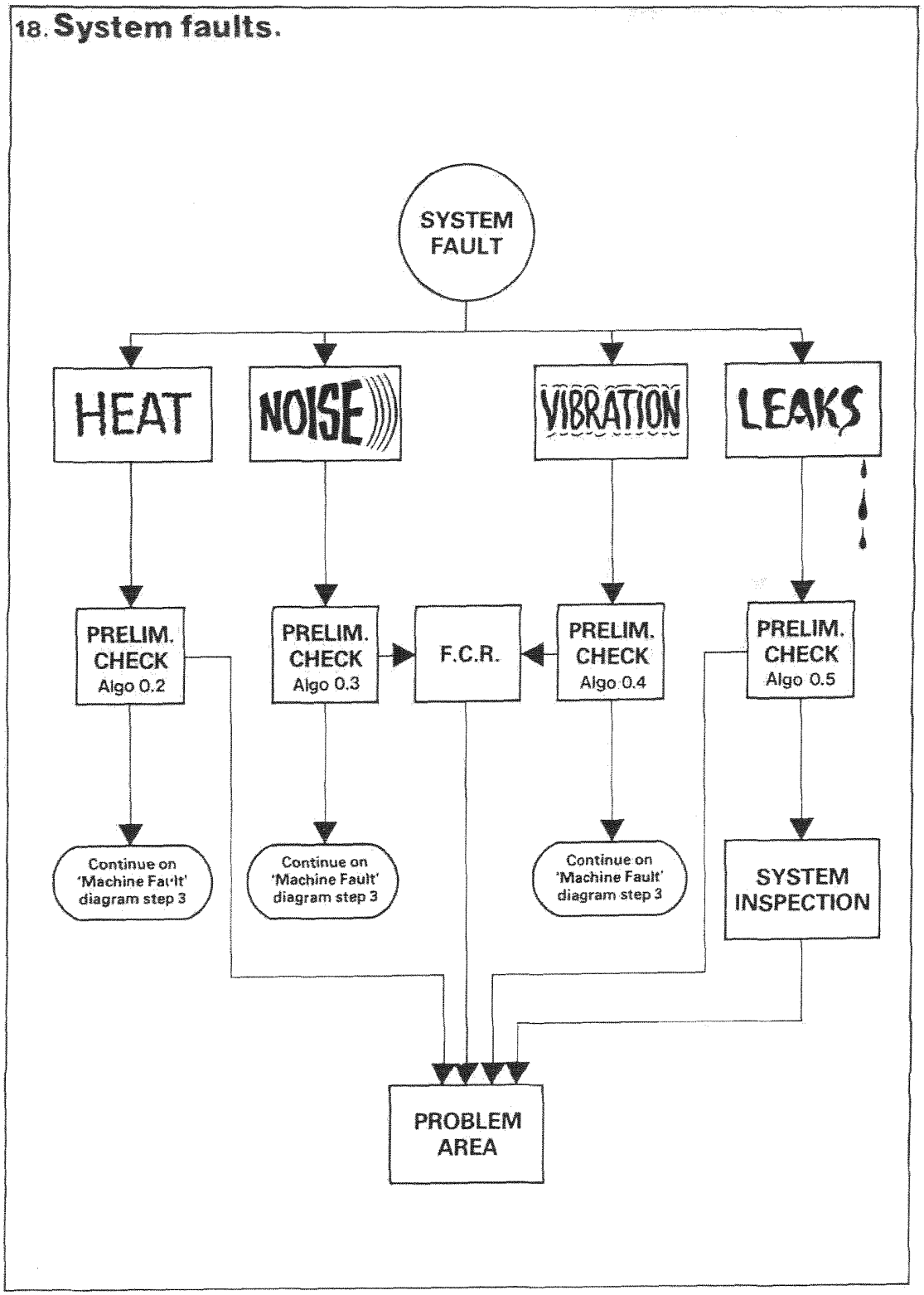
A hydraulic system may exhibit symptoms of excessive heat, noise, vibration or leakage without necessarily affecting the machine performance in the short term.

Whichever the problem, a preliminary check can be carried out to try and identify the problem area by using the human senses of sight, touch and hearing.

A unit may exhibit abnormal symptoms due to a problem elsewhere in the system e.g. cavitation or aeration on a pump inlet line. In this case the FAULT, CAUSE, REMEDY (F.C.R.) charts can be used to locate the problem area.

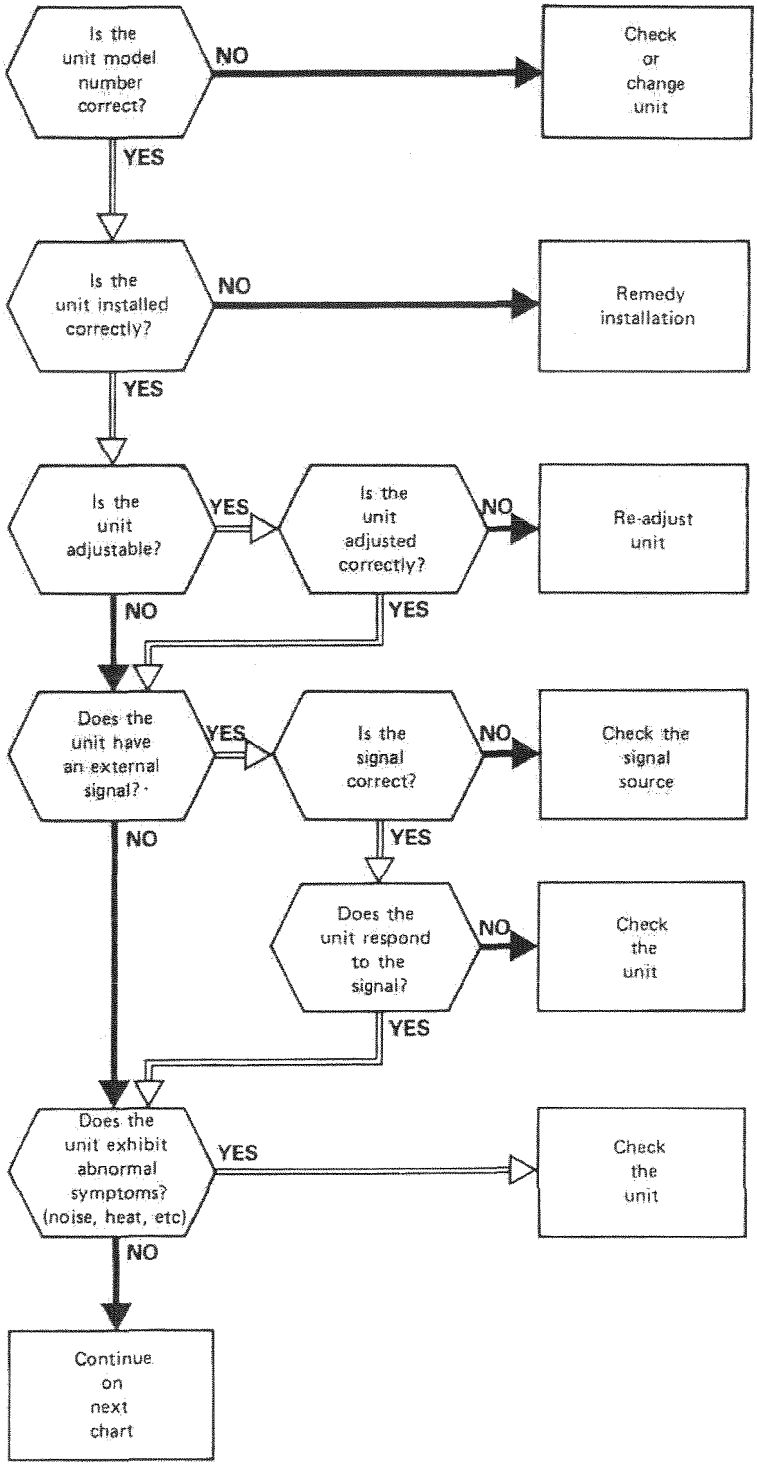
If the problem is not identified by the preliminary check, then a more exhaustive check must be carried out on suspect units and a similar procedure to the 'Machine Fault' exercise can be carried out.

18. System faults.



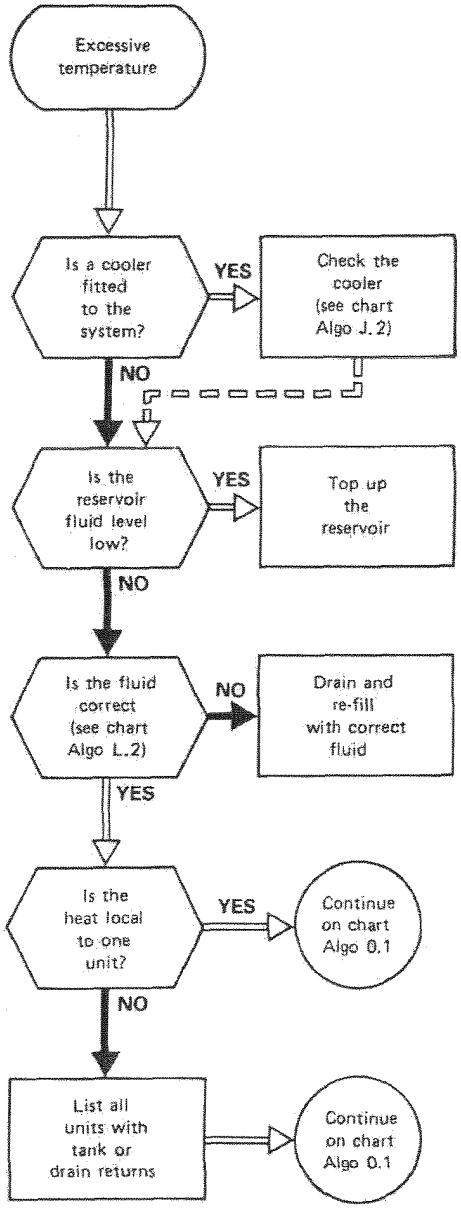
Unit fault preliminary check

Algo 0.1



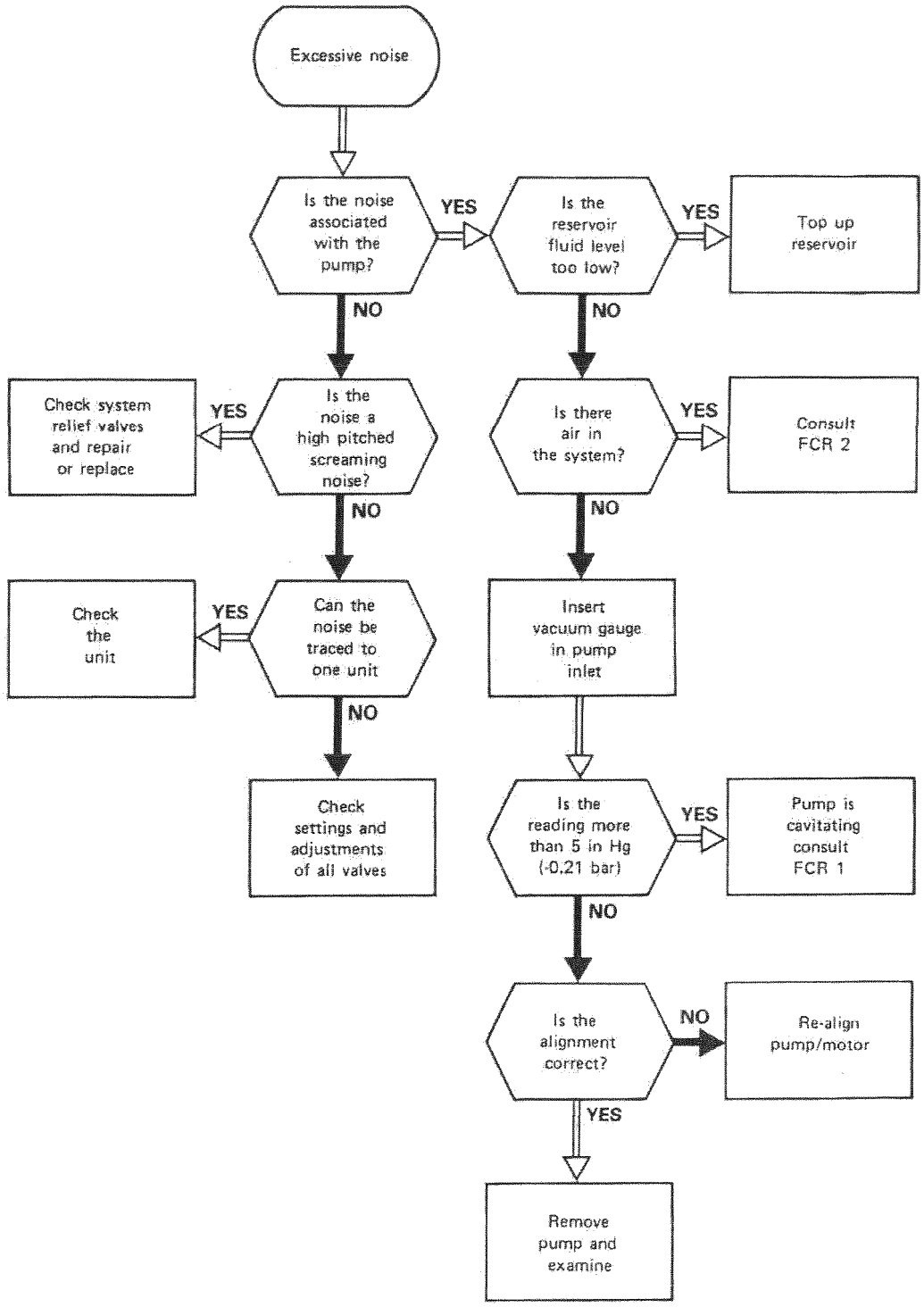
Excessive temperature

Algo 0.2



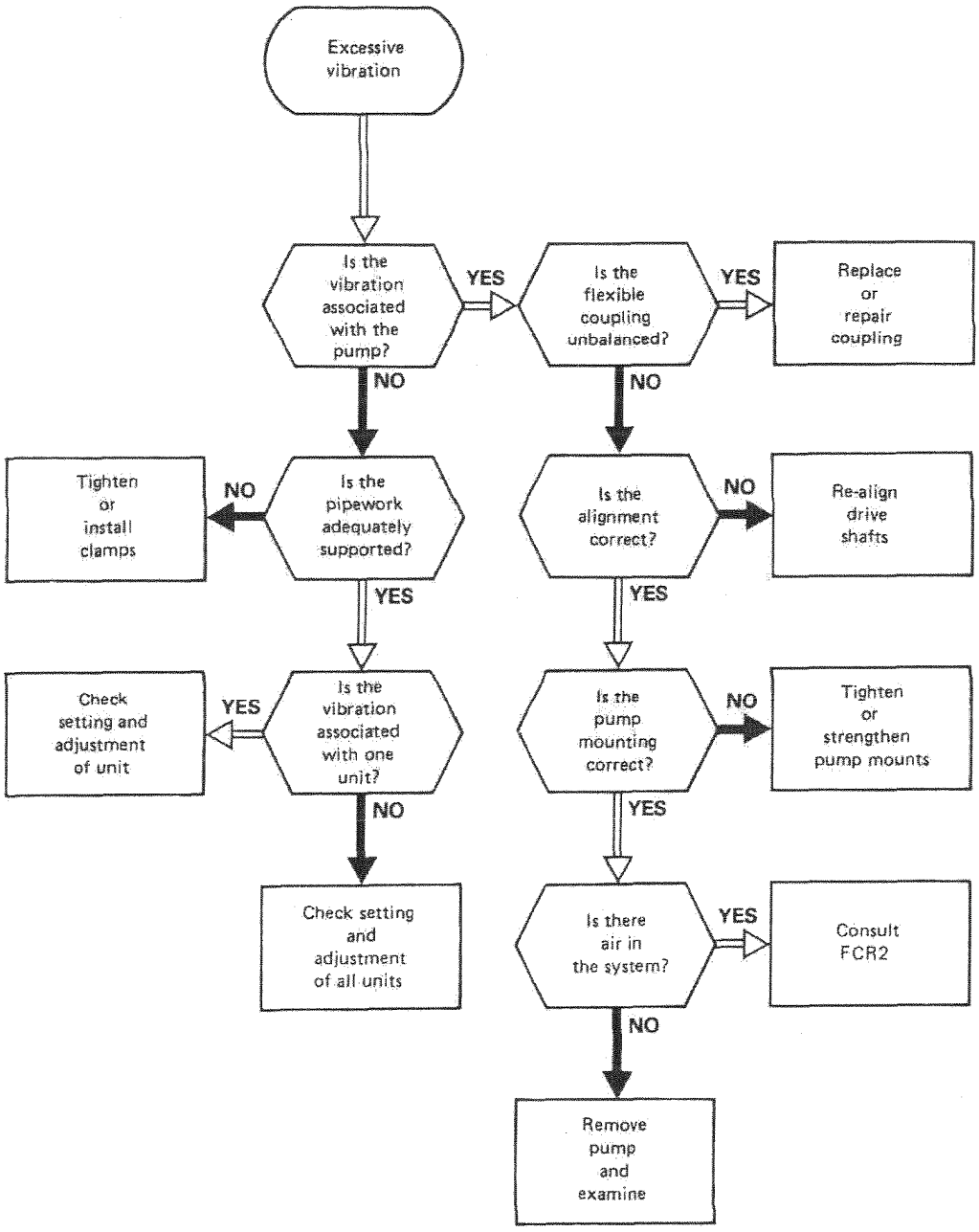
Excessive noise

Algo 0.3



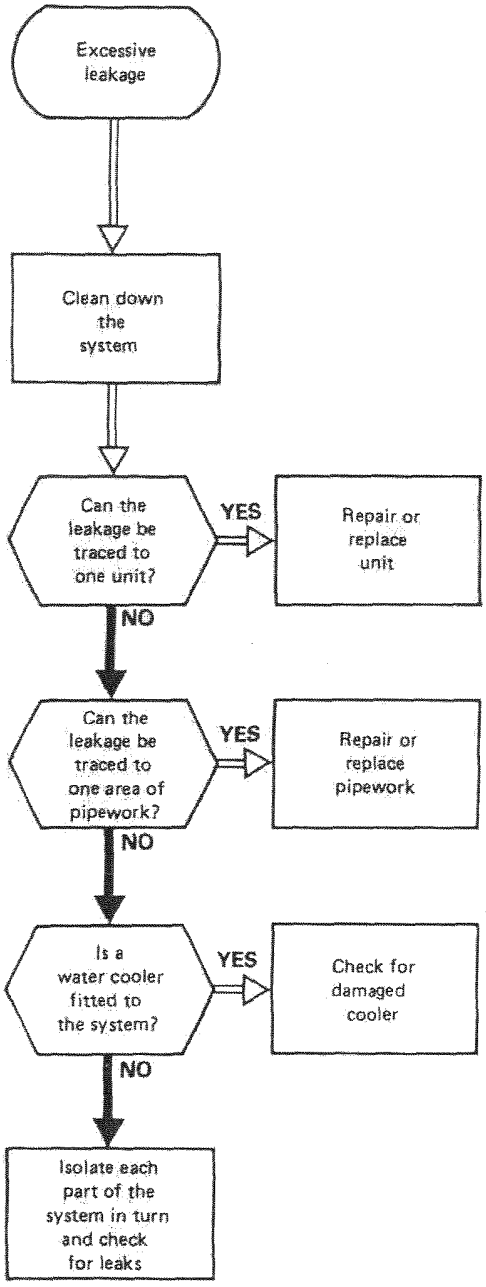
Excessive vibration

Algo 0.4



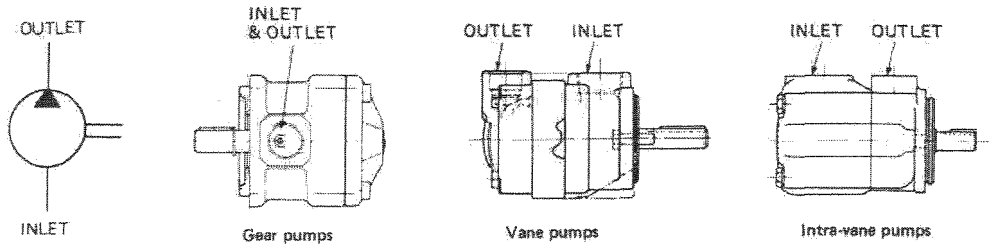
Excessive leakage

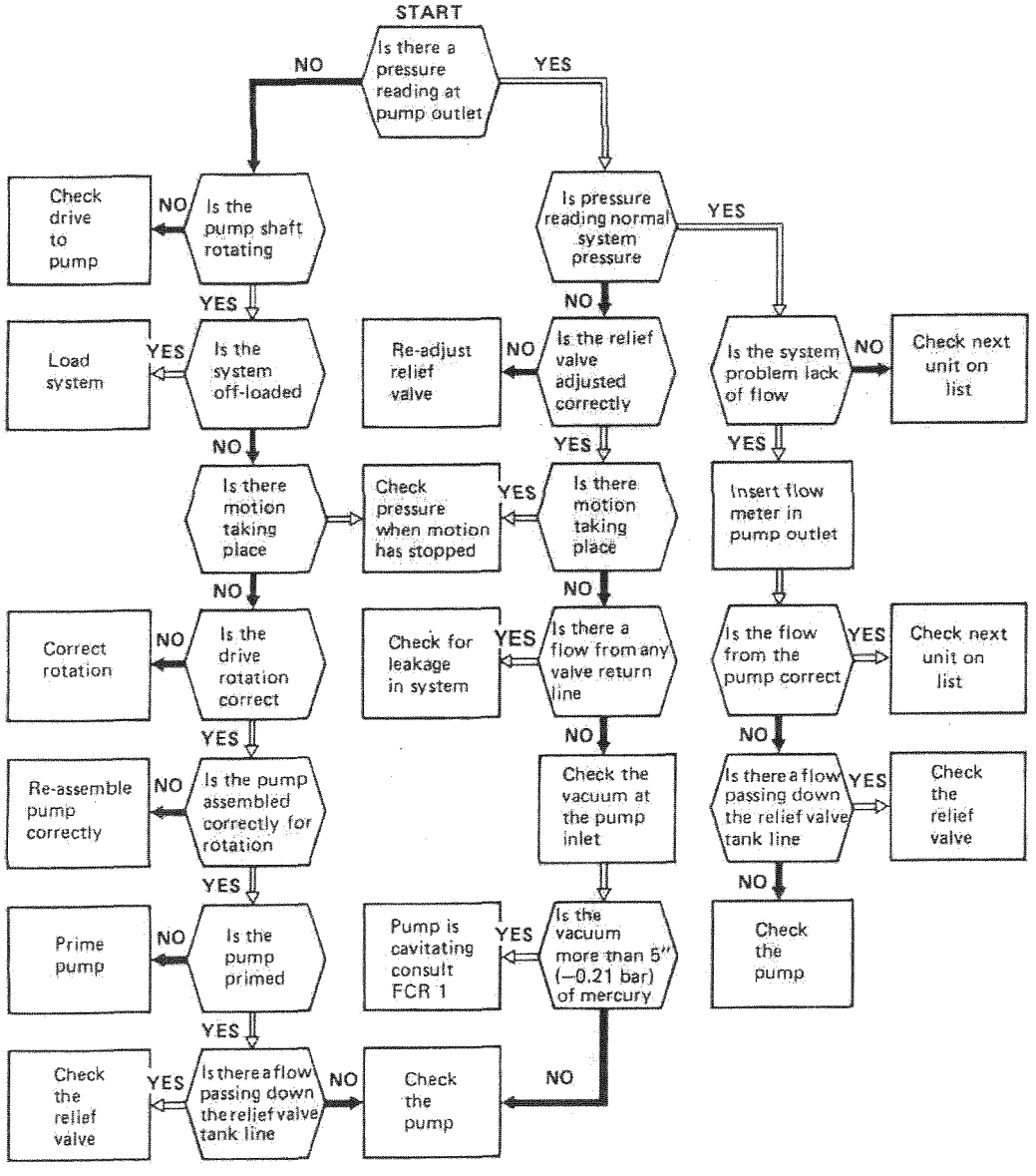
Algo 0.5



System test for gear and vane pumps

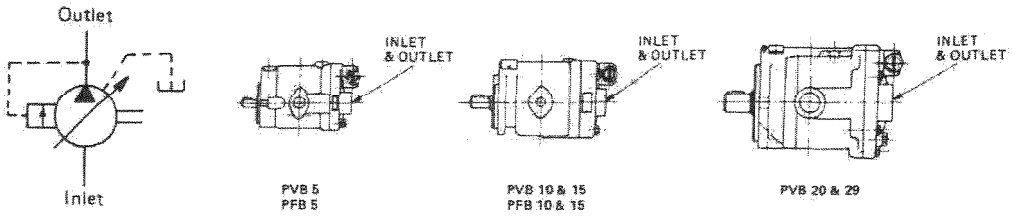
Algo A.1

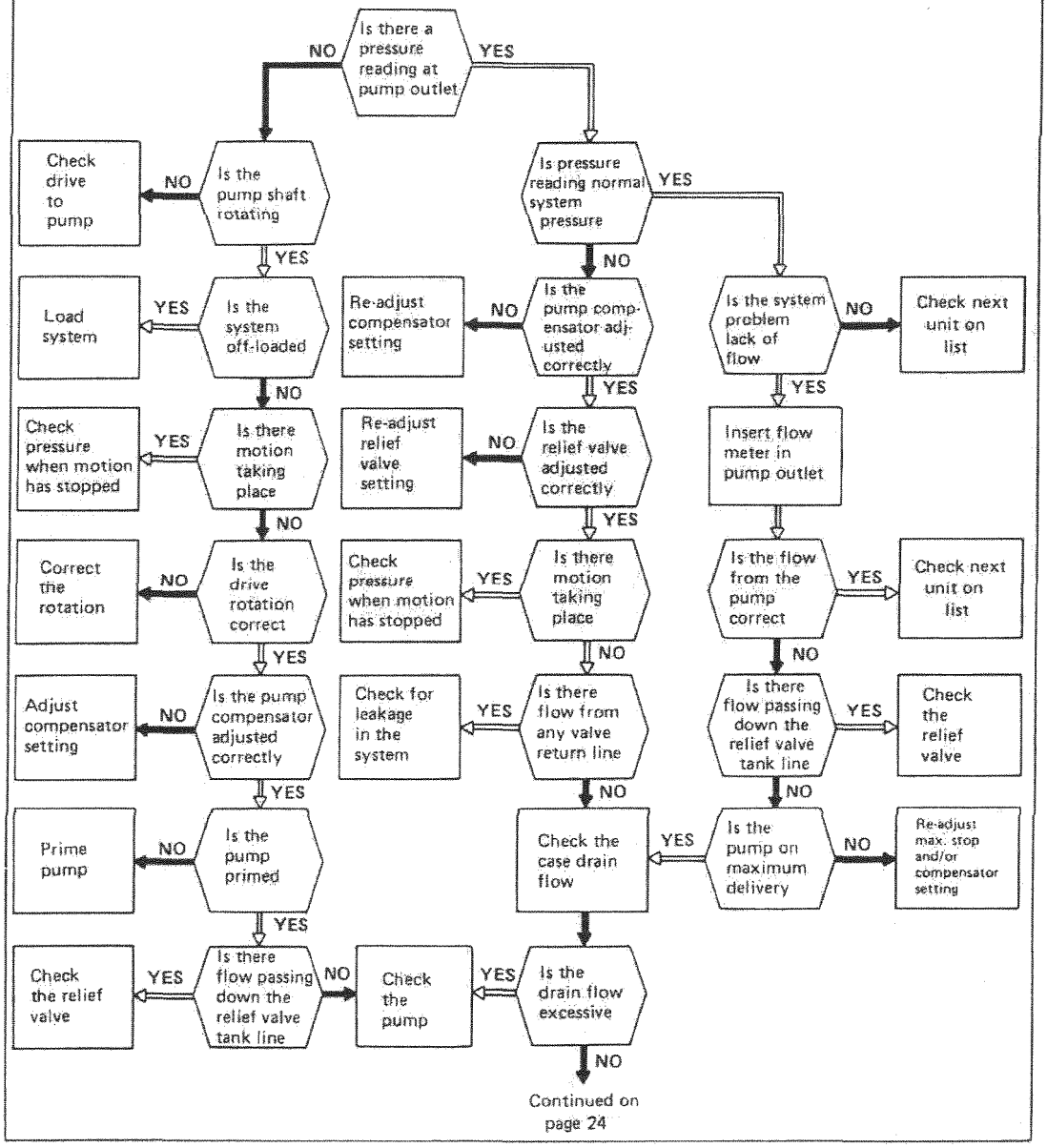




System test for piston pumps

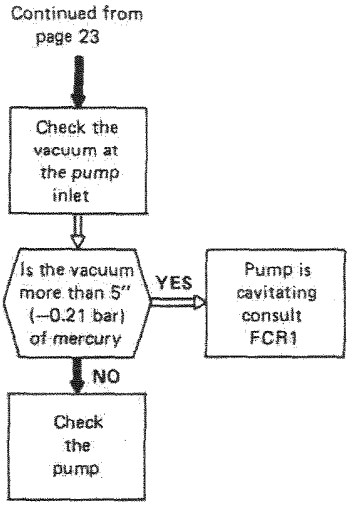
Algo A.2





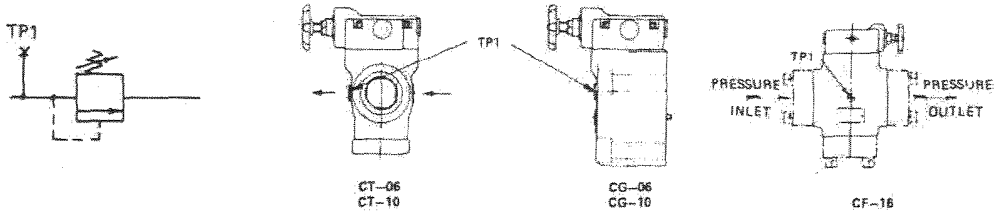
System test for piston pumps (continued)

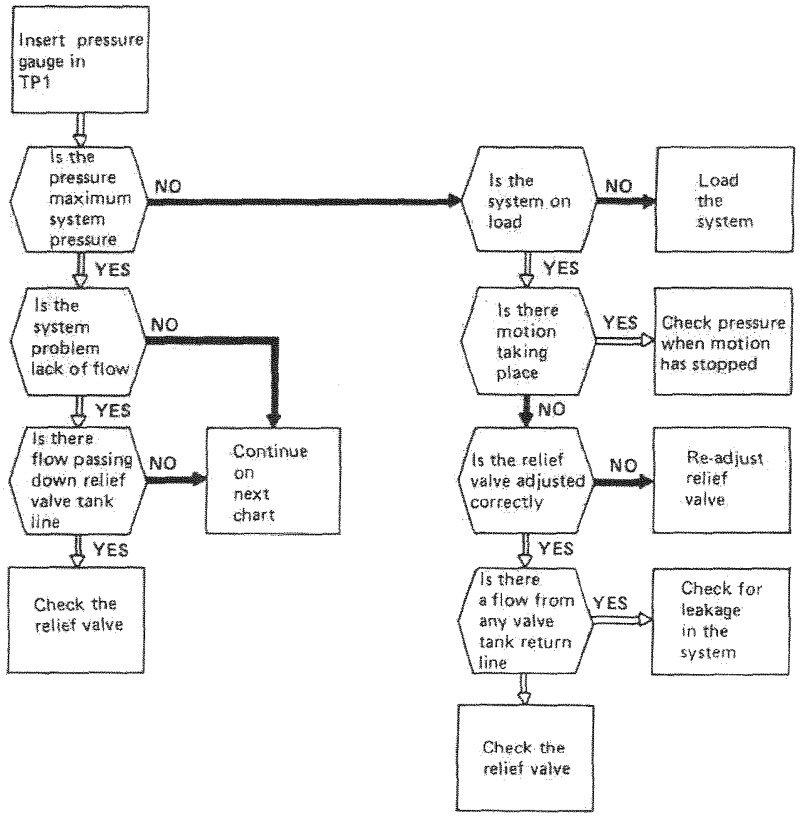
Algo A.2



Sytem test for pressure relief valves

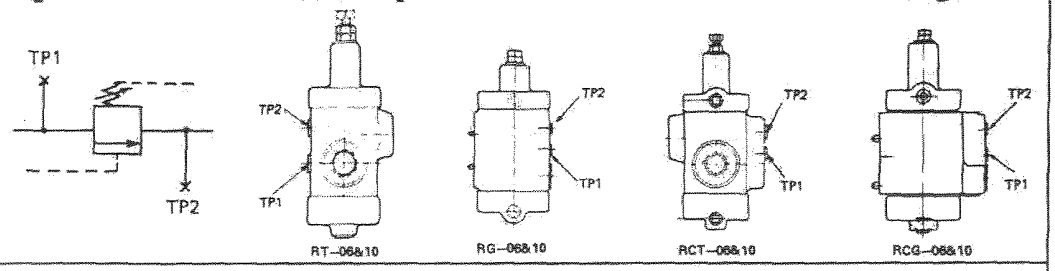
Algo B.1

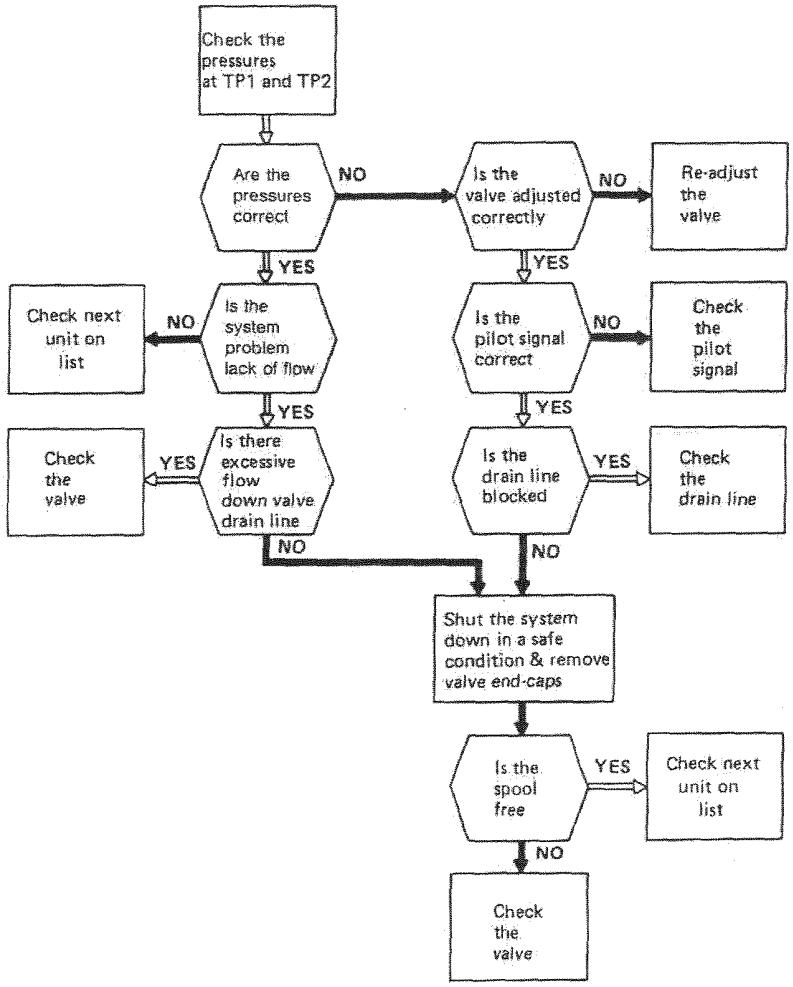




System check for sequence valves

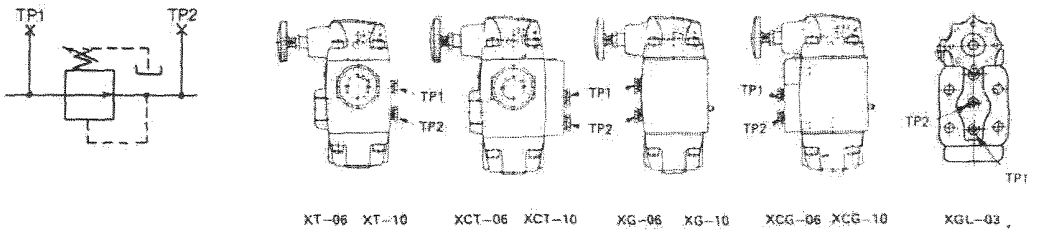
Algo B.2

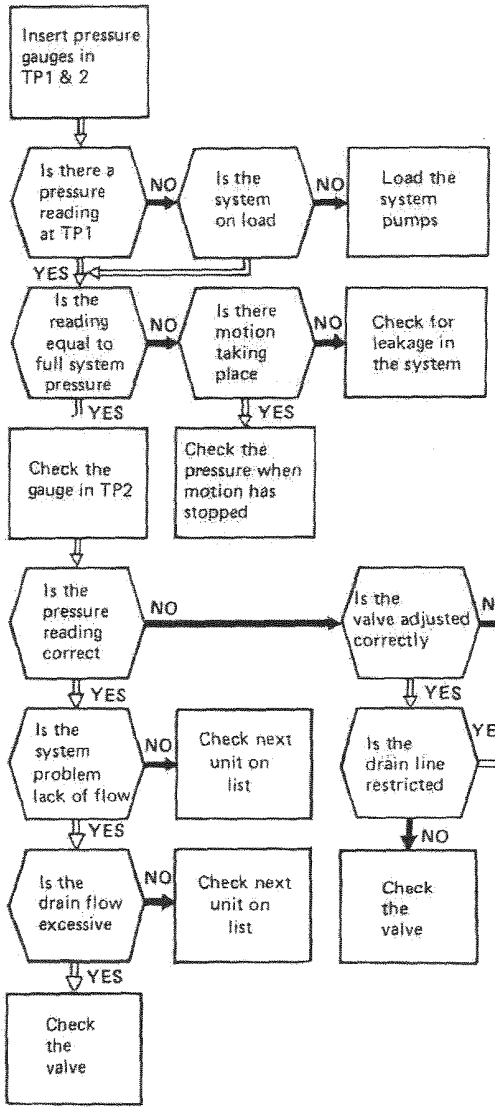




System test for Pressure reducing valves

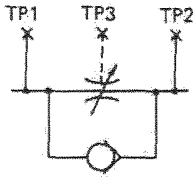
Algo B.3

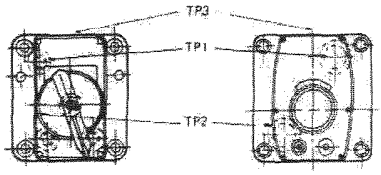




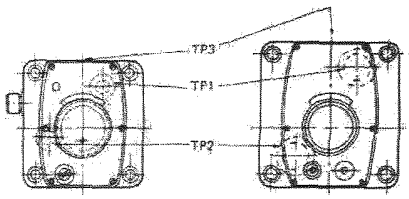
System test for flow control valves

Algo C.1

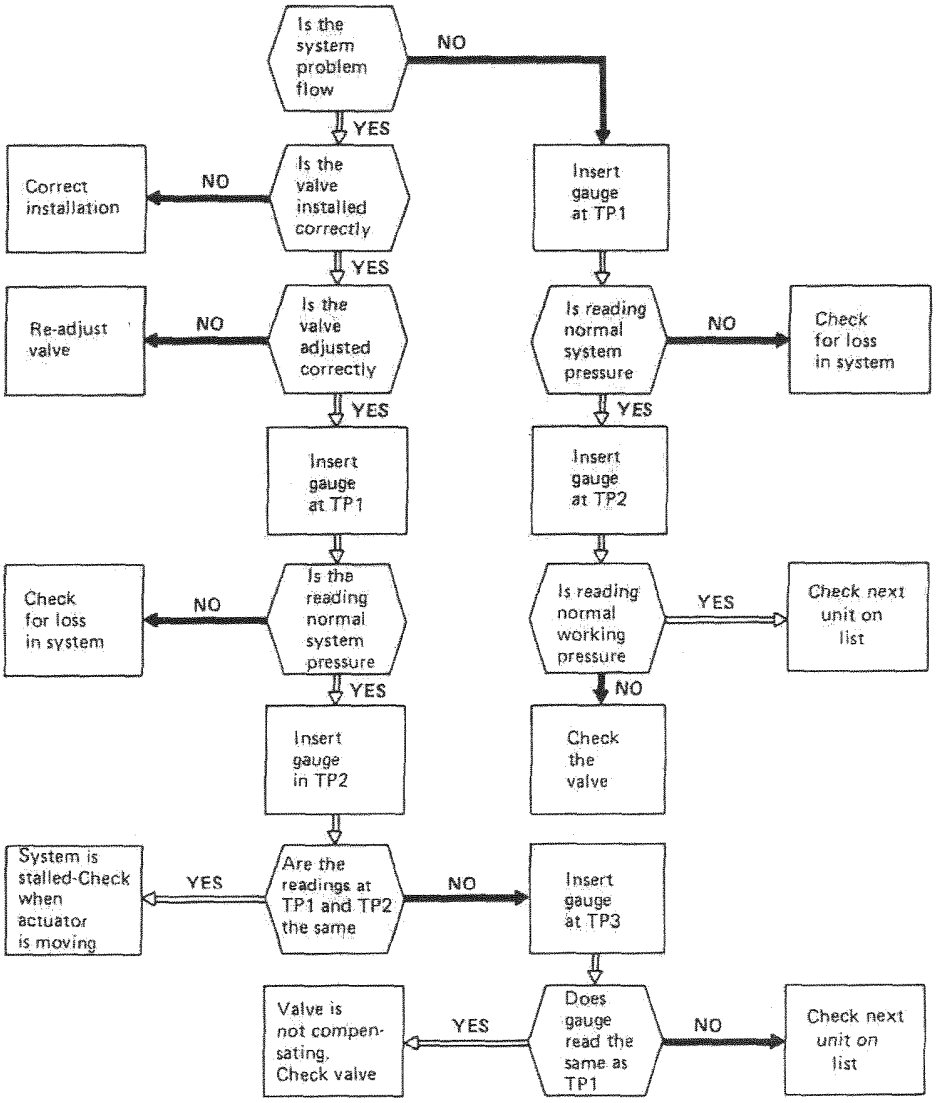




FG–02 FCG–02-1000

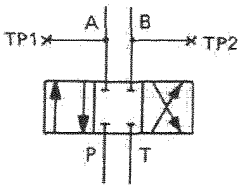


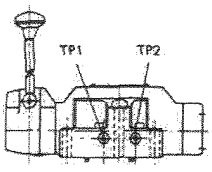
F*G–02–1500 FG–03–28–22



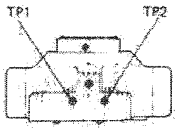
System test for directional control valves

Algo D.1

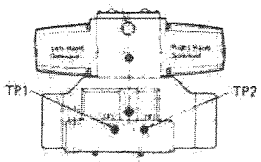




DG17S4–06



DG3S4–06 –10



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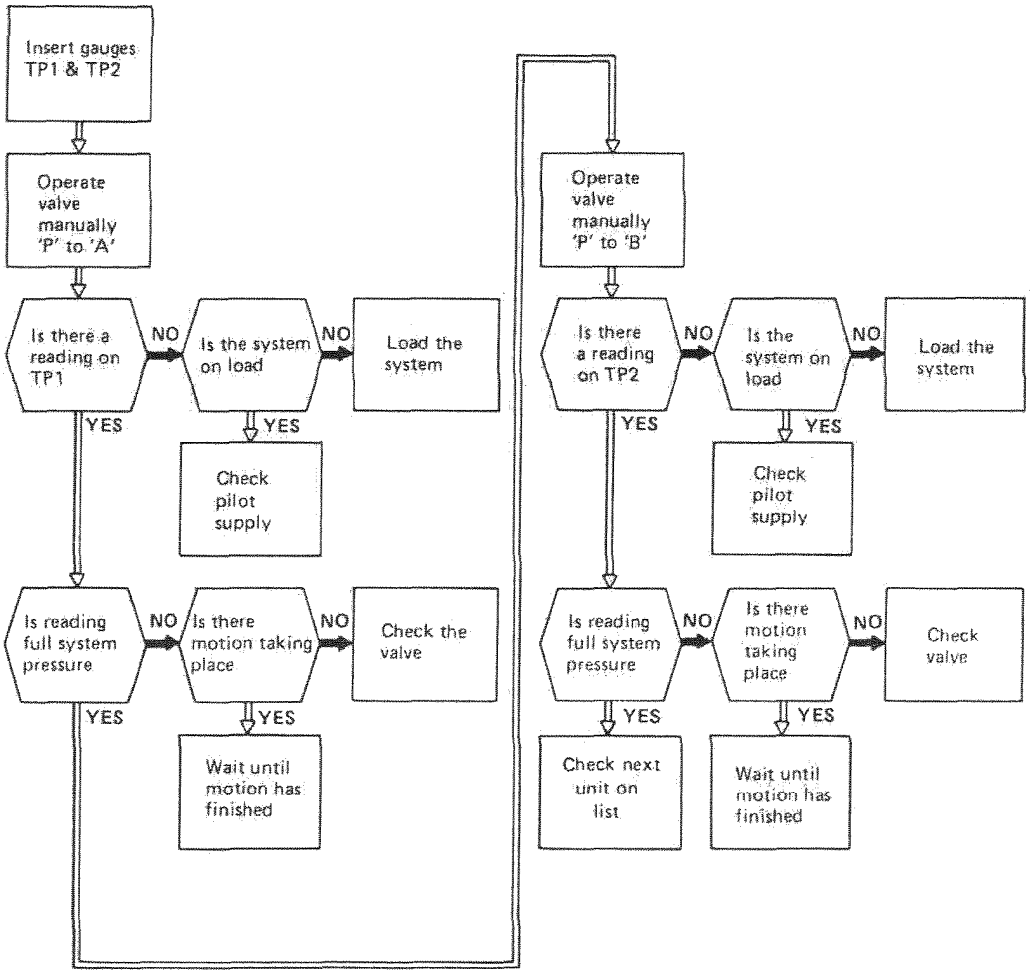
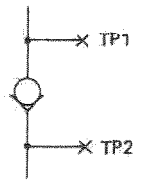
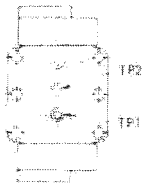


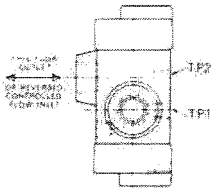
System test for pilot operated check valves

Algo E.1

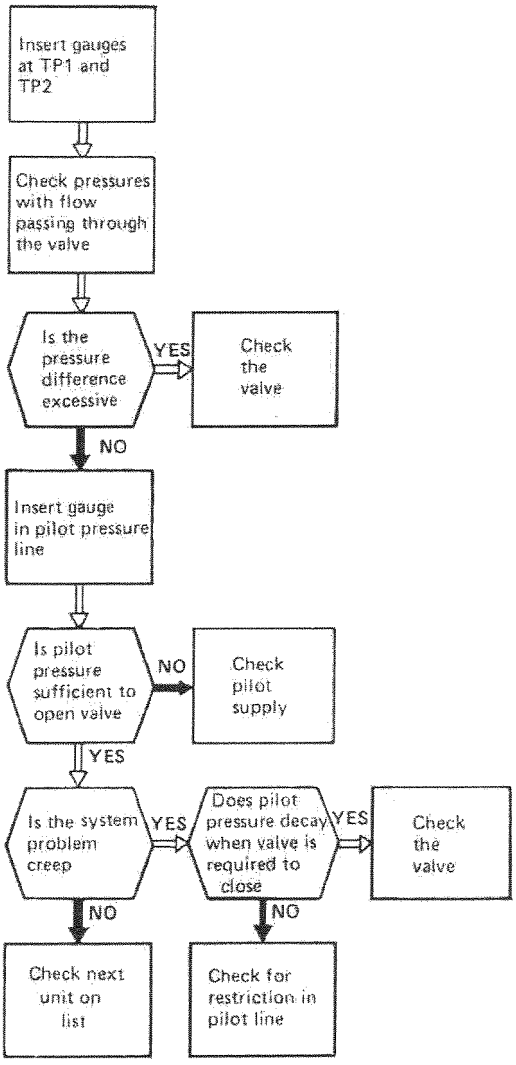




4CG–06
4CG–10

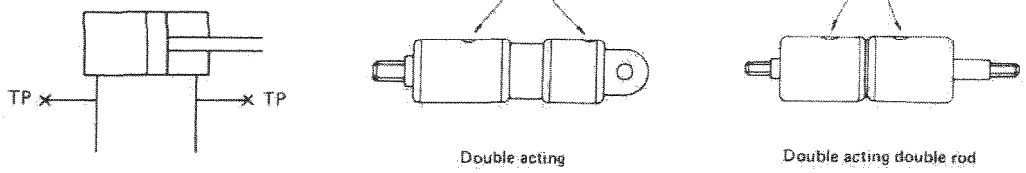


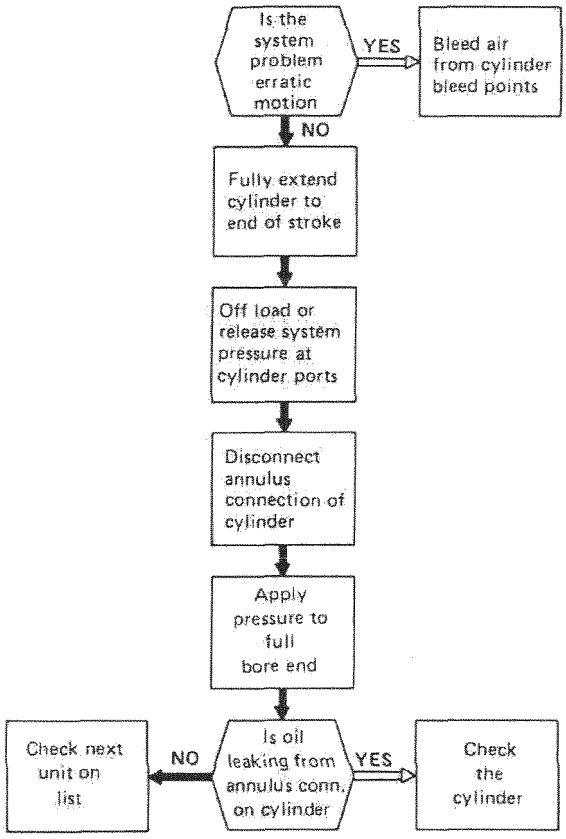
4CT–06
4CT–10



System test for cylinders

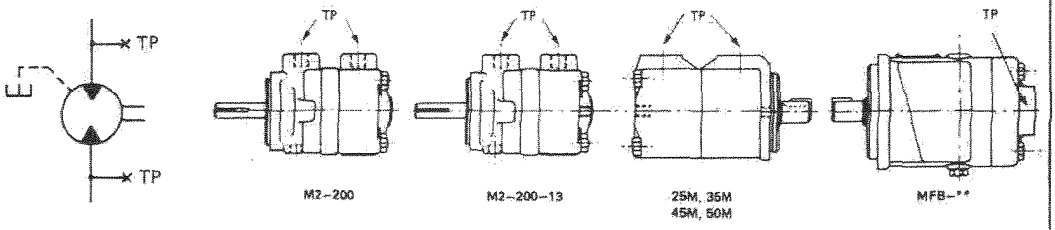
Algo G.1

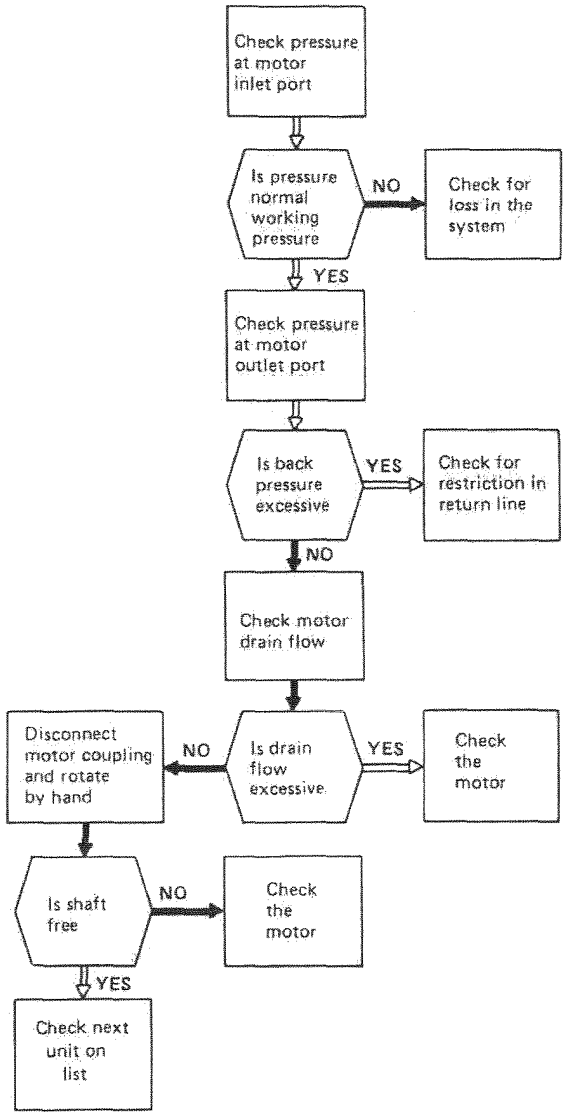




System test for hydraulic motors

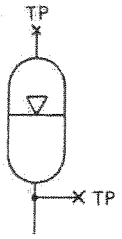
Algo G.2

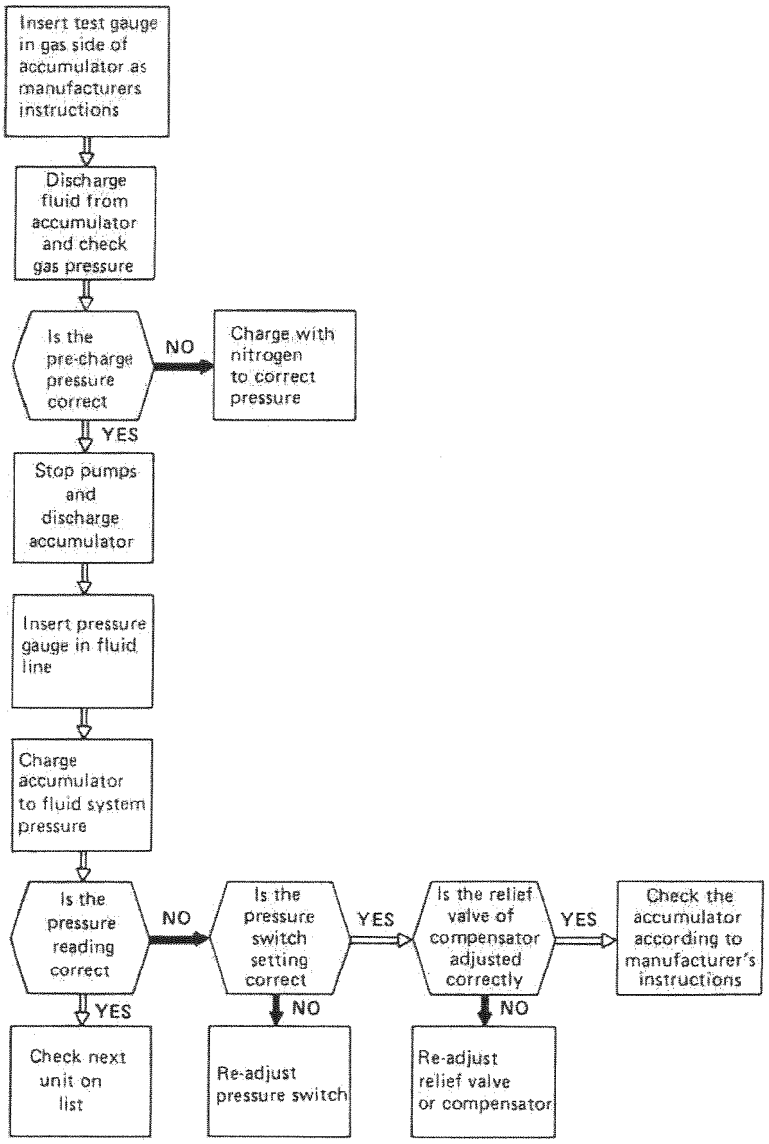




System test for accumulators

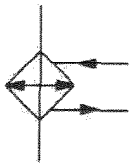
Algo J.1

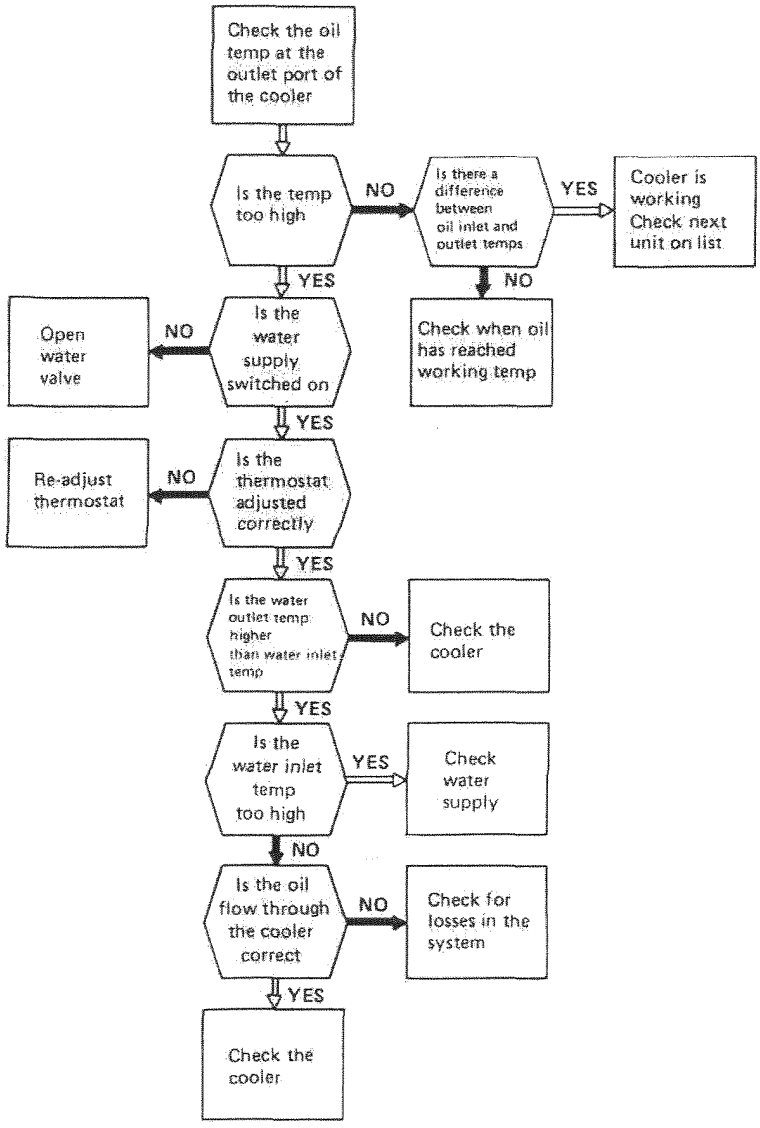




System test for coolers

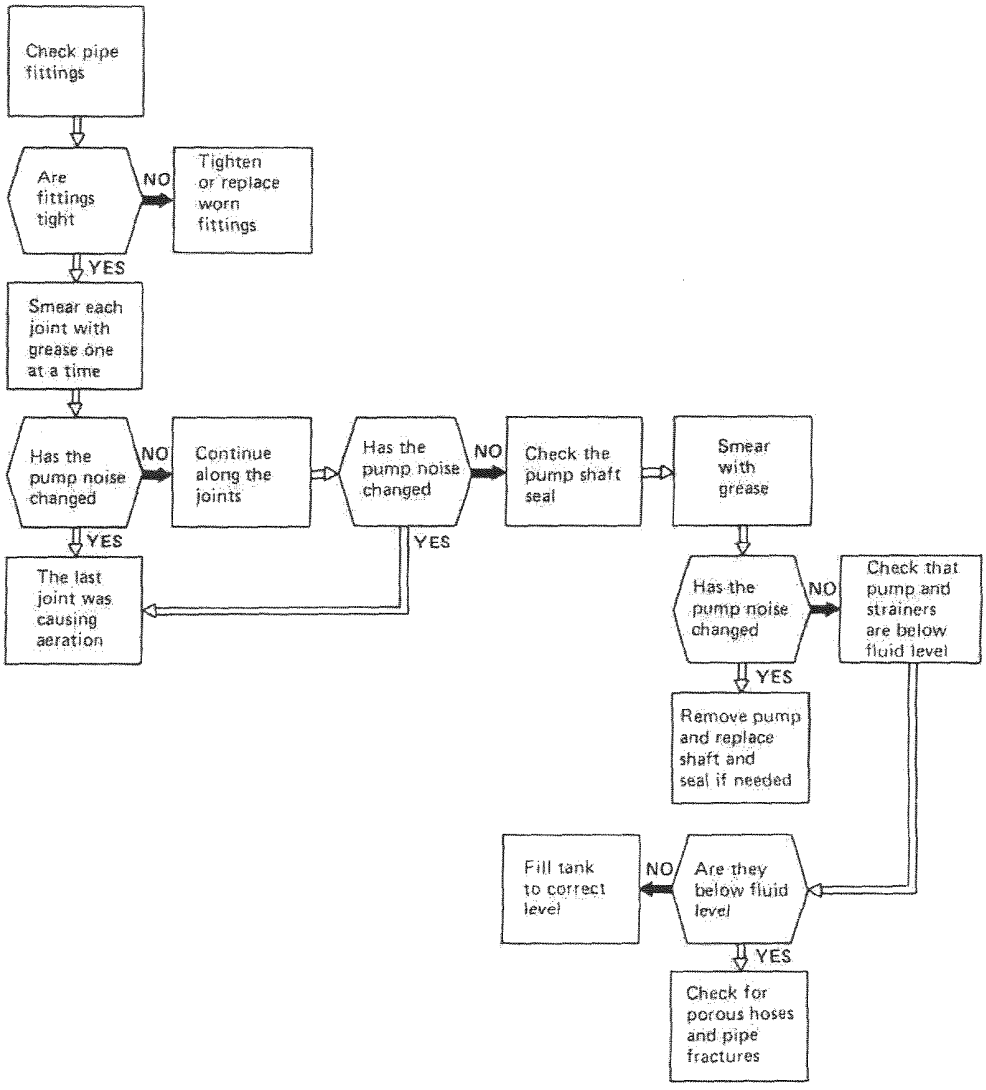
Algo J.2





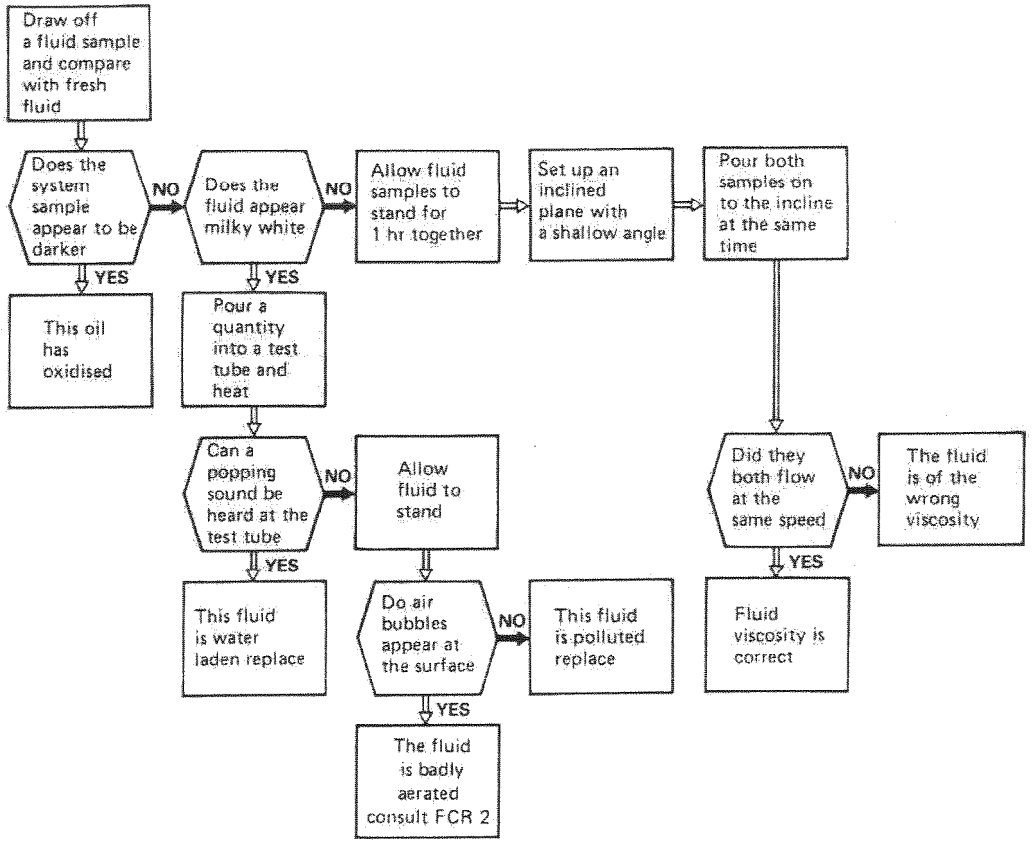
System test for air leaks

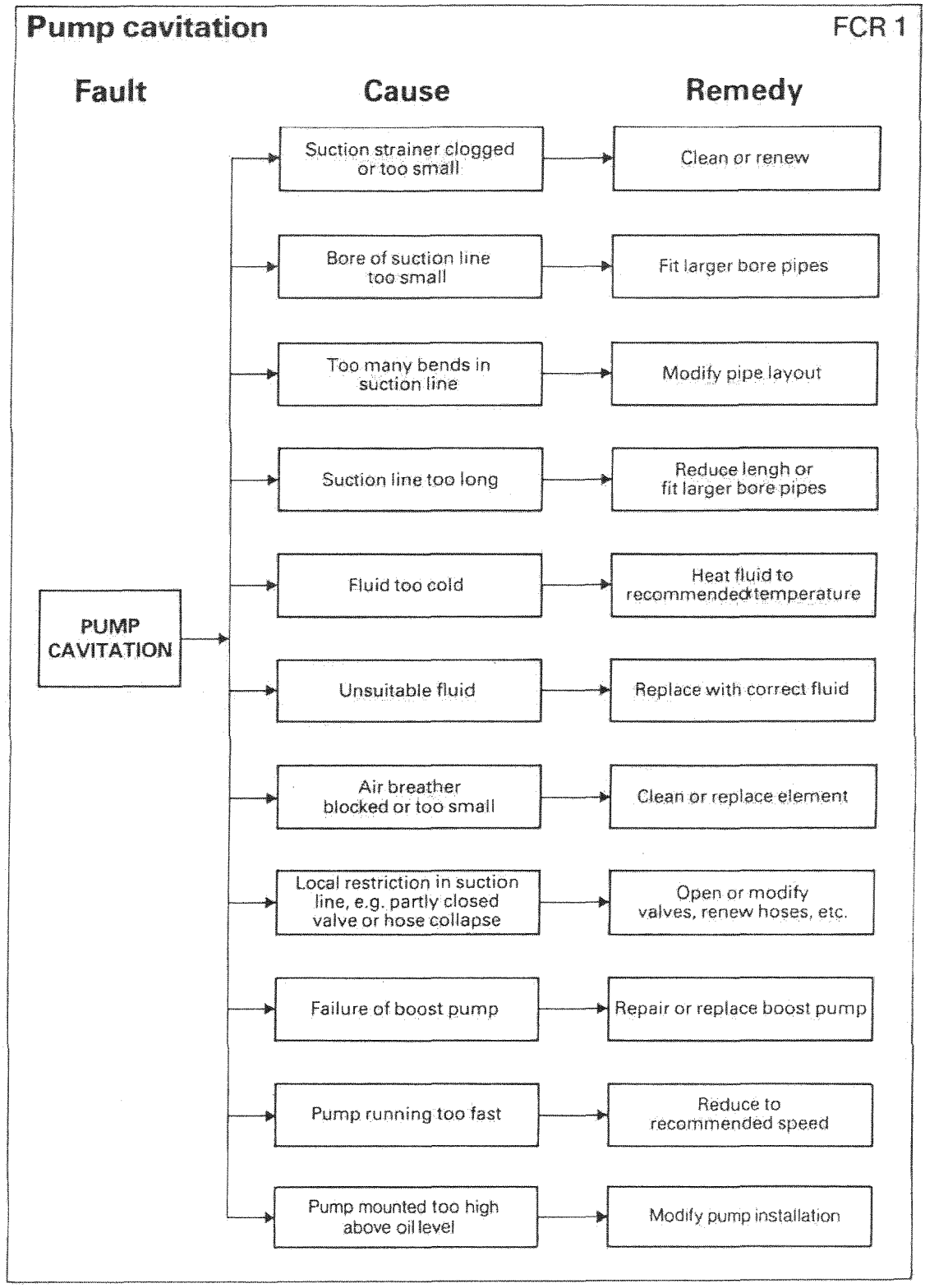
Algo L.1



System test for fluid contamination

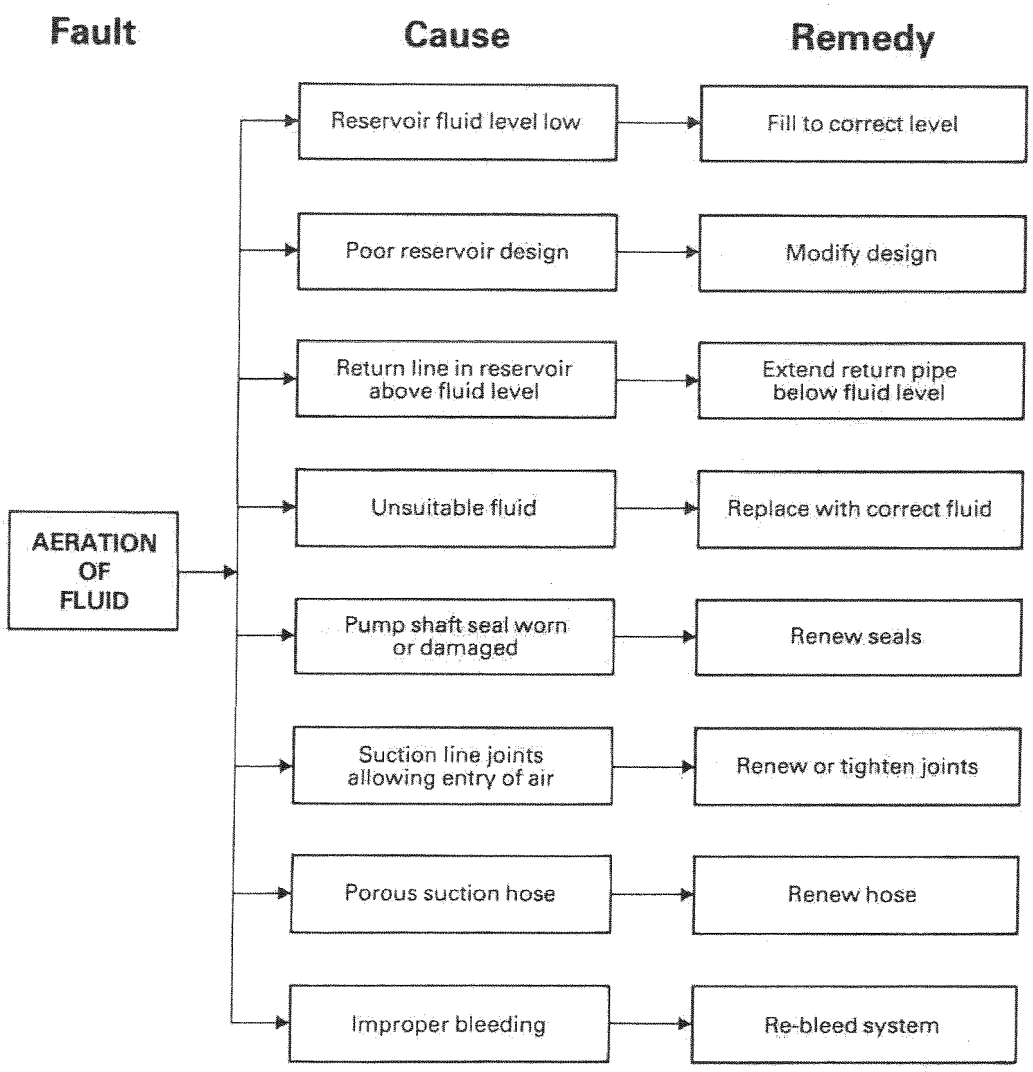
Algo L.2




Pump cavitation
FCR 1
Fault
Cause
Remedy
PUMP CAVITATION
Suction strainer clogged or too small
Clean or renew
Bore of suction line too small
Fit larger bore pipes
Too many bends in suction line
Modify pipe layout
Suction line too long
Reduce lengh or fit larger bore pipes
Fluid too cold
Heat fluid to recommended temperature
Unsuitable fluid
Replace with correct fluid
Air breather blocked or too small
Clean or replace element
Local restriction in suction line, e.g. partly closed valve or hose collapse
Open or modify valves, renew hoses, etc.
Failure of boost pump
Repair or replace boost pump
Pump running too fast
Reduce to recommended speed
Pump mounted too high above oil level
Modify pump installation

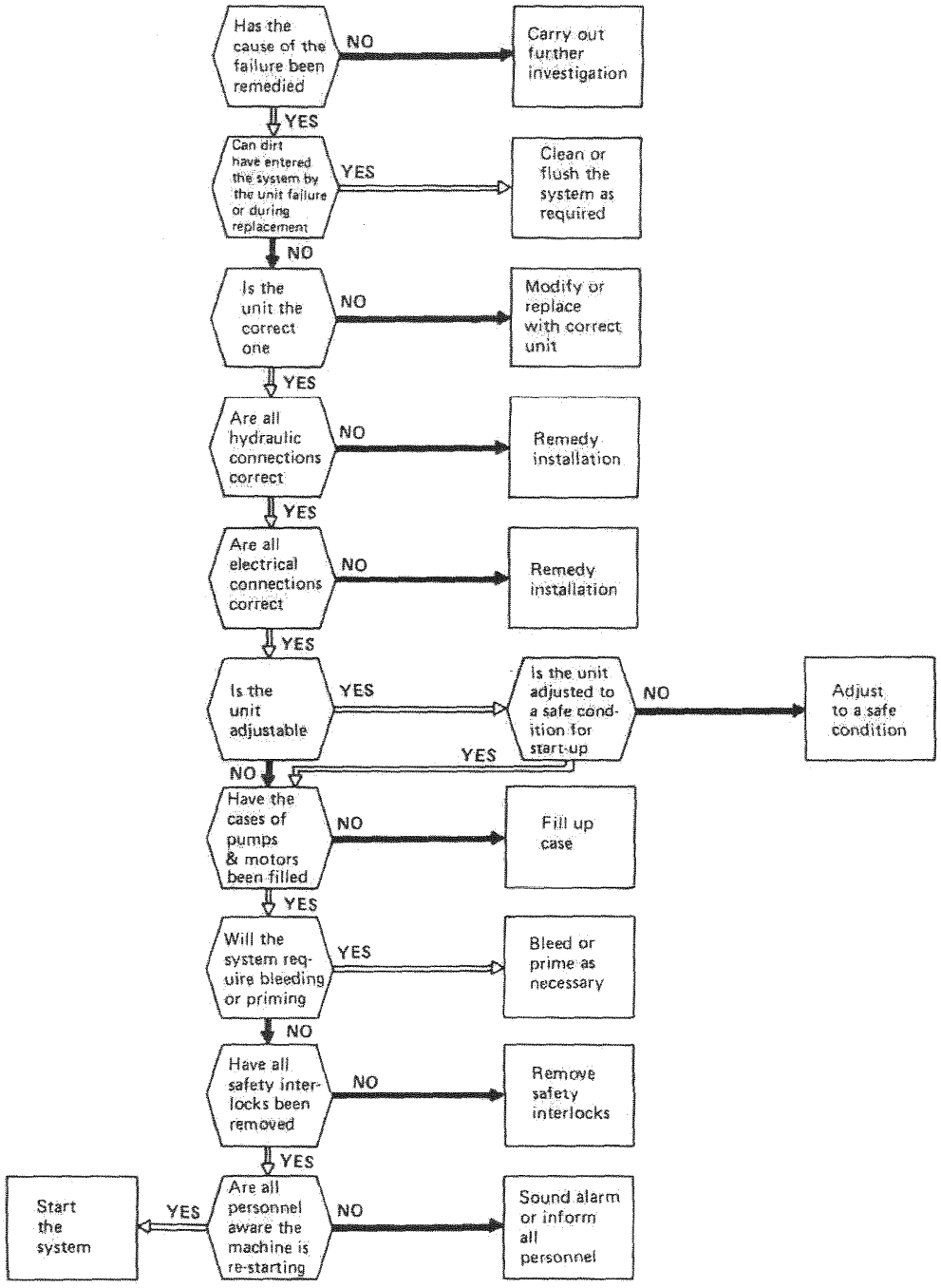
Aeration of fluid

FCR 2



Re-start procedure

Algo 0.6



Bar trimming machine

Troubleshooting exercise

Introduction

To illustrate the procedure described in this book, an example will be worked through in detail for a typical machine as shown on page 41.

The Bar Trimming Machine consists of a carriage which is driven backwards and forwards by a hydraulic motor. Mounted on the carriage is a traverse cylinder which moves a cutting torch across a metal bar. Two clamp cylinders hold the bar in place and a semi-rotary actuator pushes the bar onto a roller table at the end of the cycle.

Assume that the operator has reported three problems which occurred simultaneously and prior to which the machine was operating satisfactorily.

Symptoms

1. The carriage drive motor is slow in both directions
2. The traverse cylinder is slow when extending.
3. The system is running hotter than usual.

Starting Point

Start at the fundamental problem, ie. the slow movement of the carriage motor and traverse cylinder, using the heat problem as a clue.

Since two machine faults have occurred it is not impossible that two faults have occurred in the hydraulic system simultaneously. It is more likely however, that one fault in the hydraulic system is causing both machine faults. The logical procedure therefore, is to look at each machine fault in turn and arrive at a list of units which may be responsible for that particular symptoms then look for units common to both lists, ie. units which could cause both symptoms.

Machine Fault 1

Slow speed of carriage drive motor.

Step 1. The symptom is one of speed, therefore, the problem is *Flow*.

Step 2. Consult the circuit diagram and identify the units and their function.

Step 3. List the units that could affect the flow to the carriage drive motor

(The object of this step is to narrow down the number of units to be checked as much as possible. It is important however not to apply too much judgement at this stage, since it is better to have a long list rather than a short one which misses out the vital unit.

It is very easy to overlook a component when drawing up the list, so for most systems it is safest to go through the parts list numerically and consider each unit in turn)

Referring to the circuit diagram the following units may cause the problem.

Unit No	Comments
9.	A partially closed inlet valve could starve the pump and hence the system of fluid *(under these circumstances the pump would probably be cavitating and hence noisy but as mentioned above, do not apply too much judgement at this stage).*
10.	A blocked inlet filter could cause the same effect.
11.	Low output from the pump would affect the carriage drive motor since the flow to the motor is not throttled by any flow control valves.
13.	A partially closed shut-off valve may have the same effect as a low pump output.
16.	A partially closed check valve will also have the same effect.
17.	A leaking relief valve again reduces the effective pump output.
18.	A blocked return line filter may restrict the exhaust flow from the motor. *(Although a by-pass is fitted the filter may have been installed the wrong way round).*
20.	It can be assumed that the purpose of the accumulator in this system is to supplement the pump flow, therefore an incorrect pre-charge pressure may affect the flow rate from the accumulator.
21.	A partially closed isolating valve would tend to restrict the flow from the accumulator and hence to the motor.
22.	A blow-down valve left open would reduce the effective flow from both the accumulator and the pump.
30.	A directional valve leaking 'P' to 'T' could reduce the flow to the carriage drive motor.
31.	As above.
34.	An excessive leakage down the drain line of the pressure reducing valve could again reduce the flow to the carriage drive motor.
35.	A restriction in the directional valve controlling the carriage drive motor *(caused by a large piece of swarf, incomplete spool movement or wrongly adjusted stroke adjusters for example)* could reduce the flow to the motor.
(36 & 37.	*Although a leaking relief valve may affect the flow to the motor, two faults would have to occur to affect the speed in both directions ie. either 36 & 37 both leaking or 36 & 38 leaking or 37 & 39 leaking. While this is not impossible it is probably very much less likely).*
40.	As for 30 and 31.
42.	As above.
48.	A worn or damaged motor having excessive drain leakage would reduce the effective flow to the motor.
(49 & 50.	*From the solenoid energisation chart it can be seen that neither the traverse cylinder nor the eject rotary actuator are operating at the same time as the carriage drive motor, therefore a leakage in either of these two actuators would not affect flow to the Motor).*
51.	Because the clamp cylinders are held down under pressure when the carriage drive motor is operating (refer to solenoid energisation chart) a leakage across the piston seals could affect the flow to the carriage drive motor.
52.	As above.

Machine Fault 2.

Slow speed of traverse cylinder when extending.

Step 1. Again the symptom is one of speed, therefore the problem is *Flow*

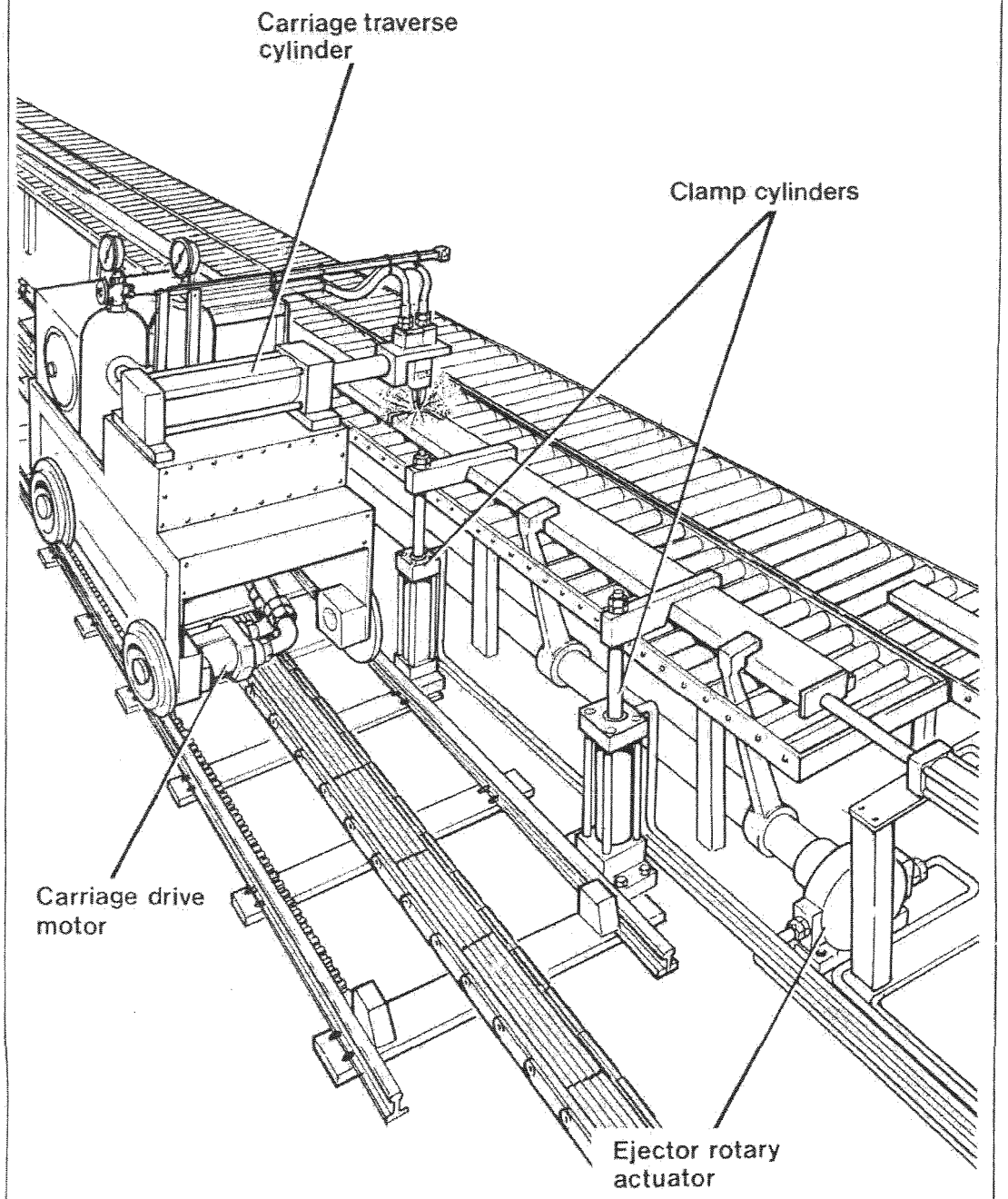
Step 2. Consult the circuit diagram and identify the units and their functions.

Step 3. List the units that could affect the flow to the traverse cylinder when extending.

Unit	Comments
9.	See Machine Fault 1
10.	See Machine Fault 1
11.	See Machine Fault 1.
13.	See Machine Fault 1.
16.	See Machine Fault 1.
17.	See Machine Fault 1.
18.	See Machine Fault 1.
20.	See Machine Fault 1.
21	See Machine Fault 1.
22.	See Machine Fault 1.
30.	See Machine Fault 1
31	See Machine Fault 1.
34.	See Machine Fault 1.
35.	See Machine Fault 1.
40.	See Machine Fault 1.
42	See Machine Fault 1

44. Failure of the by-pass check valve ie. jammed closed, in the flow control valve would restrict the flow to the

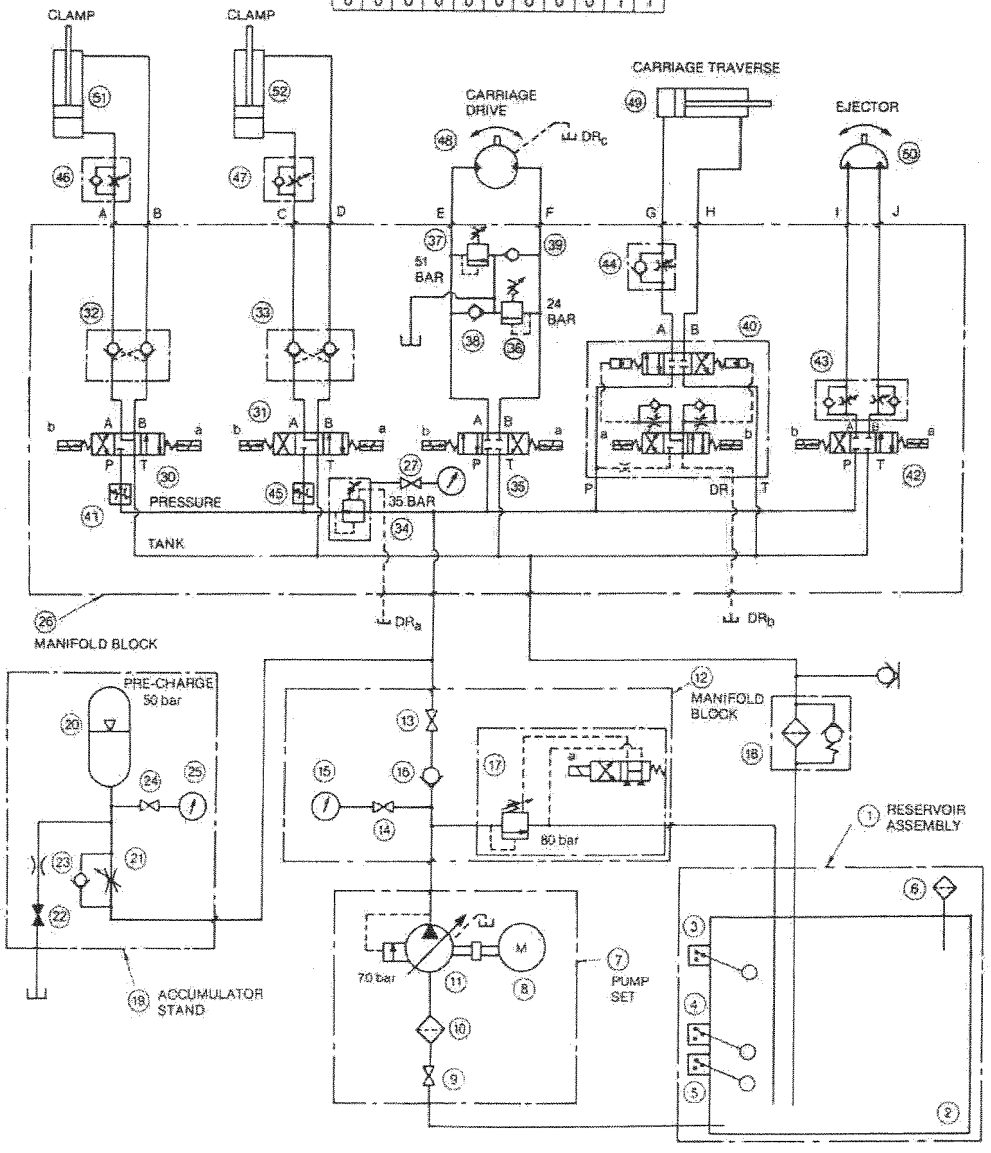
19. Bar trimming machine layout



Circuit diagram for bar trimming machine

SOLENOID CHART

VALVE	30		31		35		40		42	17
SOL	a	b	a	b	a	b	a	b	a	b	a
	0	0	0	0	0	0	0	0	0	0	1
	0	1	0	1	0	0	0	0	0	0	1
	0	1	0	1	0	1	0	0	0	0	1
	0	1	0	1	0	0	1	0	0	0	1
	0	1	0	1	0	0	0	1	0	0	1
	0	1	0	1	1	0	0	0	0	0	1
	1	0	1	0	0	0	0	0	0	0	1
	0	0	0	0	0	0	0	0	1	0	1
	0	0	0	0	0	0	0	0	0	1	1



traverse cylinder when extending.
49. A leakage across the piston seals of the traverse cylinder would reduce the effective flow rate to the cylinder.
51. See Machine Fault 1.
52. See Machine Fault 1.
The units common to both lists ie: units which on their own could cause both machine faults are as follows:-
9, 10, 11, 13, 16, 17, 18, 20, 21, 22, 30, 31, 34, 35, 40, 42, 51, 52.
(Therefore, from a total of 52 units on the system the search has been narrowed down to 18 by doing no more than look at the circuit diagram, highlighting the importance of being able to identify and understand circuit diagrams).
Step 4. Arrange the list of units in order of checking.
(The order in which units are checked is purely arbitrary and may be influenced by such things as past experience, layout of components, position of gauges etc., however, some units will inevitably be easier to check than others).

(a) Shut-off valves can be checked very easily to ensure they are in the correct position, so these may come first on the list – **9, 13, 21, 22.**
(b) Assuming indicators are fitted to the filters, these can also be checked easily – **10, 18.**
(c) A pressure gauge is fitted to the pump outlet port so the setting of the pump compensator and relief valve can be checked quite readily – **11, 17.**
(d) A pressure gauge is fitted to reducing valve **34** so the setting of this valve can be checked – **34.**
(e) The clamp cylinders can be quickly checked for abnormal symptoms – **51, 52.**
(f) The directional valves can now be checked for any abnormal symptoms – **30, 31, 35, 40, 42.**
(g) Finally check valve 16 can be checked for abnormal symptoms giving the complete list in order as – **9, 13, 21, 22, 10, 18, 11, 17, 34, 51, 52, 30, 31, 35, 40, 42, 16.**
Step 5. Preliminary check.
(Before going to the trouble of fitting additional pressure gauges, flow meters etc., or of removing pipework, there are certain things that can be checked with the instrumentation already installed, or with the human senses of sight, touch, and hearing. Unless this step is carried out, it is very easy to overlook what in hindsight appears a very obvious problem, ie: look for the obvious first).
For each of the units on the list the following questions should be answered where applicable.
Is the unit correct? (model number).
Is the unit installed correctly?
Is the unit adjusted correctly?
Is the external signal correct?
Does the unit respond to the signal?
Are there any abnormal symptoms (heat, noise etc.)?
Assume that the preliminary check is carried out for each unit up to the clamp cylinder **52**, which is unusually hot.
Step 6. Algotest
Having discovered that one unit exhibits abnormal symptoms ie: heat, the unit can now be checked in more detail be referring to the system test sheet for cylinders ie: **ALGO G.1**
Assume that having removed the connection from the rod end of the cylinder and pressurised the full bore side fluid is found to be leaking from the rod end connection, ie; the piston seals have failed.
Step 7. The failed unit has now been located, and a decision can be made whether to strip the unit in situ and make a repair or replace the complete unit, removing the failed unit to the second line service area for further examination.
Step 8. Think!
Having made the repair or replaced the unit, thought should be given to both the cause and the consequence of the failure. Assuming the cylinder piston seals were damaged, the following questions should be answerd before the machine is restarted:–
What caused the seals to become damaged?
- contamination?
- heat?
- wrong seals?
- wrong installation?
  etc.

Will the failure have had any effect on the rest of the system?
- If the seal has broken up,have particles of rubber entered the system?
- has the oil become overheated and oxidised?
- have any valves been adjusted to compensate for the leakage and will now require re-adjusting etc.

By thinking about the cause and the consequence of the failure, the same problem (or a consequential one) may be prevented at a later date.

VICKERS

A TRINOVA Company

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Troy, Michigan 48007
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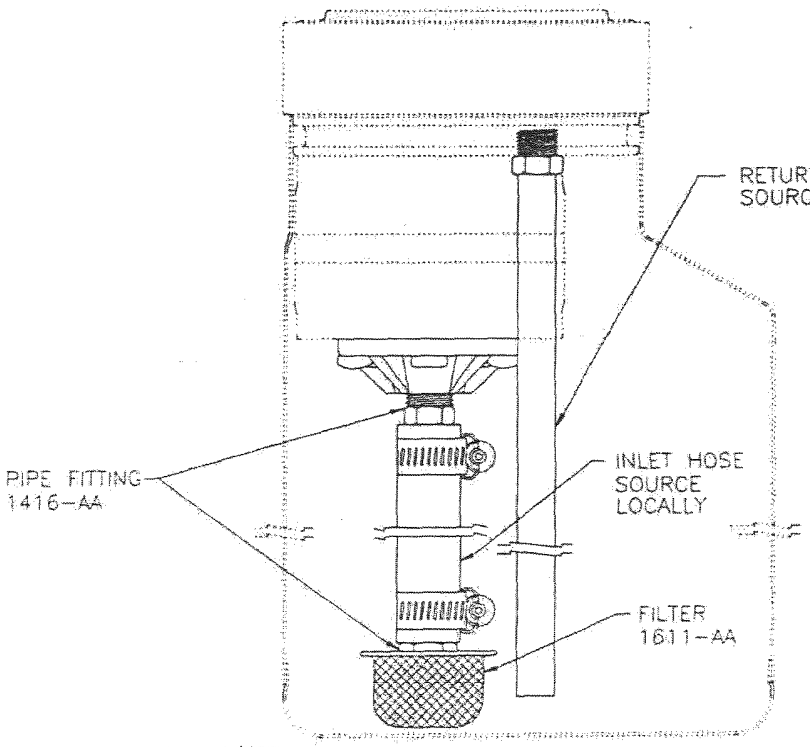
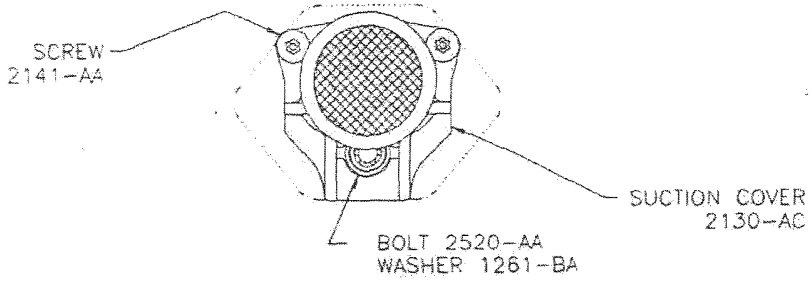
Printed in U.S.A.

Fenner Fluid Power

DISTRIBUTOR POWER UNIT PROGRAM



FOR FLOWS OVER 3 U.S. GPM
USE 1413-AA LARGE FILTER.



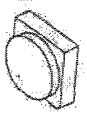
NOTE:

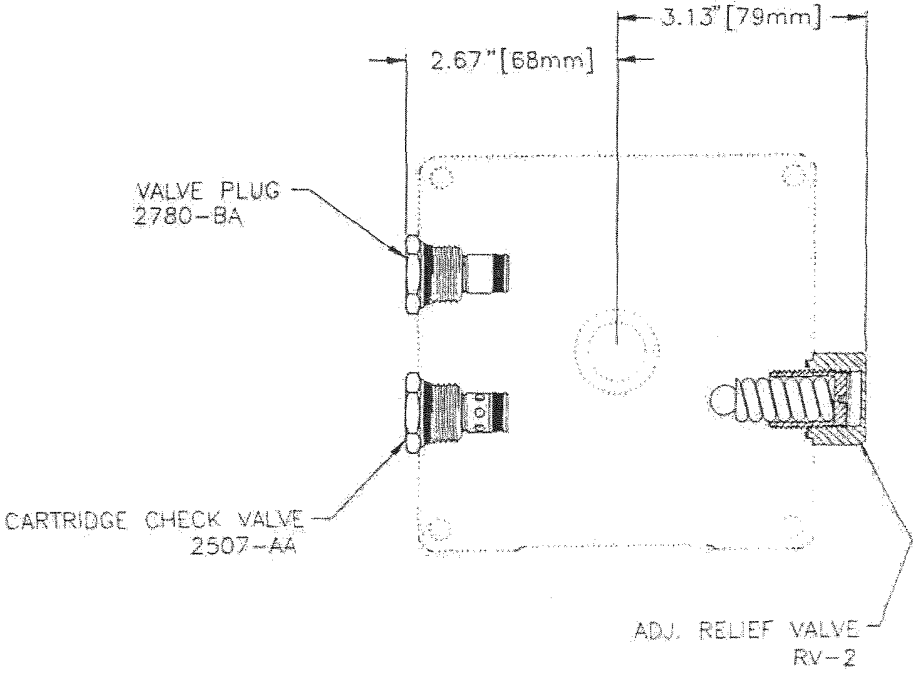
THE INLET HOSE AND RETURN TUBE ARE TO BE SOURCED LOCALLY-
RETURN TUBE - 3/8"[9.5mm] ODx ANY GAGE STEEL TUBE.
INLET HOSE - 5/8"[15.8mm] ID (7/8"[22.2mm] OD) CLEAR VINYL TUBE.

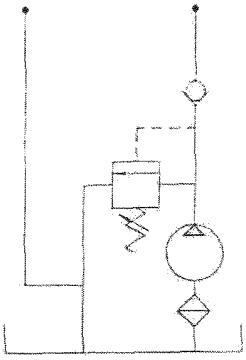
CHANGE	TITLE	SCALE	REV
ADD METRIC DIMS.	VERTICAL PLUMBING KIT	NONE	C
DRAWN: GLC — DATE: 24-JUL-95 — CHECK: DP — DATE: 13 SEP 95		PART NO.: KV	

Fenner Fluid Power

DISTRIBUTOR POWER UNIT PROGRAM







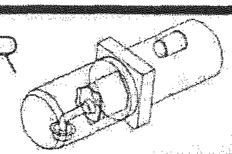
* KIT INCLUDES 4 COLOR-CODED RELIEF SPRINGS AS FOLLOWS. BLUE (500-1000 PSI)[34.5-69 BAR], GREEN (1000-2000 PSI)[69-138 BAR], RED (2000-3000 PSI) [138-207 BAR], BLACK (3000-4000 PSI)[207-276 BAR].

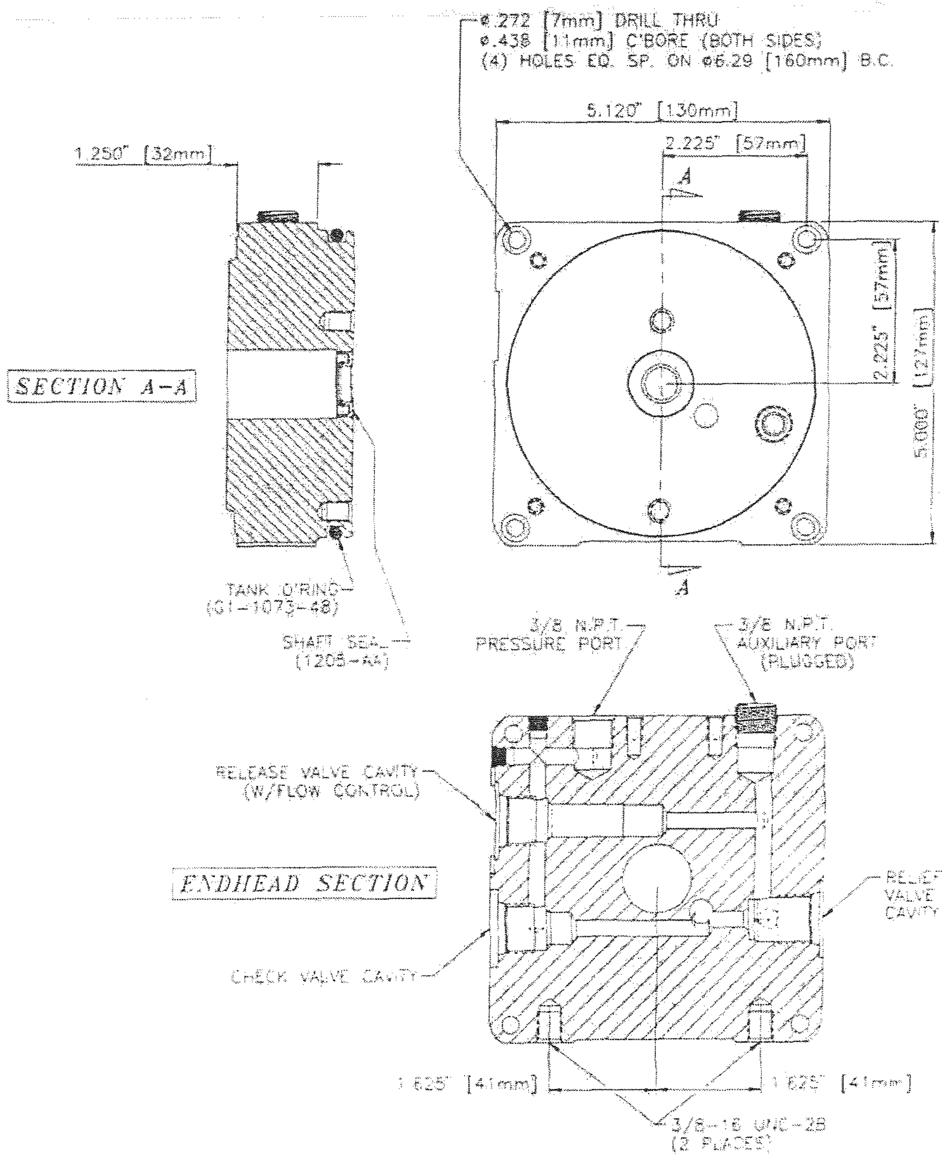
CHANGE	TITLE	SCALE	REV.
ADD METRIC DIMS.	RELIEF & CHECK VALVE KIT	NONE	D

DRAWN	DATE	CHECK	DATE	PART NO.
GLC	24-JUL-95	Def	13 Sep 95	KC07

Fenner
Fluid Power

DISTRIBUTOR POWER UNIT PROGRAM

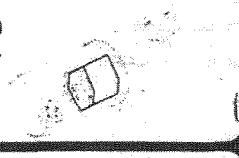


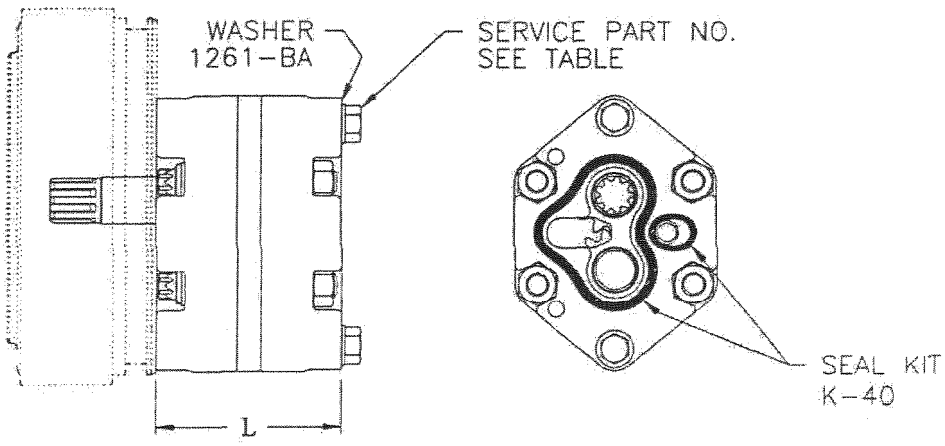


B CHANGE: REVISED DRWG. TO MATCH PARTS USED	TITLE: ENDHEAD UNC FOOTMOUNTS N.P.T. PORTS	SCALE: NONE	REV. A
DRAWN: MwC DATE: 20-DEC-93 CHECK: DeP DATE: 13-DEC-93		PART NO. KN11	

Fenner Fluid Power

DISTRIBUTOR POWER UNIT PROGRAM





- KIT INCLUDES WASHERS AND METRIC MOUNTING BOLTS.
- MOUNTING BOLTS ARE GRADE 5.
  DO NOT SUBSTITUTE.

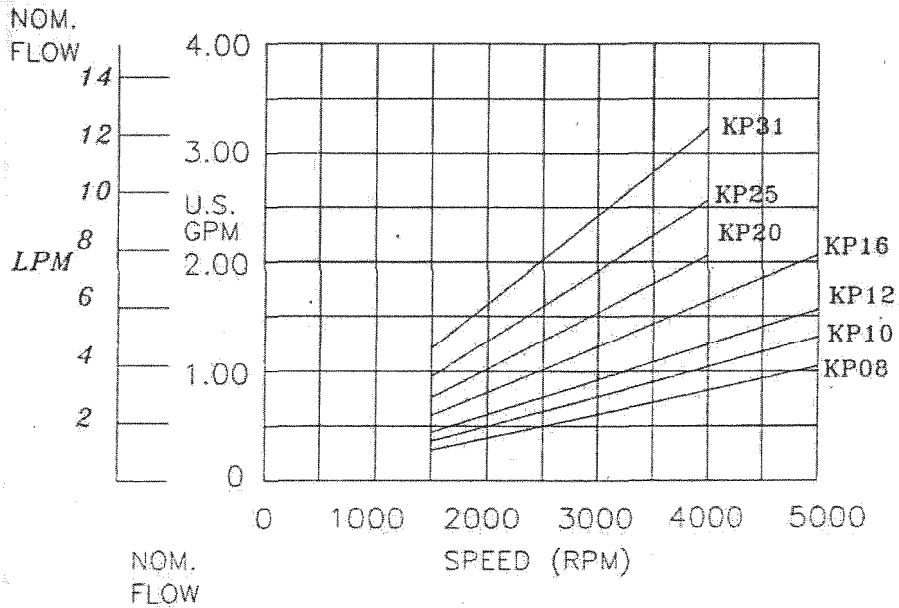
KP10 CAN NOT BE USED IN DUPLEX PUMP APPLICATIONS.

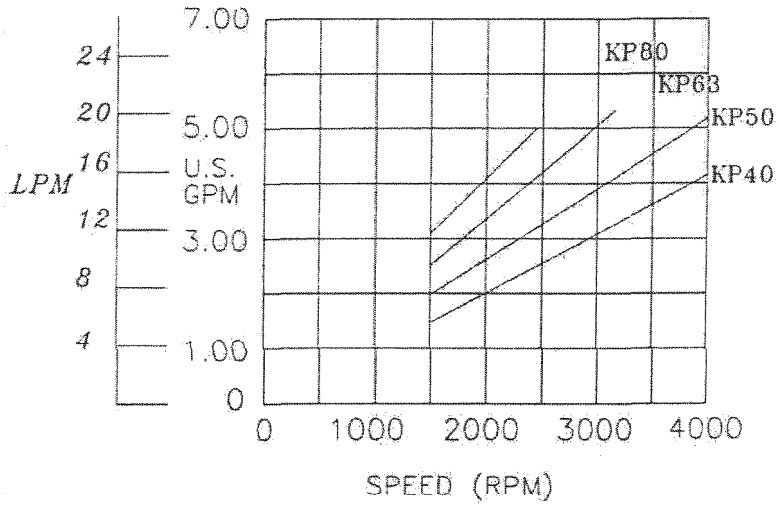
KIT NO.	DISPLACEMENT		LENGTH		MAXIMUM RPM	MAXIMUM PRESS.		SERVICE BOLT PART NO.
	CC/REV	CIPR	mm	INCH		CONT. PSI / BAR	INTERMIT. PSI / BAR	
KP08	0.8	0.049	57	2.25	5000	5000/350	5000/350	2824-AA
KP10	1.0	0.061	58	2.28	5000	5000/350	5000/350	2824-AA
KP12	1.2	0.073	59	2.32	5000	5000/350	5000/350	2825-AA
KP16	1.6	0.098	60	2.38	5000	5000/350	5000/350	2825-AA
KP20	2.0	0.122	62	2.44	4000	5000/350	5000/350	2825-AA
KP25	2.5	0.153	64	2.52	4000	4600/320	5000/350	2826-AA
KP31	3.1	0.189	67	2.62	4000	3600/250	5000/350	2826-AA
KP40	4.0	0.244	70	2.75	4000	3000/200	4000/280	2826-AA
KP50	5.0	0.305	74	2.90	4000	2300/160	3200/220	2827-AA
KP63	6.3	0.384	79	3.11	3200	1800/125	2500/175	2827-AA
KP80	8.0	0.488	86	3.37	2400	1500/100	2000/140	2828-AA

A	CHANGE: ADD "METRIC" BOLTS			TITLE: PUMP KITS AFC SERIES	SCALE: NONE	REV.: A
DRAWN: GEC	DATE: 150CT93	CHECK: DeP	DATE: 13-SEP95	PAGE 1 OF 2	PART NO.: KP___	

Fenner Fluid Power

DISTRIBUTOR POWER UNIT PROGRAM



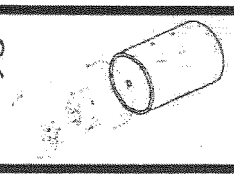


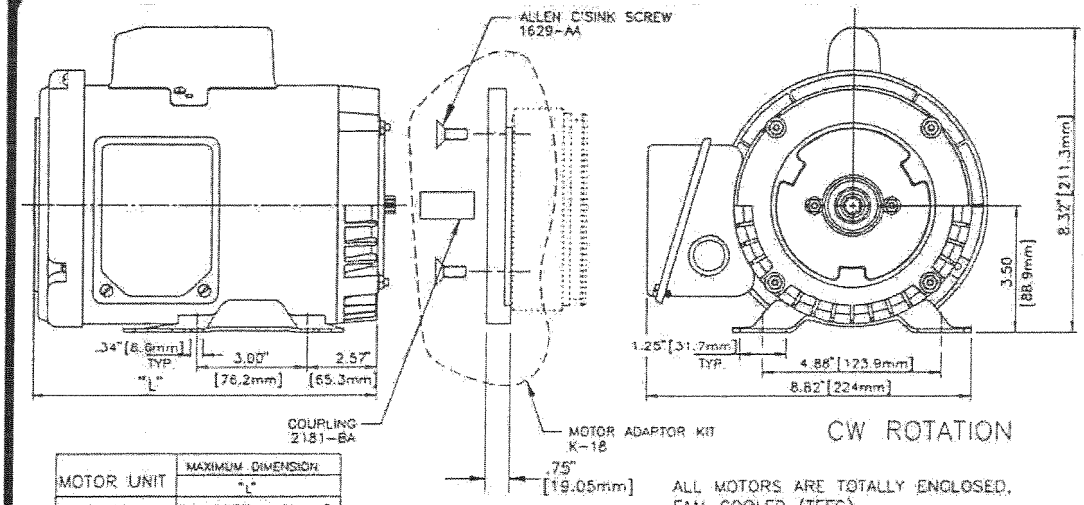
1500 RPM MIN. LIMIT

CHANGE	TITLE	SCALE	REV.
ADD METRIC SCALE	PUMP KITS AFC SERIES	NONE	B
DRAWN: GLC / DATE: 24-JUL-95 / CHECK: DEP / DATE: 13 SEP 95	PAGE 2 OF 2	PART NO. KP__	

Fenner Fluid Power

DISTRIBUTOR POWER UNIT PROGRAM





MOTOR UNIT	MAXIMUM DIMENSION "L"
MC16	11.19" [284.2mm]
MC17	12.50" [317.5mm]
MC21	11.19" [284.2mm]
MC23	11.19" [284.2mm]

FOR FLOWS OVER 3 U.S. GPM (11 LPM), USE 1413-AA FILTER.

ALL MOTORS ARE TOTALLY ENCLOSED, FAN-COOLED (TEFC).

MOTORS ARE CONTINUOUS DUTY BUT CAN NOT BE USED ABOVE THEIR RATED HORSEPOWER, REGARDLESS OF DUTY CYCLE, AND MUST HAVE FULL VOLTAGE TO ACHIEVE RATED HORSEPOWER.

NOTE: FENNER USES A NETWORK OF QUALIFIED SUPPLIERS TO ENSURE AVAILABILITY. THERE ARE MINOR DIMENSIONAL AND COSMETIC DIFFERENCES BETWEEN VENDOR'S PRODUCTS.

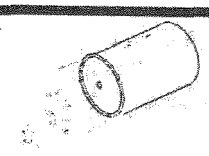
PERFORMANCE AT 45 CST (200 SSU) AND 90% MECHANICAL EFFICIENCY. GPM'S ARE U.S. VALUES.

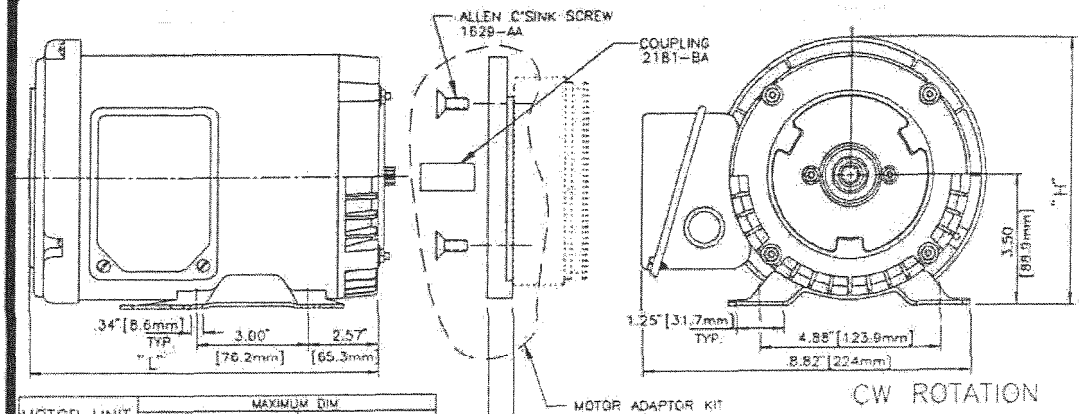
PUMP / MOTOR	KP08	KP10	KP12	KP16	KP20	KP25	KP31	KP40	KP50	KP63	KP80
KMC16 1HP 3450 RPM, 1PH 115/230v 60Hz	.65 GPM 2150 PSI	.8 GPM 1700 PSI	.99 GPM 1400 PSI	1.4 GPM 1050 PSI	1.7 GPM 800 PSI	2.2 GPM 650 PSI	2.7 GPM 450 PSI	3.5 GPM 300 PSI	4.4 GPM 200 PSI	NOT RECOMMENDED	
	2.5 LPM 150 BAR	3.1 LPM 120 BAR	3.8 LPM 100 BAR	5.3 LPM 75 BAR	6.7 LPM 55 BAR	8.5 LPM 45 BAR	11 LPM 30 BAR	14 LPM 20 BAR	17 LPM 14 BAR		
KMC17 2HP 3450 RPM, 1PH 115/230v 60Hz	.58 GPM 4300 PSI	.7 GPM 3450 PSI	.91 GPM 2850 PSI	1.3 GPM 2150 PSI	1.7 GPM 1700 PSI	2.1 GPM 1300 PSI	2.6 GPM 1000 PSI	3.5 GPM 750 PSI	4.4 GPM 500 PSI		
	2.3 LPM 300 BAR	2.7 LPM 240 BAR	3.5 LPM 200 BAR	5.1 LPM 150 BAR	6.6 LPM 115 BAR	8.4 LPM 90 BAR	10 LPM 70 BAR	13 LPM 50 BAR	16 LPM 35 BAR		
KMC21 1/2 HP 1725 RPM, 1PH 115/230v 60Hz	.29 GPM 2150 PSI	.35 GPM 1700 PSI	.46 GPM 1400 PSI	.65 GPM 1050 PSI	.84 GPM 850 PSI	1.1 GPM 650 PSI	1.3 GPM 500 PSI	1.7 GPM 400 PSI	2.2 GPM 300 PSI	2.8 GPM 200 PSI	3.5 GPM 100 PSI
	1.1 LPM 150 BAR	1.4 LPM 120 BAR	1.8 LPM 100 BAR	2.5 LPM 75 BAR	3.3 LPM 60 BAR	4.2 LPM 45 BAR	5.2 LPM 35 BAR	6.7 LPM 25 BAR	8.5 LPM 20 BAR	11 LPM 14 BAR	14 LPM 7 BAR
KMC23 1HP 1725 RPM, 1PH 115/230v 60Hz	.22 GPM 4300 PSI	.26 GPM 3450 PSI	.38 GPM 2850 PSI	.59 GPM 2150 PSI	.8 GPM 1700 PSI	1.0 GPM 1350 PSI	1.3 GPM 1100 PSI	1.7 GPM 800 PSI	2.2 GPM 650 PSI	2.7 GPM 450 PSI	3.5 GPM 300 PSI
	.9 LPM 300 BAR	1.0 LPM 240 BAR	1.5 LPM 200 BAR	2.3 LPM 150 BAR	3.1 LPM 115 BAR	4.0 LPM 95 BAR	5.0 LPM 75 BAR	6.5 LPM 55 BAR	8.3 LPM 45 BAR	11 LPM 30 BAR	14 LPM 20 BAR

CHANGE	TITLE	SCALE	REV.
ADD METRIC DIMS.	CONTINUOUS DUTY 1 PH AC MOTORS	NONE	C
DRAWN: GLC — DATE: 21-JUL-95 — CHECK: DEP — DATE: 13 Sep 95	PAGE 1 OF 2	PART NO.: KMC___	

Fenner Fluid Power

DISTRIBUTOR POWER UNIT PROGRAM





CW ROTATION

MOTOR UNIT	MAXIMUM DIM "L"		"H"	
MC18	11.19"	[284.2mm]	7.18"	[182.4mm]
MC19	12.50"	[317.5mm]	7.18"	[182.4mm]
MC20	13.53"	[343.6mm]	7.44"	[188.9mm]
MC22	11.19"	[284.2mm]	7.18"	[182.4mm]
MC24	11.19"	[284.2mm]	7.18"	[182.4mm]

ALL MOTORS ARE TOTALLY ENCLOSED, FAN-COOLED (TEFC) MOTORS ARE CONTINUOUS DUTY BUT CAN NOT BE USED ABOVE THEIR RATED HORSEPOWER, REGARDLESS OF DUTY CYCLE, AND MUST HAVE FULL VOLTAGE TO ACHIEVE RATED HORSEPOWER.

FOR FLOWS OVER 3 U.S. GPM (11 LPM), USE 1413-AA FILTER.

NOTE: FENNER USES A NETWORK OF QUALIFIED SUPPLIERS TO ENSURE AVAILABILITY. THERE ARE MINOR DIMENSIONAL AND COSMETIC DIFFERENCES BETWEEN VENDOR'S PRODUCTS.

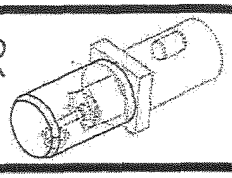
PERFORMANCE AT 45 CST (200 SSU) AND 90% MECHANICAL EFFICIENCY. GPM'S ARE U.S. VALUES.

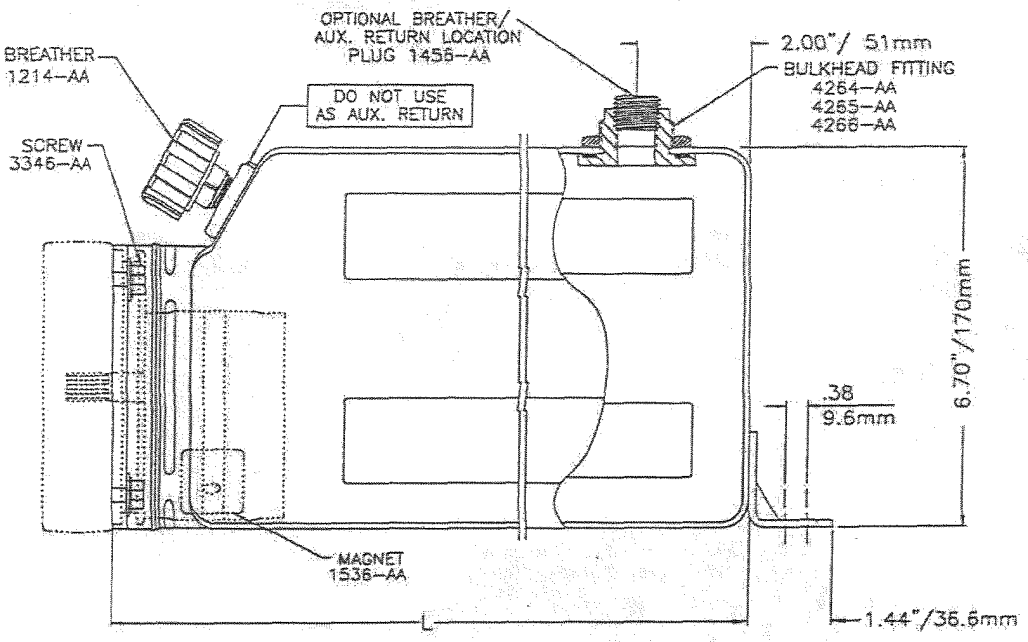
MOTOR \ PUMP	KP08	KP10	KP12	KP16	KP20	KP25	KP31	KP40	KP50	KP63	KP80
KMC18 2HP 3450 RPM, 3PH 230/460v 60Hz	.58 GPM 4300 PSI	.7 GPM 3450 PSI	.91 GPM 2850 PSI	1.3 GPM 2150 PSI	1.7 GPM 1700 PSI	2.2 GPM 1300 PSI	2.7 GPM 1000 PSI	3.5 GPM 750 PSI	4.4 GPM 500 PSI	NOT RECOMMENDED	
	2.3 LPM 300 BAR	2.7 LPM 240 BAR	3.5 LPM 200 BAR	5.1 LPM 150 BAR	6.6 LPM 115 BAR	8.4 LPM 90 BAR	10 LPM 70 BAR	14 LPM 50 BAR	17 LPM 35 BAR		
KMC19 3HP 3450 RPM, 3PH 230/460v 60Hz	.56 GPM 5000 PSI	.62 GPM 5000 PSI	.83 GPM 4300 PSI	1.2 GPM 3200 PSI	1.6 GPM 2550 PSI	2.1 GPM 2000 PSI	2.6 GPM 1600 PSI	3.4 GPM 1200 PSI	4.3 GPM 900 PSI		
	2.2 LPM 350 BAR	2.4 LPM 350 BAR	3.2 LPM 300 BAR	4.8 LPM 225 BAR	6.4 LPM 175 BAR	8.2 LPM 140 BAR	10 LPM 110 BAR	13 LPM 80 BAR	17 LPM 60 BAR		
KMC20 5HP 3450 RPM, 3PH 230/460v 60Hz	.56 GPM 5000 PSI	.62 GPM 5000 PSI	.79 GPM 5000 PSI	1.2 GPM 5000 PSI	1.5 GPM 4300 PSI	2.0 GPM 3400 PSI	2.5 GPM 2700 PSI	3.3 GPM 2050 PSI	4.2 GPM 1600 PSI		
	2.2 LPM 350 BAR	2.4 LPM 350 BAR	3.1 LPM 350 BAR	4.5 LPM 350 BAR	6.0 LPM 295 BAR	7.9 LPM 235 BAR	9.8 LPM 185 BAR	13 LPM 140 BAR	16 LPM 110 BAR		
KMC22 1/2HP 1725 RPM, 3PH 230/460v 60Hz	.29 GPM 2150 PSI	.35 GPM 1700 PSI	.46 GPM 1200 PSI	.65 GPM 1050 PSI	.84 GPM 850 PSI	1.1 GPM 650 PSI	1.3 GPM 500 PSI	1.7 GPM 400 PSI	2.2 GPM 300 PSI	2.8 GPM 200 PSI	3.5 GPM 100 PSI
	1.1 LPM 150 BAR	1.4 LPM 120 BAR	1.8 LPM 100 BAR	2.5 LPM 75 BAR	3.3 LPM 60 BAR	4.2 LPM 45 BAR	5.2 LPM 35 BAR	6.7 LPM 25 BAR	8.5 LPM 20 BAR	11 LPM 14 BAR	14 LPM 7 BAR
KMC24 1HP 1725 RPM, 3PH 230/460v 60Hz	.22 GPM 4300 PSI	.26 GPM 3450 PSI	.38 GPM 2850 PSI	.59 GPM 2150 PSI	.8 GPM 1700 PSI	1.0 GPM 1350 PSI	1.3 GPM 1100 PSI	1.7 GPM 800 PSI	2.2 GPM 650 PSI	2.7 GPM 450 PSI	3.5 GPM 300 PSI
	0.9 LPM 300 BAR	1.0 LPM 240 BAR	1.5 LPM 200 BAR	2.3 LPM 150 BAR	3.1 LPM 115 BAR	4.0 LPM 95 BAR	5.0 LPM 75 BAR	6.5 LPM 55 BAR	8.3 LPM 45 BAR	11 LPM 30 BAR	14 LPM 20 BAR

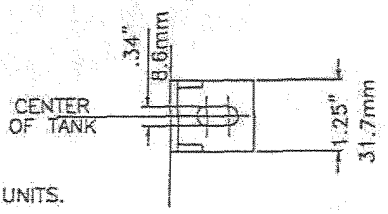
CHANGE	TITLE	SCALE	REV
ADD METRIC DIMS.	CONTINUOUS DUTY 3 PH AC MOTORS	NONE	B
DRAWN: GLC / DATE: 21-JUL-95 / CHECK: DEP / DATE: 13 SEP 95	PAGE 2 OF 2	PART NO: KMC___	

Fenner Fluid Power

DISTRIBUTOR POWER UNIT PROGRAM







- FOOT INCLUDED ON 1.5 GAL. AND LARGER.
- SHIMMING MAY BE REQUIRED AT INSTALLATION.
- DO NOT USE KR50 OR KR55 WITH DUPLEX PUMP UNITS.

KIT NO.	NOMINAL CAPACITY (GALS.)	TANK LENGTH (L)		USEABLE OIL CAPACITY			
				VERTICAL		HORIZONTAL	
		mm	IN.	LITRE	CUBIC IN.	LITRE	CUBIC IN.
KR50	1.0	190.5	7.50	1.9	120	3.1	186
KR55	1.2	228.6	9.00	2.9	180	3.8	230
KR51	1.5	279.4	11.00	4.3	260	4.7	286
KR52	2.0	330.2	13.00	5.6	340	5.6	345
KR56	2.5	381.0	15.00	6.9	420	6.6	400
KR53	3.0	508.0	20.00	10.2	620	8.8	540
KR54	4.0	660.4	26.00	14.1	860	11.7	715

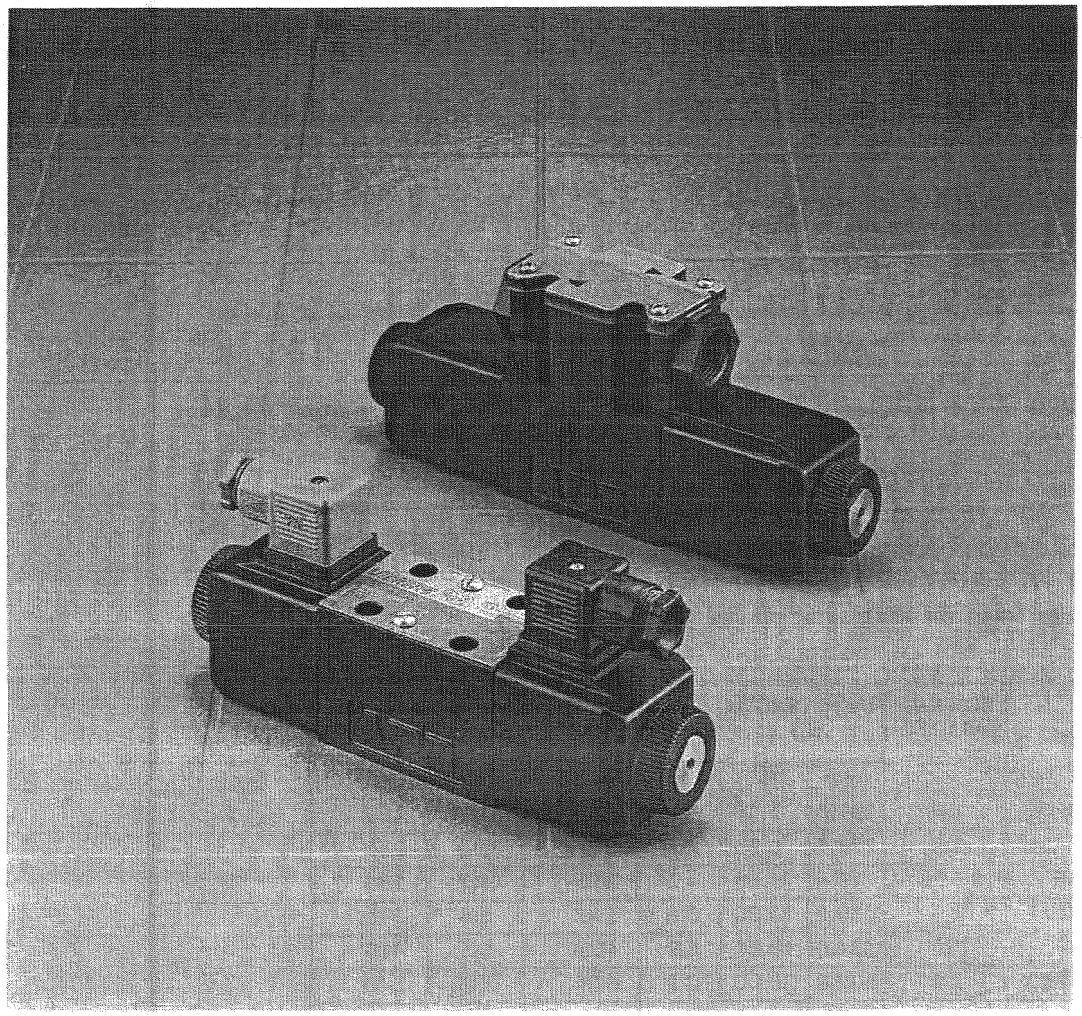
CHANGE	TITLE	SCALE	REV.
REM'D FITTING 4191–AA (REF: ECO#970903A)	RESERVOIR PLASTIC 6.7"[170mm] OFFSET	NONE	F

DRAWN	DATE	CHECK	DATE	PART NO.
MM	08-SEP-97		10-5-97	KR5__

VICKERS

Solenoid Operated Directional Valves

DG4V-3 flows to 80 l/min (21 USgpm), 6* design
DG4V-3S flows to 40 l/min (10.5 USgpm), 6* design
ISO 4401, size 03; ANSI/B93.7M-D03



Revised 6/94

GB-C-2015

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Introduction

General description

These solenoid operated directional control valves are for directing and stopping flow at any point in a hydraulic system. This 60-design series has been specially designed and developed to cover expanded demands in the industry as well as the many traditional uses of the earlier designs. Some of the more important benefits to users are outlined.

- Efficient control of greater hydraulic powers without increasing solenoid power consumption.
- Installed cost and space savings from higher power/weight-and-size ratios.
- Increases system efficiency; the result of improved manufacture of spools and bores.
- Installation flexibility resulting from choice of numerous combinations of solenoid connectors and locations.
- Multi-fluid capability without need to change seals.
- Higher sustained machine productivity and higher uptime because of proven fatigue life and endurance, tested over 20 million cycles.
- Solenoid coils can be changed quickly and easily without leakage from hydraulic system.
- Compact, cost effective system design when used with Vickers SystemStak™ valves and subplates.

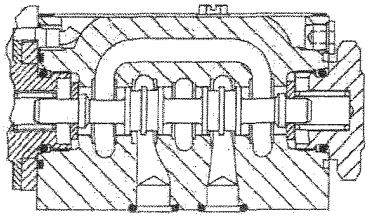
DG4V-3 and DG4V-3S High and standard performance models:

- Up to 80 l/min (21 USgpm) and up to 40 l/min (10.5 USgpm) respectively at 350 bar (5000 psi).
- Builds on Vickers experience as the major supplier of size 03 valves worldwide.
- Offers designers the opportunity to select the optimum value package for each application.
- International standard interface. The valve mounting face conforms to ISO 4401, size 03 and is compatible with related international standards.

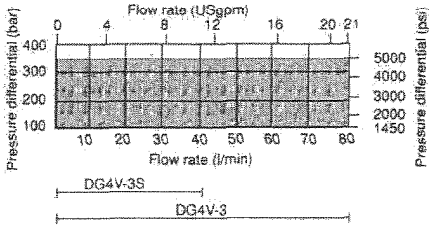
Features and Benefits

- **High pressure and flow capabilities, thanks to special design features**

Highly reliable operation up to 80 l/min (21 USgpm) at 350 bar (5000 psi). Establishes new market standards and opens new possibilities to design engineers on valve size selection.



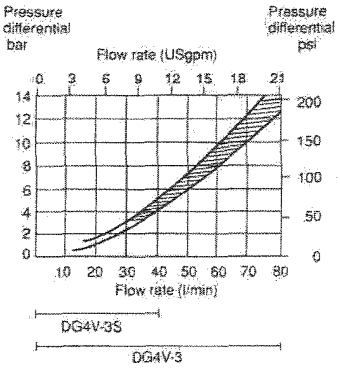
Typical maximum pressure differential (P-A-B-T) flow envelope, blocked center spool.

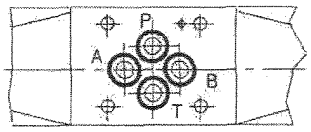


Features and Benefits

• Minimal pressure drop, i.e. 2,5 bar (36 psi) at 30 l/min (7.9 USgpm)

Achieved by optimization of the valve body, spool and spool-stroke design. The results: low energy consumption and improved efficiency.

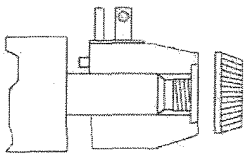




Mounting surface to ISO 4401 size 03

• Ease of servicing

Wet-armature solenoid, screw-in core tube design allows coils to be changed without removing valve from installation and without oil spillage or risk of contaminating system fluid.

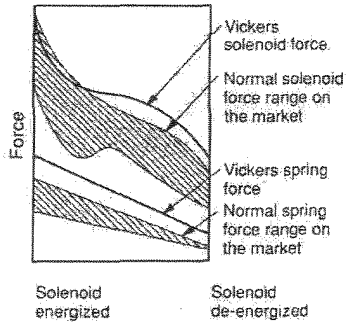


ISO4400 (DIN 43650) coil shown

• High reliability

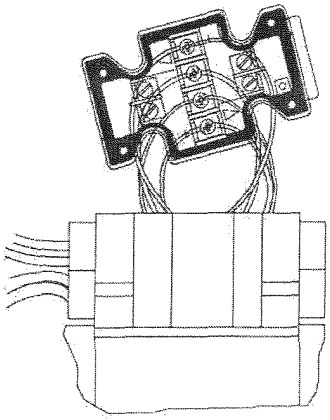
Design of spring forces and profile of DC solenoid force characteristics ensure spool position selection under extreme operating conditions. Result is a valve with high reliability when being energized or de-energied.

Performance leader



• Electrical connections

Conduit box design that simplifies electrical wiring connections to solenoids. Orientation tabs prevent incorrect positioning.



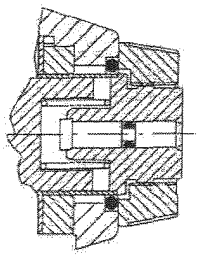
• Scratch-proof manual override seal

Internal seals are located such that they are beyond reach of any bore damage caused by small tools used to operate the manual override.

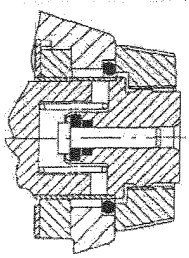
Result is no messy oil drips from the manual overrides.

Small diameter manual overrides prevent inadvertent operation.

DG4V-3 – High Performance



DG4V-3S – Standard Performance



• Surge supression for DC valves

Surge suppression is used to prevent coil damage by reducing contact burnoff – increasing switch life – and protecting electrical controllers from inductive spikes.

Three coil options are available:

D1 – Encapsulated diode (Industrial application)

D2 – Encapsulated diode (Mobile application)

D7 – Transzorb type

Characteristics

High performance DG4V-3, 6* design
Standard performance DG4V-3S, 6* design

Mounting interface

ISO 4401 size 03
ANSI/B93.7M size D03
CETOP RP65H, size 3
DIN 24340, NG6

Basic characteristics

Maximum pressure:

DG4V-3	350 bar (5075 psi)
DG4V-3S	350 bar (5075 psi)

Maximum flow:

DG4V-3	up to 80 l/min (21 USgpm)
DG4V-3S	up to 40 l/min (10.5 USgpm)

DG4V-3 models are direct solenoid operated four-way directional control valves.Their primary function in a hydraulic circuit is to direct fluid flow. This, in turn, would determine the direction of movement of a fluid cylinder, or the direction of rotation of a fluid motor.

Port connections are made by mounting the valve on a subplate or manifold. The valve has wet armature type solenoids.

Electrical connections to the valve are made in the electrical wiring housing or thru various plug-in connectors such as a DIN 43650 type coil

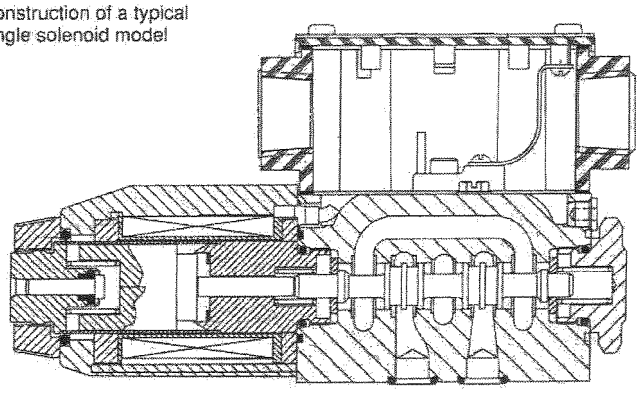
Good hydraulic design practice suggests that detented models be mounted with longitudinal axis horizontal. Other models may be mounted in any position.

Operating considerations

1. Dependent on the application and the system filtration, any sliding spool valve if held shifted under pressure for long periods of time, may stick and not move readily due to fluid residue formation. It may therefore need to be cycled periodically to prevent this from happening.

2. Surges of fluid in a common tank line serving two or more valves can be of sufficient magnitude to cause inadvertent shifting of these valves. This is particularly critical in no-spring detented models, separate drain lines are necessary.

Construction of a typical single solenoid model



Temperature limits

Minimum ambient ..... -20°C (-4°F)

Maximum ambient
Valves with coils listed in model code and at stated percentages of rated voltage.

Coil type and frequency	Percentage voltage	Maximum ambient temperature DG4V-3	DG4V-3S
Dual frequency coils			
@ 50 Hz	107%	40°C (104°F)	65°C (149°F)
@ 50 Hz	110%	30°C (86°F)	65°C (149°F)
@ 60 Hz	107%	50°C (122°F)	65°C (149°F)
@ 60 Hz	110%	40°C (104°F)	65°C (149°F)
Single frequency (50 Hz) coils			
@ 50 Hz	110%	40°C (104°F)	65°C (149°F)
DC coils	110%	70°C (158°F)	70°C (158°F)

Fluid temperature

Fluid Temp.	Mineral oil	Water-containing
Min	-20°C (-4°F)	+10°C (+50°F)
Max.*	+70°C (+158°F)	+54°C (+129°F)

** To obtain optimum service life from both fluid and hydraulic system, 65°C (150°F) normally is the maximum temperature except for water-containing fluids.*

For synthetic fluids consult manufacturer or Vickers representative where limits are outside those for mineral oil.

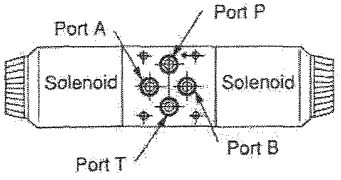
Whatever the actual temperature range, ensure that viscosities stay within the limits specified in the "Hydraulic fluids" section.

Functional Symbols

Spool types shown represent the highest proportion of market requirements. For other spool functions that may be required, consult your Vickers sales representative.

Solenoids identified to U.S. standards

Functional symbols related to solenoid identity "A" and/or "B" according to NFPA/ANSI standards, i.e. energizing solenoid "A" gives flow P to A, solenoid "B" gives flow P to B (as applicable).

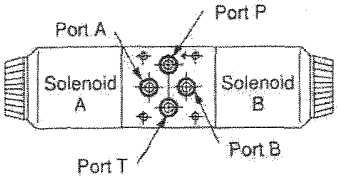


Solenoid	For spool type	Solenoid
B	All except "8"	A
A	"8" only	B

For valves with type "8" spools, solenoid identity to U.S. convention is the same as for European convention.

Solenoids identified to European standards (specify "V" in model code)

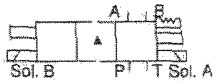
Functional symbols related to solenoid identity "A" and/or "B" according to European convention i.e. solenoid "A" adjacent to "A" port, solenoid "B" adjacent to "B" port of valve.



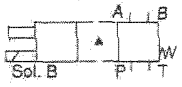
- *For differences in valve function, refer to Performance Data.*
- ◇ *F build spools.*

U.S. solenoid standard

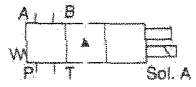
Double solenoid valves, two position, detented



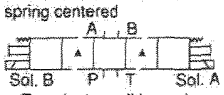
Single solenoid valves, solenoid at port A end



Single solenoid valves, solenoid at port B end



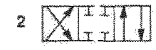
Double solenoid valves, spring centered



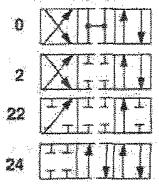
▲ *Transient condition only*

The valve function schematics apply to both U.S. and European valves.

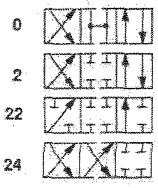
DG4V-3(S)-*N(V)



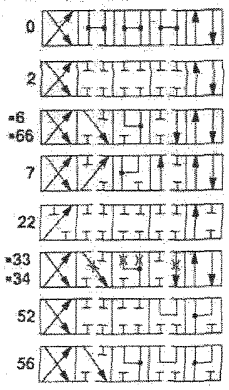
DG4V-3(S)-*A(V)



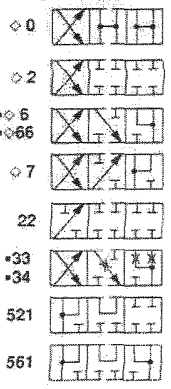
DG4V-3(S)-*AL(V)



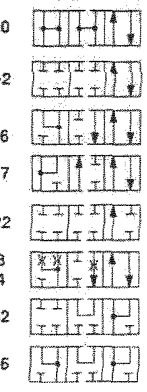
DG4V-3(S)-*C(V)



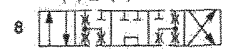
DG4V-3(S)-*B/F(V)



DG4V-3(S)-*BL/FL(V)



DG4V-3(S)-8C(V)

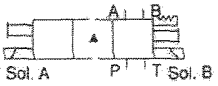


DG4V-3(S)-8BL(V)

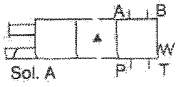
DG4V-3(S)-8B(V)

European solenoid standard

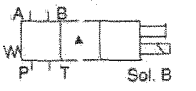
Double solenoid valves, two position, detented



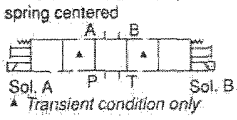
Single solenoid valves, solenoid at port A end



Single solenoid valves, solenoid at port B end

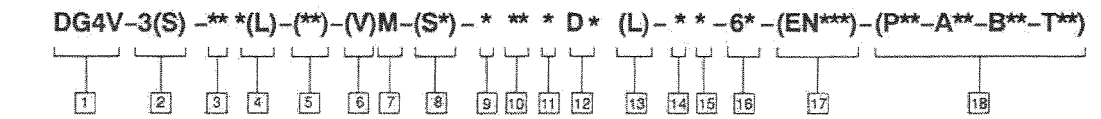


Double solenoid valves, spring centered



▲ *Transient condition only*

Model Code



1 Model series

D – Directional valve
G – Subplate/manifold mounted
4 – Solenoid operated
V – Pressure rating 350 bar (5075 psi) on P, A & B ports

2 Standard or high performance

3 – High performance specification: up to 80 l/min (21 USgpm) at 350 bar (5075 psi)
3S – Standard performance specification: up to 40 l/min (10.5 USgpm) at 350 bar (5075 psi)

3 Spool type

See "Functional symbols" section.

4 Spool spring arrangement

A – Spring offset, end-to-end
AL – Same as "A" but left hand build
B – Spring offset, end to center
BL – Same as "B" but left hand build
C – Spring centered
F – Spring offset, shift to center
FL – Same as "F" but left hand build
N – No-spring detented

5 Manual override option

No symbol – Plain override(s) in solenoid end(s) only▲
H – Water-resistant override(s) on solenoid end(s)▲
Y● – Latching manual override on solenoid ends (includes "H" feature seal)▲
Z – No overrides at either end

▲ *No override in non-solenoid end of single solenoid valves*
● *Not available on DG4V-3S, AC models*

6 Solenoid energization identity

V – Solenoid "A" is at port "A" end and/or solenoid "B" is at port "B" end, independent of spool type

Omit for U.S. ANSI B93.9 standard requiring solenoid "A" energization to connect P to A and/or solenoid "B" to connect P to B, independent of solenoid location.

NOTE: Type "8" spool valves conform to both U.S. and European solenoid designations. When ordering an "8" spool, designate a "V" in the model code.

7 Flag symbol

M – Electrical options and features

8 Spool indicator switch

Available on high performance models, DG4V-3, only. Omit when not required.

DG4V-3-*A(L)-(V)M models with type U (ISO4400) electrical connector to solenoid; spool type 0, 2 or 22 only:
S6 – LVDT type DC switch with Pg7 connector plug.

DG4V-3-*A(L)-(Z)-(V)M-S*-FPA5W valves with mechanical type AC (~) switch, wired to 5-pin receptacle:
S3 – Switch, wired normally open
S4 – Switch, wired normally closed

*DG4V-3-*A(L)-(Z)-(V)M-S5-F(T)W/J valves with mechanical type AC (~) switch:*
S5 – Switch, free leads

9 Coil type

U – ISO 4400 (DIN 43650) mounting◆
U1 – Connector fitted
U6 – Connector fitted w/lights
U11 – Connector fitted w/rectifier & lights**
U12 – Connector fitted w/rectifier**
F – 1/2" NPT thread conduit box
KU – Top exit flying leads*
SP1 – Single 6,3 mm spade*◆
SP2 – Dual 6,3 mm spade*◆

◆ *Female connector to be supplied by customer*
* DC service only
** AC service only

10 Electrical connector

T – Wired terminal block
PA – Instaplug male receptacle only
PB – Instaplug male & female receptacle
PA3 – Three pin connector
PA5 – Five pin connector

11 Housing (F type coils only)

W – 1/2" NPT thread wiring housing
J – 20 mm thread wiring housing

12 Surge suppressor/damper

D1 – Encapsulated diode (Industrial applications)
D2 – Encapsulated diode (Mobile applications)
D7 – Transzorb type (F,KU,U,SP1,SP2 only)

13 Solenoid indicator lights

Not available on PA, KU, U, SP1& SP2

14 Coil rating

Full power coils, see "Operating Data".
A – 110V AC 50Hz
B◇ – 110V AC 50Hz/120V AC 60 Hz
C – 220V AC 50 Hz
D◇ – 220V AC 50 Hz/240V AC 60 Hz
G – 12V DC
H – 24V DC

For DG4V-3 only (not usable with DG4V-3S):
Low power coils, see "Operating Data".
BL – 110V 50 Hz/120V 60 Hz
DL – 220V AC 50 Hz/240V AC 60 Hz
GL – 12V DC
HL – 24V DC

◇ *For 60 Hz or dual frequency*

Contact your Vickers representative for additional coil voltage options

15 Port T code

Refer to "Operating Data" for port T pressure ratings.
2 – 10 bar (145 psi) for spool position indicator models S3, S4 and S5.
5 – 100 bar (1450 psi) for standard performance models, DG4V-3S, with AC or DC solenoids.
6 – 207 bar (3000 psi) for AC high performance models, DG4V-3, including spool position indicator type S6.
7 – 207 bar (3000 psi) for DC high performance models, DG4V-3, including spool position indicator type S6.

16 Design number

60 – Basic design
61 – Type 8 spool

17 Special features

"EN***" code number assigned as required.
EN21 – CSA approved models with 1/2" NPT entry conduit box, type FW and solenoid coil letter B,D,G, or H.

18 Port restrictor plugs

For details of plug orifice sizes and how to specify in model code see page 13. May be fitted to valves by agreement with your Vickers representative.

Omit – No restrictor plugs fitted

Operating Data

Performance data is typical with fluid at 36cSt (168 SUS) and 50°C (122°F).

Feature	Standard performance valve DG4V-3S		High performance valve DG4V-3	
Pressure limits:				
P, A and B ports	350 bar (5075 psi) ■		350 bar (5075 psi)	
T port:				
Spool indicator switch models				
Types S3, S4, S5	N/A		10 bar (145 psi)	
Type S6	N/A		210 bar (3045 psi)	
All other models	100 bar (1450 psi)		210 bar (3045 psi)	
Flow rating	See performance data		See performance data	
Relative duty factor	Continuous; ED = 100%		Continuous; ED = 100%	
Type of protection:				
ISO 4400 coils with plug fitted correctly	IEC 144 class IP65		IEC 144 class IP65	
SP1 – Single spade 6,3 mm	IEC 760		IEC 760	
SP2 – Dual spade 6,3 mm	IEC 760		IEC 760	
Coil winding	Class H		Class H	
Lead wires (coils type F***)	Class H		Class H	
Coil encapsulation	Class F		Class F	
Permissable voltage fluctuation:				
Maximum	Refer to temperature limits.		Refer to temperature limits.	
Minimum	90% rated		90% rated	
Typical response times at 100% rated volts measured from application/removal of voltage to full spool displacement of "2C" spool at:				
Flow rate P-A, B-T	20 l/min (5.3 USgpm)		40 l/min (10.6 USgpm)	
Pressure	175 bar (2537 psi)		175 bar (2537 psi)	
AC (~) energizing	18 ms		15 ms	
AC (~) de–energizing	32 ms		23 ms	
DC (=) energizing	60 ms		45 ms	
DC (=) de–energizing	40 ms		28 ms	
Power consumption, AC solenoids (for coils listed in model code).	Initial ▲ VA (RMS)	Holding VA (RMS	Initial ▲ VA (RMS)	Holding VA (RMS)
Full power coils:				
Single frequency coils AC 50 Hz	225	39	265	54
Dual frequency coils at 50 Hz	265	49	280	61
Dual frequency coils at 60 HZ	260	48	300	58
Low power coils, "BL" and "DL":				
Dual frequency coils at 50 Hz	Low power coils not usable		170	37
Dual frequency coils at 60 Hz	with DG4V-3S valves.		190	37
Power consumption, DC solenoids at rated voltage and 20°C (68°F).				
Full power coils:				
12V, model type "G"	30W	–	30W	–
24V, model type "H"	30W	–	30W	–
Low power coils:				
12V, model type "GL"	Low power coils not usable		18W	–
24V, model type "HL"	with DG4V-3S valves.		18W	–

■ *For applications where valves are to remain pressurized (either energized or de-energized) at pressures over 210 bar (3045 psi) without frequent switching, it is recommended to use the high performance model, DG4V-3.*

▲ *1st half cycle; armature fully retracted*

Feature	High performance valve DG4V-3 *ONLY*
Characteristics of Spool Position Indicator Models	
DC model type "S6": Spool types/spool spring arrangements available	Types 0A (L), 2A(L), 22A(L)
Input:	
Supply voltage	10 to 35V DC inclusive of a maximum 4V pk-to-pk ripple
Current, switch open	5 mA
Current, switch closed	255 mA
Output:	
Voltage	1V below input at maximum load
Maximum continuous current	250 mA
Maximum load impedance	136Ω at maximum input volts
Maximum switching frequency	10 Hz
Plug connections:	
Pin 1 (output 1)	Normally open
Pin 2	Supply +ve
Pin 3	0V
Pin 4 (output 2)	Normally closed
Switching point	Within the spool spring offset condition •
Connector	Pg7 plug (supplied with valve)
Protection	Overload and short-circuit protected; self re-setting. IEC 144 class IP65 with connector correctly fitted.
Micro-switch type "S3", "S4" and "S5"	
Voltage	250V maximum 50/60 Hz
Maximum current	5A

• *Factory setting ensures this condition under all combinations of manufacturing tolerance and of temperature drift (see "Temperature Limits").*

Performance Data

Typical with mineral oil at 36 cSt (168.6 SUS) and a specific gravity of 0.87.

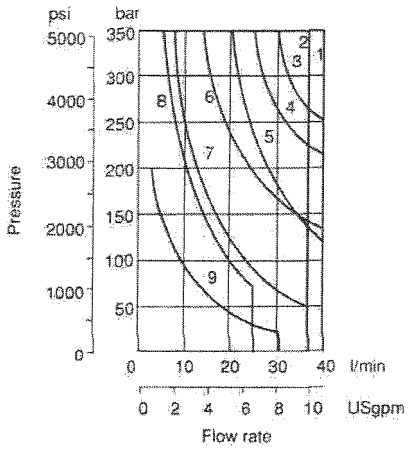
Maximum flow rates

Performance based on full power solenoid coils warm and operating at 90% rated voltage.

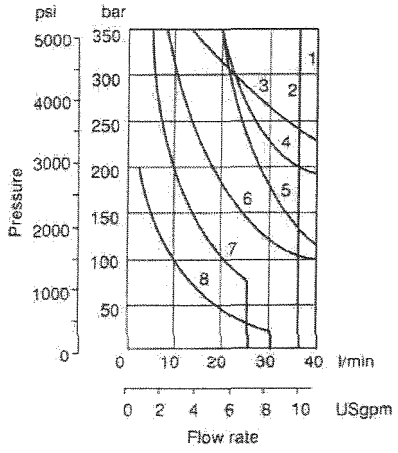
See note at bottom of next page when using low power coils (DG4V-3 models only).

DG4V-3S models (standard performance)

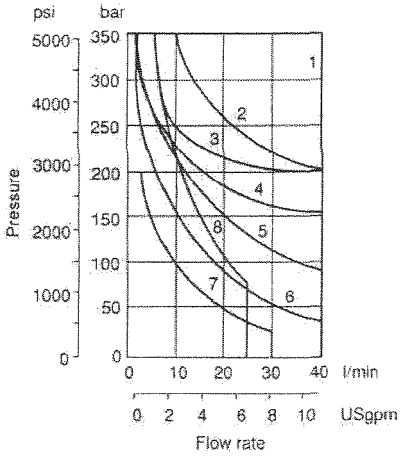
Graph 1
AC solenoid valves with dual frequency coils operating at 50 Hz



Graph 2
AC solenoid valves with
– Dual frequency coils operating at 60 Hz
– Single frequency (50 Hz) coils operating at 50 Hz



Graph 3
DC solenoid valves

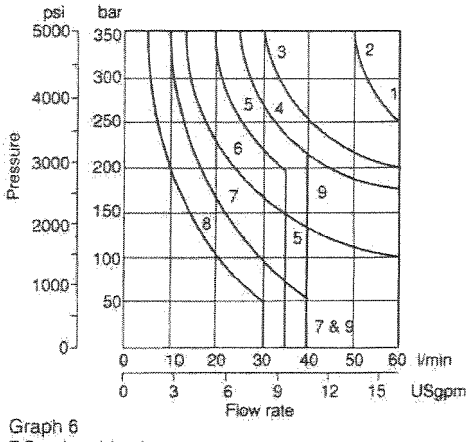


Spool/spring code	Graph 1 curve	Graph 2 curve	Graph 3 curve
0A(L)	1	1	3
0B(L) & 0C, 0F	1	1	1
2A(L)	5	5	3
2B(L) & 2C, 2F	2	2	3
2N	1	1	1
6B(L) & 6C, 6F	6	6	5
7B(L) & 7C, 7F	6	6	2
8B(L) & 8C	8▲	7▲	8▲
22A(L)	9	8	7
22B(L) & 22C	7	7	6
24A(L)	6	6	5
33B(L) & 33C	4	4	4
34B(L) & 34C	6	6	5
52BL, 52C, 56BL & 56C	6	6	5
66B(L) & 66C	3	3	5
521B & 561B	6	6	5

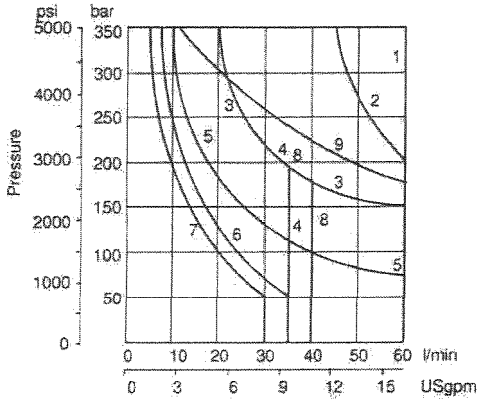
▲ *Consult Vickers regarding each application that will jointly have flow rates approaching this curve and a pressurized volume exceeding 2000 cm³ (122 cu.in.)*

DG4V-3 models (high performance)

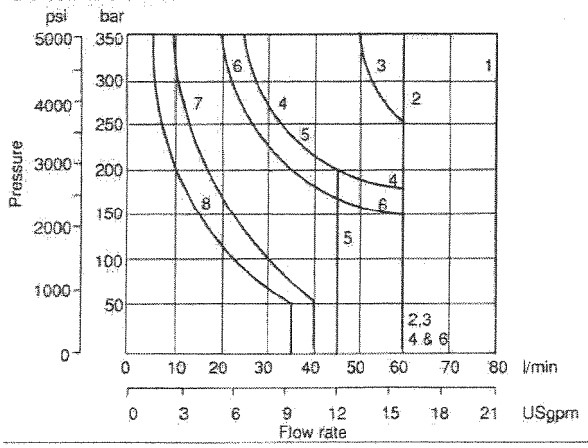
Graph 4
AC solenoid valves with:
– Single-frequency coils
– Dual-frequency coils operating at 50 Hz



Graph 5
AC solenoid valves with dual-frequency coils operating at 60 Hz



Graph 6
DC solenoid valves



Spool/ spring code	Graph 4 curve	Graph 5 curve	Graph 6 curve
0A(L)	2	2	3
0B(L) & 0C, 0F	1	1	2
2A(L)	2	2	3
2B(L) & 2C, 2F	1	1	1
2N	1	1	2
6B(L) & 6C, 6F	6	5	6
7B(L) & 7C, 7F	1	1	2
8B(L) & 8C	5▲	4▲	5▲
22A(L)	8	7	8
22B(L) & 22C	7	6	7
24A(L)	9	8	5
33B(L) & 33C	4	3	4
34B(L) & 34C	4	3	6
52BL, 52C,	6	5	6
56BL & 56C	6	5	6
66B(L) & 66C	3	9	6
521B & 561B	6	5	6

▲ *Consult Vickers regarding each application that will jointly have flow rates approaching this curve and a pressurized volume exceeding 2000 cm³ (122 cu.in.)*

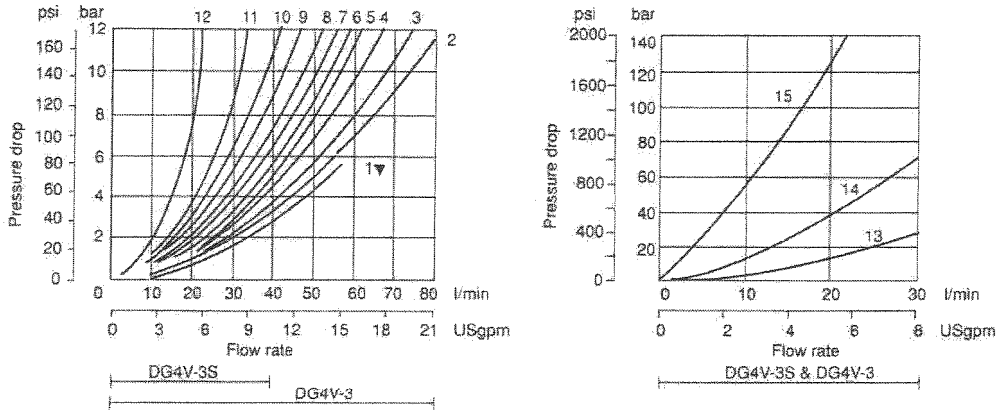
Flow limits applicable to the following usages:

1. All valves except types 22 and 52 spools having simultaneous equal flow rates from P to A or B and from B or A to T and S3, S4, S5 (limit switch) models.
2. Valves with type 22 spools having flow from P to A or B, the other being plugged. T is drained at all times.
3. Valves with type 52 spools having one service port (A or B as appropriate) connected to the full bore end of a 2:1 area ratio double-acting cylinder and the other to the annulus end.
4. Consult Vickers, with application details, if either of the following usages are required:
   (a) Single flow path, i.e. P to A, P to B, A to T or B to T.
   (b) Substantially different simultaneous flow rates between P to A or B and B or A to T, e.g. when A and B are connected to a cylinder having a large differential area.

Low Power Coils *(DG4V-3 models only)*

When using low power coils (coil designations *L in model code) the maximum flow is reduced from values given on this page (graphs 4, 5 and 6) by up to:
70% – for DC coils
50% – for AC coils
depending on spool type. Consult your Vickers representative relative to specific applications for low power coils.

Pressure drops



▼ *Curve for spool type 6: not recommended for flows in excess of 60 l/min (15.8 USgpm).*

Pressure drops in offset positions except where otherwise indicated

Spool/spring code	Spool positions covered	P to A	P to B	A to T	B to T	P to T	B to A or A to B
0A(L)	Both	5	5	2	2	–	–
0B(L) & 0C, 0F	De-energized Energized	– 4	– 4	– 2	– 2	4▲Δ –	– –
2A(L)	Both	6	6	5	5	–	–
2B(L) & 2C, 2F	Energized	5	5	2	2	–	–
2N	Both	6	6	3	3	–	–
6B(L) & 6C, 6F	De-energized Energized	– 6	– 6	3▲ 1	3Δ 1	– –	– –
7B(L) & 7C, 7F	De-energized Energized	6▲ 4	6Δ 4	– 3	– 3	– –	7○ –
8B(L) & 8C	All	9	9	5	5	3	–
22A(L), 22B(L) & 22C	All	6	6	–	–	–	–
24A(L)	De-energized	6	6	2	2	–	–
33B(L) & 33C	De-energized Energized	– 5	– 5	15▲ 2	15Δ 2	– –	– –
34B(L) & 34C	De-energized Energized	– 5	– 5	14▲ 2	14Δ 2	– –	– –
52BL & 52C	Energized	6▲	6Δ	2	–	–	10○
56BL	Both	6▲	6Δ	11▲	10Δ	–	10○
56C	De-energized Energized	– 6▲	– 6Δ	11▲ 2	10Δ –	– –	10○ 10○
66B(L) & 66C	De-energized Energized	– 6	– 6	12 2	12 2	– –	13 –
521B	All	6▲	6Δ	–	–	–	10○
561B	De-energized Energized	– 6	– 6Δ	10▲ –	11Δ –	– –	10○ 10○

▲ *"B" plugged* Δ *"A" plugged* ○ *"P" plugged*

For other viscosities, pressure drops approximate to:

Viscosity cSt (SUS)						
14 (17.5)	20 (97.8)	43 (200)	54 (251)	65 (302)	76 (352)	85 (399)
% of Δp						
81	88	104	111	116	120	124

A change to another specific gravity will yield an approximately proportional change in pressure drop.

The specific gravity of a fluid may be obtained from its producer. Fire resistant fluids usually have higher specific gravities than oil.

Installation Dimensions

Models for use with ISO 4400 (DIN 43650) connectors

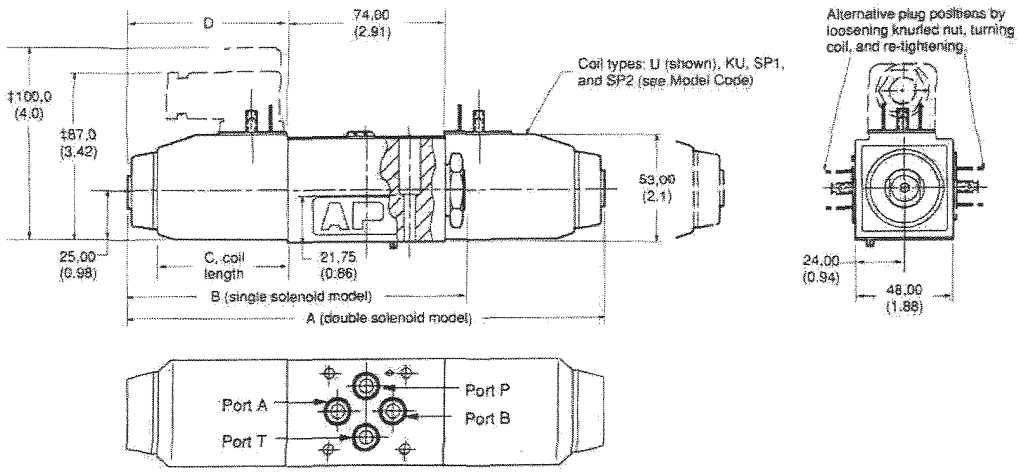
3rd angle projection

Double solenoid models ▲
DG4V-3(S)-*C-**-(V)M-U-**-60
DG4V-3(S)-*N-**-(V)M-U-**-60

Single solenoid models ▲
DG4V-3(S)-*A(-**)■
DG4V-3(S)-*B(-**)■
DG4V-3(S)-8BL(-**)
DG3V-3(S)-*F■
} As shown

DG4V-3(S)-*AL(-**)■
DG4V-3(S)-*BL(-**)■
DG4V-3(S)-8B(-**)
DG4V-3(S)-*FL(-**)■
} Solenoid and end cap interchanged

Dim mm (in.)



Model type	AC or DC	A Dim.	B Dim.	C Dim.	D Dim.
All	DC ⎓	220 (8.66)	156 (6.14)	61 (2.5)	73 (2.87)
DG4V-3	AC ~	200 (7.87)	146 (5.75)	51 (2.1)	63 (2.48)
DG4V-3S	AC ~	200 (7.87)	146 (5.75)	45 (1.7)	63 (2.48)

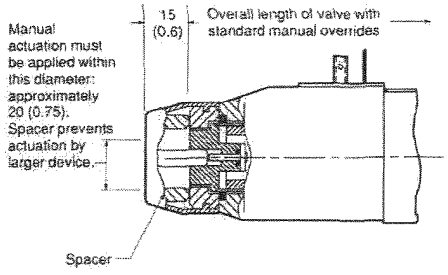
■ *Not applicable to type "8" spool.*
▲ *For solenoid identities see table on page 16.*
‡ *Can vary dependent on source of plug.*

Water-resistant manual override on solenoid

DG4V-3(S)-**(L)-H-(V)M-**-**-60**

Application

General use where finger operation is required (standard manual overrides cannot be operated without using small tool).



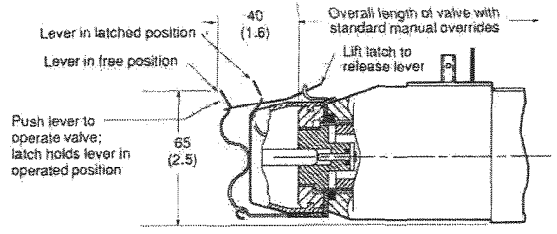
Note:
"H" feature is not field convertible from other models, specify with order.

Latching manual override on solenoid

DG4V-3-**(L)-Y-(V)M-**-**-60**
DG4V-3S-**(L)-Y-(V)M-**-**-60, DC coil models only**

Application

Stainless steel lever/latch mechanism and water-resistant seal make this feature ideal for vehicle-mounted and exposed applications requiring emergency selection of valve for a period of time in the event of electrical failure.



Notes:
1. *Opposite solenoid (on "C" and "N" double solenoid models) should not be energized while the valve is latched in selected position; AC solenoid coils will burn out under this improper usage.*
2. *"Y" feature is field-convertible from "H" type manual override (omitting spacer), but is not field-convertible from other models.*

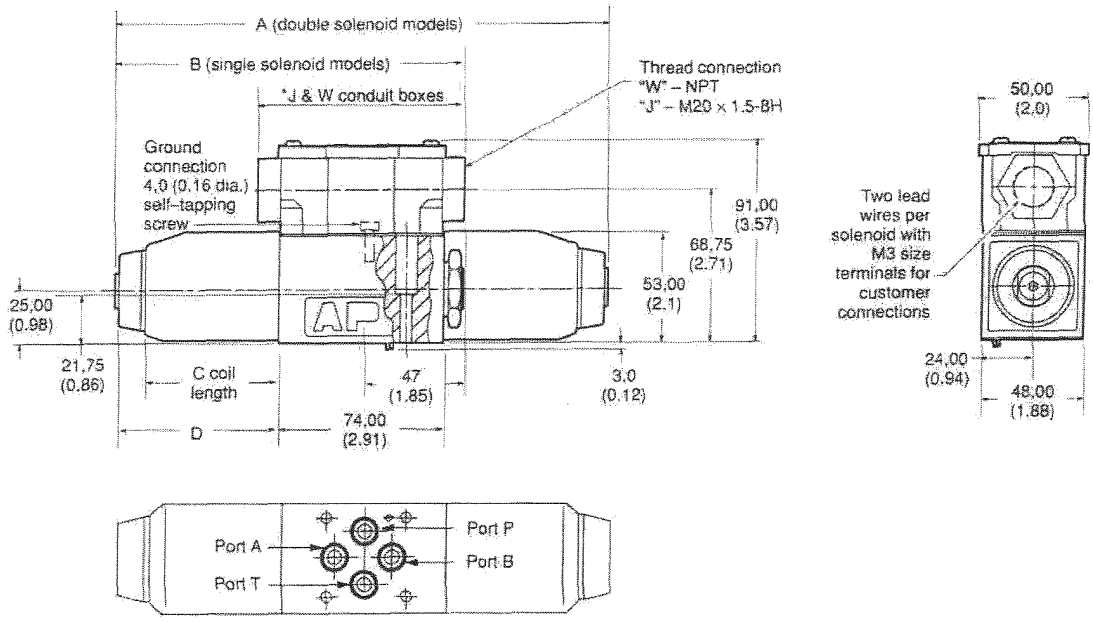
Models with "F" type coils (lead wires) and conduit box.

Double solenoid models ▲
DG4V-3(S)-*C-**-(V)M-F-**-60
DG4V-3(S)-*N-**-(V)M-F-**-60

Single solenoid models ▲ — As shown
DG4V-3(S)-*A(-**)•
DG4V-3(S)-*B(-**)•
DG4V-3(S)-8BL(-**)
DG3V-3(S)-*F•

DG4V-3(S)-*AL(-**)• — Solenoid and end cap interchanged
DG4V-3(S)-*BL(-**)•
DG4V-3(S)-8B(-**)
DG4V-3(S)-*FL(-**)•

Dim mm (in.)



* 89 (3.5) for FPB – J & W conduit boxes
104 (4.0) All plug-in conduit boxes

Model type	AC or DC	A Dim.	B Dim.	C Dim.	D Dim.
All	DC ⎓	220 (8.66)	156,5 (6.14)	61 (2.5)	73 (2.87)
DG4V-3	AC ~	200 (7.87)	146,5 (5.75)	51 (2.1)	63 (2.48)
DG4V-3S	AC ~	200 (7.87)	146,5 (5.75)	45 (1.7)	63 (2.48)

• *Not applicable to type "8" spool.*

▲ *For solenoid identities see table on page 16.*

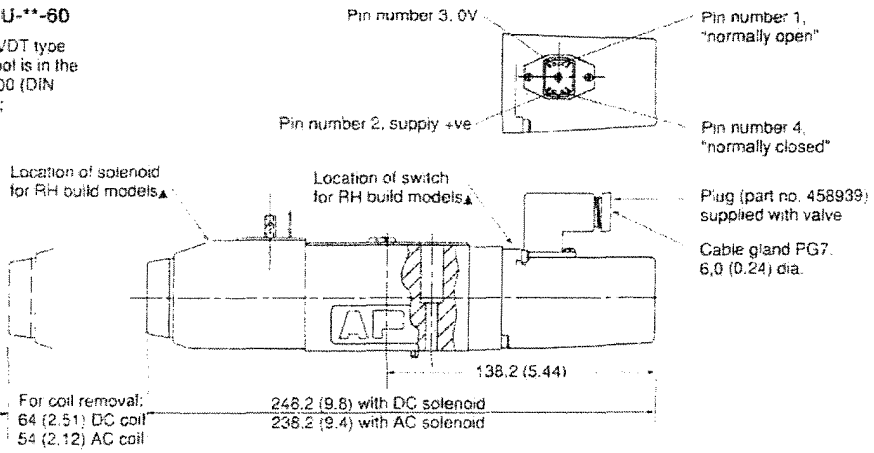
Codes "FJ" and "FW": *2 lead wires for each solenoid, approximately 150,00 (6.00) long. M3 (#6) terminals provided for customer connection.*

Codes "FTJ" and "FTW": *Valve supplied with lead wires connected into terminal strip suitable for M3 (#6) terminals for customer connection.*

DG4V-3-*A(L)-(V)M-S6-U-**-60

Single solenoid models with LVDT type switch indicating when the spool is in the spring off-set position. ISO 4400 (DIN 43650) connection to solenoid; Pg7 connection to switch.

Dim mm (in.)

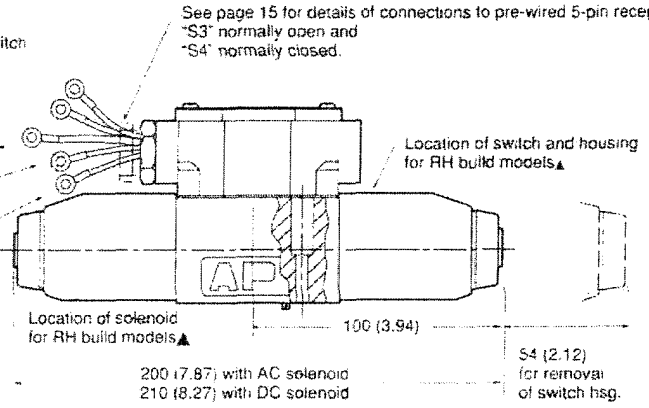


▲For LH build (DG4V-3-*AL) solenoid and switch locations are reversed.

DG4V-3-*A(L)-(Z)-(V)M-S3-FPA5W-*2-60
DG4V-3-*A(L)-(Z)-(V)M-S4-FPA5W-*2-60
DG4V-3-*A(L)-(Z)-(V)M-S5-F-*2-60

Single solenoid models with mechanical type switch monitoring of spool movement.

Conduit box with leads, or pre-wired to NFPA T3.5.29-1980 receptacle.



▲For LH build (DG4V-3-*AL) solenoid and switch locations are reversed.

Port restrictor plugs

Restrictor plugs are available for use in ports P, T, A or B. These can be used for restricting flow or for circuit dampening. Restrictor plugs are not recommended for use above 210 bar (3000 psi) system pressure.

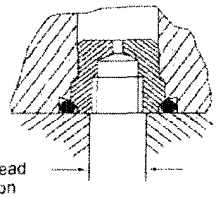
Typical model codes:
DG4V-3(S)-**-M-**-**-60-P08
(0.8 mm dia orifice in port P)

DG4V-3(S)-**-M-**-**-60-P10-A10
(1.0 mm dia orifice in ports P and A)

Restrictor plug selection table

Code	Orifice diameter	Part number■
*00	Blank	694353
*03	0,30 (0.012)	694341
*06	0,60 (0.024)	694342
*08	0,80 (0.030)	694343
*10	1,00 (0.040)	694344
*13	1,30 (0.050)	694345
*15	1,50 (0.060)	694346
*20	2,00 (0.080)	694347
*23	2,30 (0.090)	694348

** = P, T, A or B, as required*
■ Available in multiples of 25 per part number



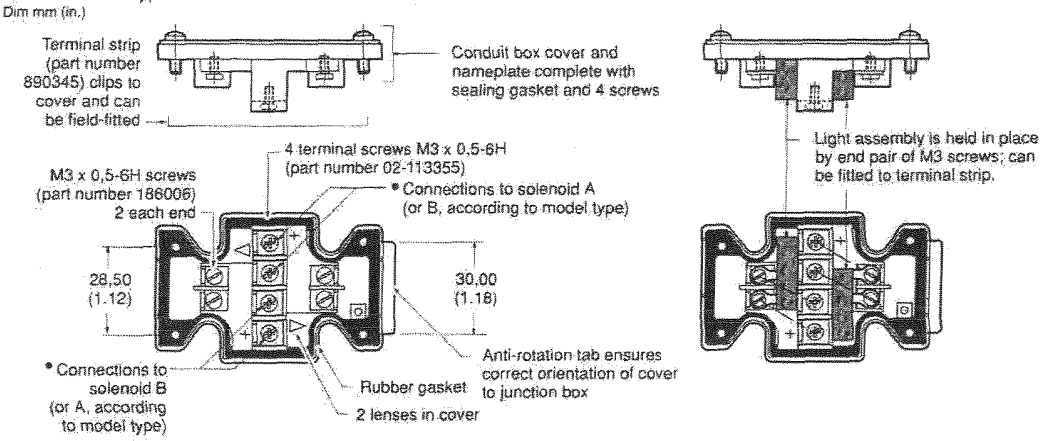
Maximum port dia in subplate/manifold block:
For steel and SG (ductile) iron: 7,0 (0.3)
For gray iron: 6,5 (0.25)

Electrical Plugs and Connectors

Terminal strip and lights

For valves with type "F" coils.

Dim mm (in.)



• 1. For DC coils the +ve lead(s) must be connected to the terminal(s) marked +. When using 3-wire incoming leads to double solenoid valves (i.e. common neutral) the inner pair of terminals must be interconnected

2. For correct light indication of energized solenoid ensure that solenoid leads are correctly connected: light terminals are common with each outer pair of solenoid terminals according to the side with + mark.

Insta-Plug

DG4V-3(S)---FPA---60
DG4V-3(S)---FPBW---60

Vickers 2-part "Insta-Plug" eliminates breaking electrical inputs for valve disconnect. A male half is pre-wired to the valve body. The mating plug is inside a wire housing with external terminals for machine wire connections.

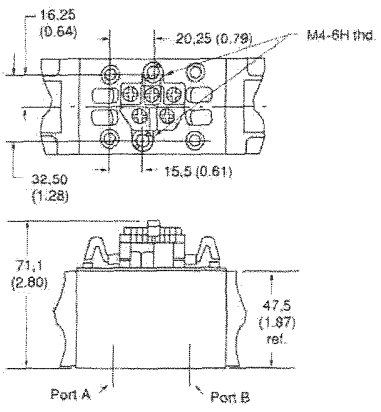
Captive thumb screws, when loosened, permit the wire housing to be pulled clear of the valve for disconnect. A longer ground post provides first make/last break ground connection.

The PBW configuration combines both male and female plugs in the wiring housing for a self-contained plug-in unit.

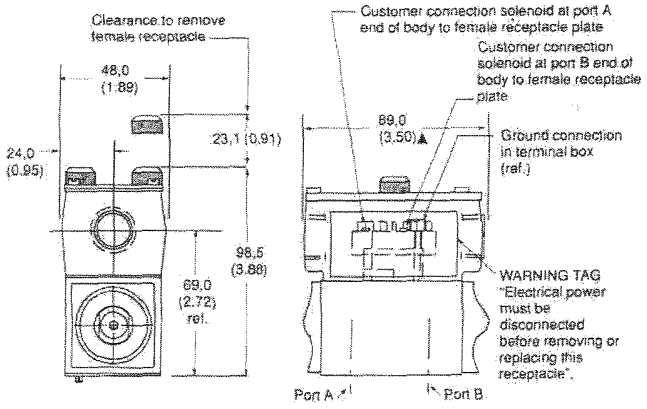
Optional solenoid indicator lights are pre-wired to the female plug. Solenoids "A" and/or "B" are identified on the wiring housing.

PA configuration

Dim mm (in.)



PBW configuration

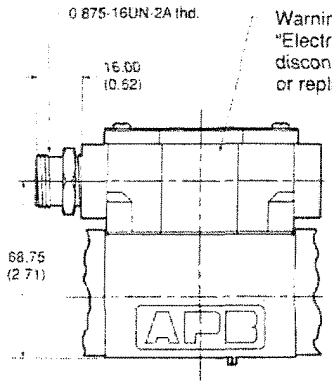


▲ The conduit box dimensions used for the PA/PBW type connector are different from those on the other "F" type coil models.

NFPA Connector T3.5.29-1980 Connection details and model type/model code references

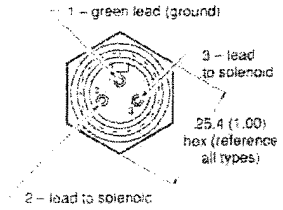
DG4V-3(S)---FPA3W(L)-**-60
DG4V-3(S)---FPA5W(L)-**-60
DG4V-3---S3-FPA5W(L)-**-60
DG4V-3---S4-FPA5W(L)-**-60

The receptacle is a standard three or five pole connector with shortened leads and terminals added. The five pole plug has four leads 101,6 (4.0) long and one 177,8 (7.0) long. The three pole plug has two leads 101,6 (4.0) long and one 177,8 (7.0). All wires have underwriters recognized non-solder insulated eyelet terminals. The green wire is used for the ground (earth) connection (No. 8 screw furnished). Valves are supplied pre-wired.

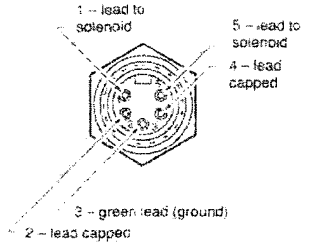


Warning tag:
"Electrical power must be disconnected before removing or replacing electrical plug."

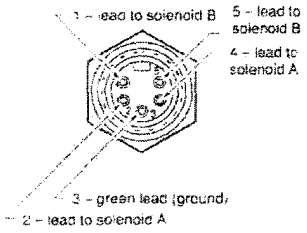
3 pin connector
Use with single solenoid valve
Key model code designations:
DG4V-3(S)-*A(L)(-**)-(V)M-FPA3W(L)
DG4V-3(S)-*B(L)(-**)-(V)M-FPA3W(L)



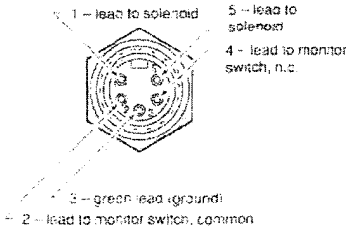
5 pin connector
Use with single solenoid valve
Key model code designations:
DG4V-3(S)-*A(L)(-**)-(V)M-FPA5W(L)
DG4V-3(S)-*B(L)(-**)-(V)M-FPA5W(L)



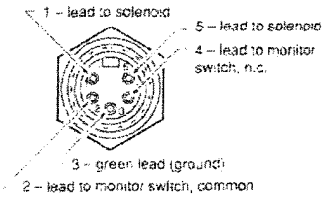
5 pin connector
Use with double solenoid valve
Key model code designations:
DG4V-3-*C/N(L)(-**)-(V)M-S4-FPA5W(L)



5 pin connector
Use with single solenoid valve with S3 spool position monitor switch
Key model code designations:
DG4V-3-*A(L)(-**)-(V)M-S3-FPA5W(L)

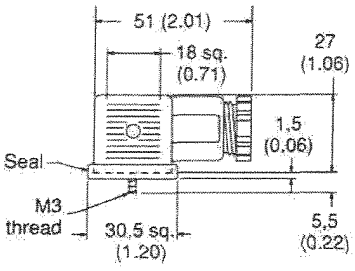


5 pin connector
Use with single solenoid valve with S4 spool position monitor switch
Key model code designations:
DG4V-3-*A(L)(-**)-(V)M-S4-FPA5W(L)



DIN 43650 Connector

Cable diameter range . . . Ø6–10 mm (0.24–0.40)
Wire section range . . . . . Ø,5–1,5 mm^2 (0.0008–0.0023 in^2)
Terminals . . . . . Screw type
Type of protection . . . . . IEC144 class IP65, when plugs are fitted correctly to the valves with interface seals (supplied with plugs) in place.

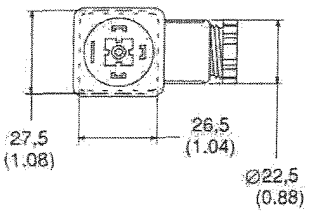


Connector can be positioned at 90° intervals on valve by re-assembling contact holder into appropriate position inside connector housing.

Use U12 or U11 type connectors with 12 and 24V DC coils if rectification is required.

Connectors with and without indicator lights are available (order separately):

Receptacle	Voltage (AC or DC)	Part Numbers Gray – "A" sol.	Black – "B" sol.
U1 Coils without lights	—	710776	710775
U6 Coils with lights	12-24	977467	977466
	100-125	977469	977468
	200-240	977471	977470
U11 Rectified coils with lights	12 DC	02-141358	
	24 DC	02-141359	
	98-240 VDC	02-141360	
	200-240 VDC	02-141361	
U12 Rectified coils without lights		02-141357	

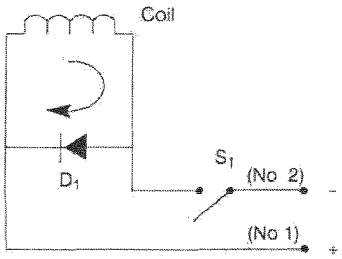


Surge Suppression Devices (For DC Valves)

Standard diode

Diode in parallel with coil. When switch (S_1) is opened, the energy stored in the coil is trapped and dissipated by the diode (D_1).

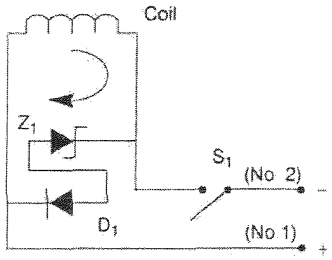
- Works only with DC voltage
- Polarity dependent
- Increases drop out time



Transzorb

Diode and Zener diode in parallel with coil. When switch (S_1) is opened, the energy stored in the coil is trapped and dissipated by the diode (D_1) and Zener diode (Z_1) and the coil resistance.

- The Zener makes exact limitation of inductive spikes.
- Works only with DC voltage
- Polarity dependent



NOTE: These surge suppression devices are "Polarity Dependent." Proper biasing conditions must be met when installing/connecting a coil in a system.

Valve Shift and Dropout Times With and Without Surge Suppression

	Shift	Dropout
CETOP 3		
No Diode	23	60
Diode Alone	23	141
Diode/Zener	23	78
CETOP 5		
No Diode	70	50
Diode Alone	70	158
Diode/Zener	70	100

Times represent cessation/application of voltage to coil versus velocity (start/stop) of a cylinder using a single solenoid, spring offset valve (time in milliseconds).

Subplates, Connection Plates and Mounting Surfaces

General description

This range of subplates and auxiliary connection plates are for use with size 3 valves. Optional BSPF or SAE/UNF pipe thread connections are available.

The subplates fall into five groups.

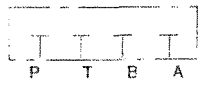
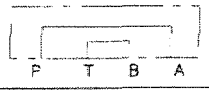
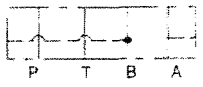
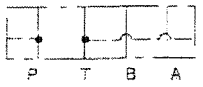
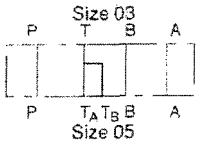
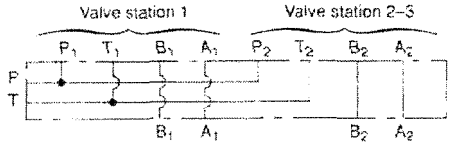
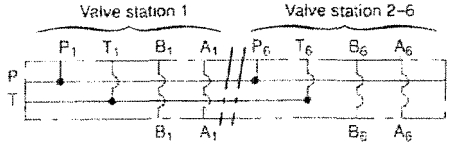
- Single station subplates with either *side or rear entry ports for connecting* to the main system.
- Multi-station manifolds having from two to six stations. The two service ports per station are arranged along one side but the pressure and tank lines are internally connected in parallel to each station.
- Tapping plates for insertion under modules or valves to provide access to service lines, e.g. for pressure gage connection.
- Cross-over plates for inter-connecting two sets of service lines at the top of module stacks when directional valves are not fitted.
- Blanking plate for terminating a valve station e.g. when the station is not to be used until later.

The 2 to 6 multi-station subplates, when used together with Vickers SystemStak valves, provide very compact control assemblies.

Plates having machined trapezoidal O-ring recesses are supplied complete with Viton O-rings.

On all models, the size 03 mounting face includes a drilled hole (for a location pin) in conformance with ANSI/B93.7M) and (NFPA) size 03. All Vickers size 3 valves and auxiliary plates contain a matching location pin to ensure correct orientation of the mounting faces.

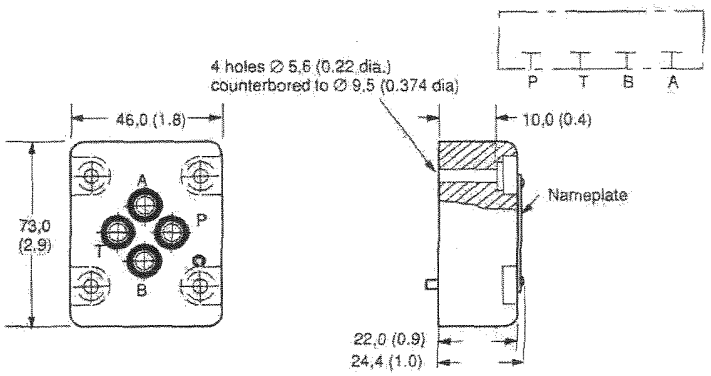
Design number subject to change. No change of installation dimensions for designs 10 thru 19. "R" (or "B") suffix – ISO 228 (BSPF) ports and/or metric attaching bolt tappings. "S" suffix – SAE/UNC ports and/or UNC attaching bolt tappings.

Description and maximum pressure	Functional symbol	Model code
Blanking plate 250 bar (3600 psi)		DGMA-3-B-1*
Crossover plate P–A, B–T 250 bar (3600 psi)		DGMA-3-C1-1*
Crossover plate P–B, A–T 250 bar (3600 psi)		DGMA-3-C2-1*
Tapping plate Ports A and B 250 bar (3600 psi)		DGMA-3-T1-1*-B DGMA-3-T1-1*-S
Tapping plate Ports P and T 250 bar (3600 psi)		DGMA-3-T2-1*-B DGMA-3-T2-1*-S
Adaptor size 05 to 03 207 bar (3000 psi)		DGAM-3-01-1*-R DGAM-3-01-1* (UNC valve mtg. bolts)
Single station subplate/manifold Rear ports P,T,A,B 250 bar (3600 psi)		DGVM-3-1*-R DGVM-3-1*-S
Single station subplate/manifold Side ports P,T,A,B 250 bar (3600 psi)		DGMS-3-1E-1*-R DGMS-3-1E-1*-S
Multi-station subplate/ manifold; side ports P,T,A_1,B_1,A_2,B_2, etc. 250 bar (3600 psi) 2 station 3 station		DGMS-3-2/3E-1*-R DGMS-3-2/3E-1*-S
Multi-station subplate/ manifold; side ports P,T,A_1,B_1,A_2,B_2, etc. 250 bar (3600 psi) 4 station 5 station 6 station		DGMS-3-4/5/6E-1*-R DGMS-3-4/5/6E-1*-S

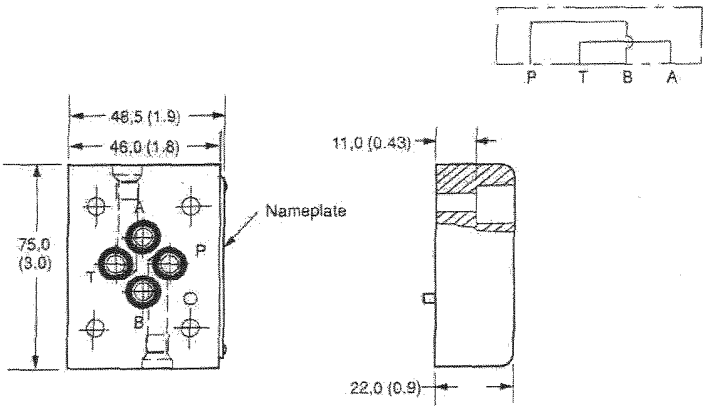
Installation Dimensions

DGMA-3-B-1* Blanking Plate

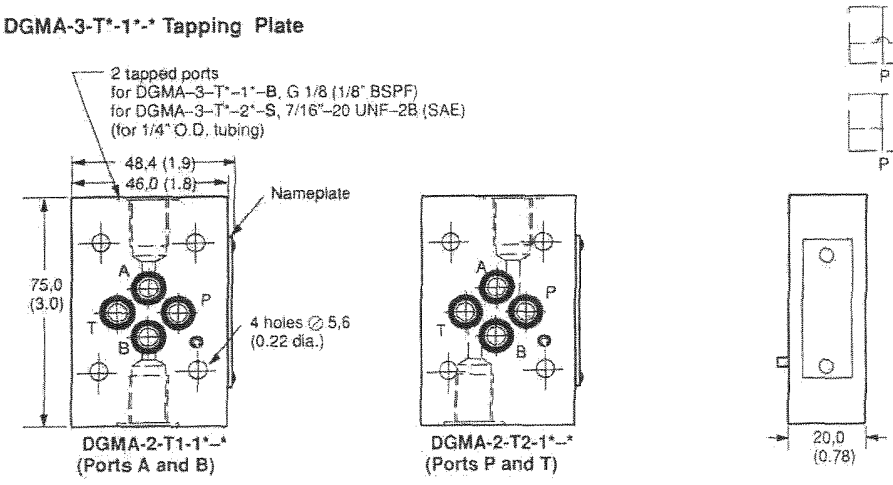
All dimensions shown
in mm (inches)

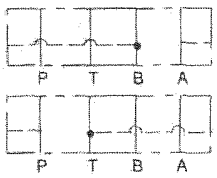


DGMA-3-C2-11 Crossover Plate



DGMA-3-T*-1*-* Tapping Plate



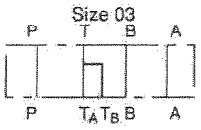


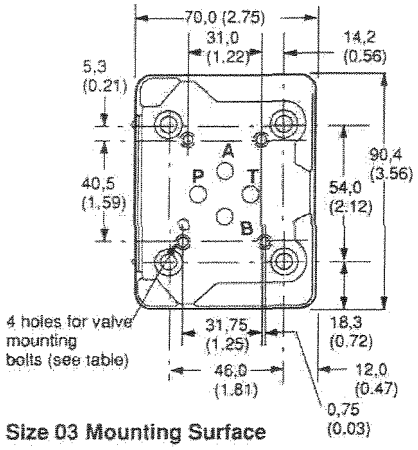
DGAM-3-01-1*-R (Metric bolt tapping)
DGAM-3-01-1* (UNC bolt tapping)
Adaptor plate, Size 05 to 03
for pressure up to 210 bar (3000 psi)

Dimensions shown
in mm (inches)

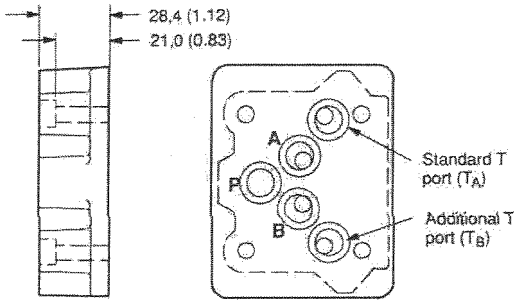
Size 3 valves can frequently be used in place of size 5 valves, typically for pilot control functions, or generally where the system flow rate is within that of size 3 valves.

The DGAM-3 adaptor bolts to an existing size 5 interface and provides a size 3 mounting face for the smaller valves.





Size 03 Mounting Surface

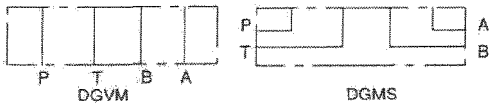


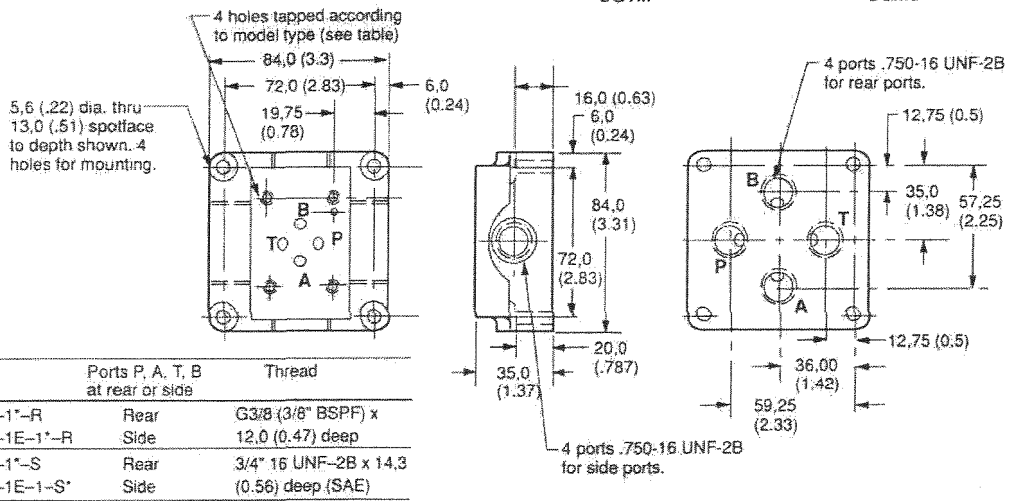
Size 05 Mounting Surface (seals included)

Model	Tappings for valve mounting bolts
DGAM-3-01-1*-R	M5-6H x 12 (0.47) deep
DGAM-3-01-1*	#10-24 UNC-2B x 12,7 (0.5) deep

Adaptor is supplied complete with bolts for mounting to size 5 interface:
M6 bolts with type DGAM-3-01-1*-R
1/4"-20 UNC bolts with type DGAM-3-01-1*

DGVM-3-1*-*
DGMS-3-1E(Y)-1*-*
Single station subplate, rear and side tapped port

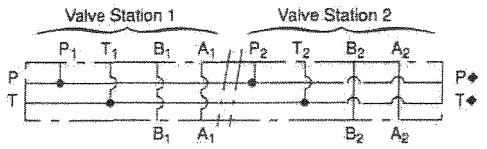


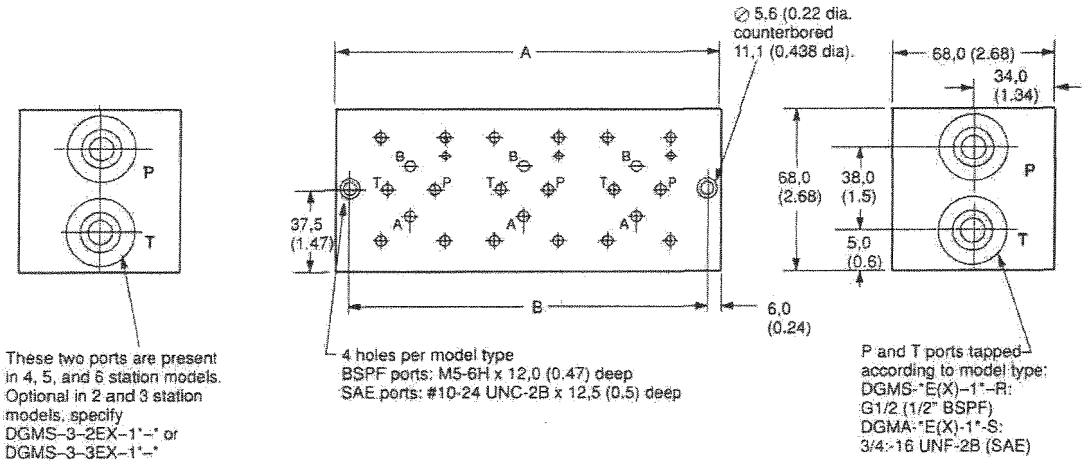


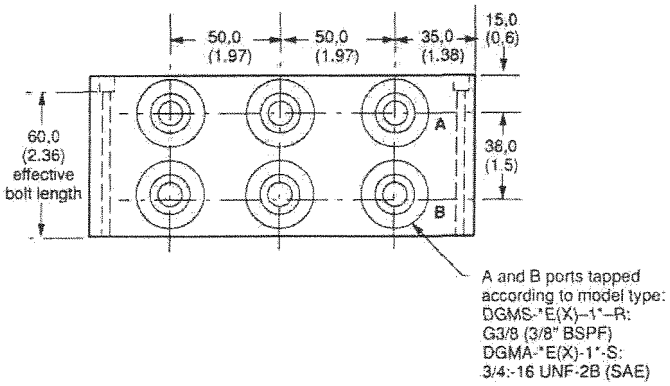
Model	Ports P, A, T, B at rear or side	Thread
DGVM-3-1*-R	Rear	G3/8 (3/8" BSPF) x
DGMS-3-1E-1*-R	Side	12,0 (0.47) deep
DGVM-3-1*-S	Rear	3/4" 16 UNF-2B x 14,3
DGMS-3-1E-1-S*	Side	(0.56) deep (SAE)
DGMS-3-1EY-1-S*	Side	5/8" 18 UNF-2B x 12,7 (0.5) deep (SAE)

DGMS-3-3E-1*-*
Multi-station subplate
(3 station shown)

Dimensions shown in mm (inches)







Model	A Dim.	B Dim.
DGMS-3-2E(X)-1*-*	121 (4.8)	108 (4.25)
DGMS-3-3E(X)-1*-*	171 (6.8)	158 (6.22)
DGMS-3-4E-1*-*	221 (8.7)	208 (8.19)
DGMS-3-5E-1*-*	271 (10.7)	258 (10.15)
DGMS-3-6E-1*-*	321 (12.7)	308 (12.12)

◆ *Thru connection P and T ports on types DGMS-3-2EX-1*-* and DGMS-3-3EX-1*-**

Mounting Surface

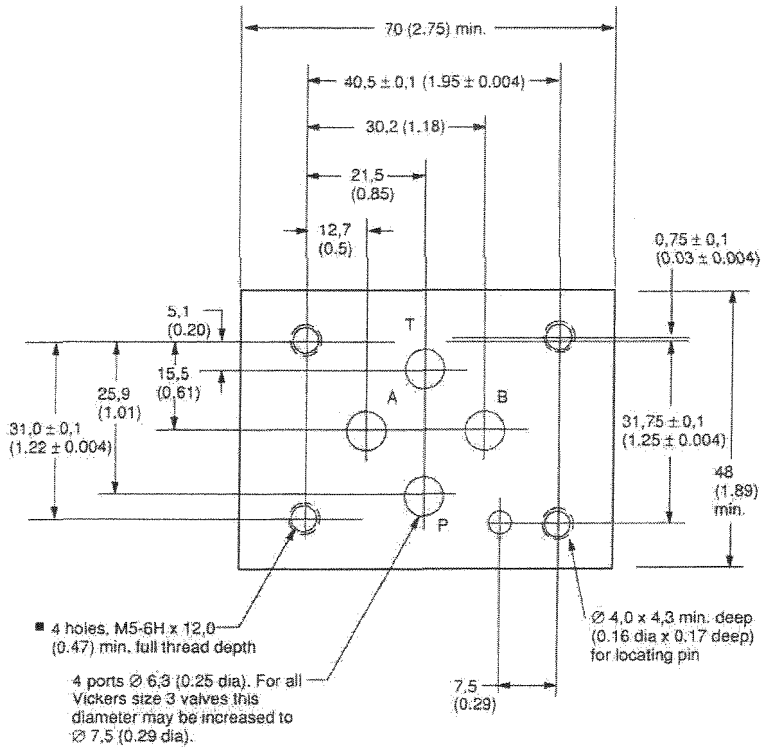
Dimensions shown in mm (inches ▲)

When a subplate is not used, a machined pad must be provided for mounting. The pad must be flat within 0,01 mm per 100 mm (0.0001" per 1") and smooth within 0,8 µm (32 µin).

The interface conforms to
ISO 4401-AB-03-4A (size 03) plus location pin hole
ANSI/B93.7M (and NFPA) size 03
CETOP R35H4.2-03, plus location pin hole
DIN 24340 Form A6, plus location pin hole

Dimensional tolerance = ± 0,2 (± 0.008) except where otherwise stated.

Prior to installing a valve, ensure that both valve and mounting surface are clean and free from burrs.



▲ *ISO 4401 gives dimensions in mm. Inch conversions are accurate to 0.01" unless stated.*

■ *#10-24 UNC-2B optional*

Appendix

Mounting Bolts

Inch bolt kits, #10–24 UNC–2B

Size x length, in (mm)

#10-24 x 12,7 (0.50)	BK590715
#10-24 x 19,05 (0.75)	BK466847
#10-24 x 25,4 (1.00)	BK304
#10-24 x 31,8 (1.25)	BK590716
#10-24 x 38,1 (1.50)	BK306
#10-24 x 44,4 (1.75)	BK02-156494
#10-24 x 50,8 (2.00)	BKDG3698
#10-24 x 57,2 (2.25)	BK02-139165
#10-24 x 60,3 (2.38)	BK466849
#10-24 x 69,9 (2.75)	BK870017
#10-24 x 69,9 (2.75)	BKDGFNL694M◆
#10-24 x 76,2 (3.00)	BK02-156496
#10-24 x 79,4 (3.13)	BK466850
#10-24 x 88,9 (3.50)	BK466851
#10-24 x 95,3 (3.75)	BK869704
#10-24 x 100 (3.94)	BK466852
#10-24 x 101,6 (4.00)	BK02-156497
#10-24 x 109,5 (4.31)	BK466853
#10-24 x 120,7 (4.75)	BK466854
#10-24 x 127,0 (5.00)	BK02-156499
#10-24 x 130,2 (5.13)	BK466855
#10-24 x 133,4 (5.25)	BK02-156498
#10-24 x 139,7 (5.50)	BK466856
#10-24 x 150,9 (5.94)	BK466857
#10-24 x 160,3 (6.31)	BK466858
#10-24 x 170,0 (6.69)	BK466859
#10-24 x 177,8 (7.00)	BK890325

Metric bolt kits, M5

Size x length, mm (in)

M5 x 20 (0.79)	BK466834M
M5 x 25 (0.98)	BK465723M
M5 x 30 (1.18)	BK616452M
M5 x 40 (1.57)	BK02–156493M
M5 x 50 (1.97)	BKDG3699M
M5 x 55 (2.17)	BK986135M
M5 x 60 (2.36)	BK466836M
M5 x 70 (2.76)	BK464125M
M5 x 75 (2.95)	BK869720M
M5 x 80 (3.15)	BK466837M
M5 x 90 (3.54)	BK466838M
M5 x 95 (3.74)	BK869721M
M5 x 100 (3.94)	BK466839M
M5 x 110 (4.33)	BK466840M
M5 x 120 (4.72)	BK466841M
M5 x 130 (5.12)	BK466842M
M5 x 140 (5.51)	BK466843M
M5 x 150 (5.91)	BK466844M
M5 x 160 (6.30)	BK466845M
M5 x 170 (6.69)	BK466846M
M5 x 200 (7.87)	BK464468M

Metric bolt kits, M6

Size x length, mm (in)

M6 x 16 (0.63)	BK534564M
M6 x 20 (0.79)	BK534565M
M6 x 25 (0.98)	BK534566M
M6 x 30 (1.18)	BK534567M
M6 x 40 (1.57)	BKDG01633M◆
M6 x 45 (1.77)	BK534569M
M6 x 50 (1.97)	BK534570M
M6 x 55 (2.17)	BK534571M
M6 x 65 (2.56)	BK534572M
M6 x 70 (2.76)	BK534573M
M6 x 75 (2.95)	BK534574M
M6 x 80 (3.15)	BK638873M
M6 x 80 (3.15)	BKDGFN01637M◆
M6 x 85 (3.35)	BK978478M
M6 x 90 (3.54)	BK534576M
M6 x 100 (3.94)	BK978479M
M6 x 110 (4.33)	BK978480M
M6 x 115 (4.53)	BK534580M
M6 x 120 (4.72)	BK534581M
M6 x 140 (5.51)	BK638878M

Note: If not using Vickers bolt kits, bolts must be to Grade 12.9 (ISO 898) or better.

The required bolt length should allow 0.40" (10 mm) thread engagement in the subplate/manifold block. Bolts should be torqued to 5–7 N.m (44–62 lbf. in.) with threads lubricated. Prior to installation of DG4V-3 valve, ensure that both the face of the valve and the face on which it is being mounted (i.e subplate, manifold, SystemStak valve or plate) is as clean as possible. Do not over tighten hold-down bolts beyond recommended values.

Spare parts data

Refer to service drawing I–3886–S for spare parts and kit information.

Seal kits

For valves with spool indicator switch, model types DG4V-3-*A---M-S*---60 ..... kit no. 859049
For other models seal kits vary according to type of coil fitted:
For "U" type coil ..... kit no. 858995
For "F" type coil ..... kit no. 858996

Note: Each seal kit covers a variety of models and may have redundant seals for a particular model.

Solenoid Coils

AC coils

Code	Voltage/ frequency	Standard performance "U" type	Standard performance "F" type	High performance "U" type	High performance "F" type
Full power coils:					
A	110V/50 Hz	02-101725	02-101730	507825	508166
B	110/120V/50/60 Hz	02-101726	02-101731	507833	508169
C	220V/50 Hz	02-101727	02-101732	507826	508167
D	220/240V/50/60 Hz	02-101728	02-101733	507834	508170
Low power coils:					
BL	110/120V/50/60 Hz	N/A	N/A	598562	698563
DL	220/240V/50/60 Hz	N/A	N/A	866455	866457

DC coils *(Standard and high performance)*

Code	Voltage	"U" type	"F" type	"SP1" type	"SP2" type	"KU" type
Full power coils:						
G	12V	507847	508172	02–111246	02-111166	02–140394
H	24V	507848	508173	02–111248	02-111168	02–140395
Low power coils:						
GL	12V	507855	508175	N/A	N/A	N/A
HL	24V	507852	508174	N/A	N/A	N/A

Mass, approx. kg (lb)

DG4V-3 and DG4V-3S (DC)	"U" coils	"F" coils
Single sol. valve	1,6 (3.5)	1,8 (4.0)
Double sol. valve	2,2 (4.8)	2,3 (5.0)
DG4V-3 and DG4V-3S (AC)	"U" coils	"F" coils
Single sol. valve	1,5 (3.3)	1,6 (3.5)
Double sol. valve	1,8 (4.0)	2,0 (4.4)
Single sol. valve w/ position switch	2,0 (4.4)	2,0 (4.4)

Mounting Attitude

No restrictions except for no-spring, detented models DG4V-3-*N and DG4V-3S-*N which should be mounted with the spool axis horizontal. These model types may be affected by severe vibration or shock, especially if a solenoid is not held energized.

Temperature Limits

Ambient range .... -20°C to 70°C
(-4°F to +158°F)

Fluid Temperature

Fluid Temp.	Mineral oil	Water containing
Minimum	-20°C (-4°F)	+10°C (+50°F)
Maximum*	+70°C (+158°F)	+54°C (+129°F)

** To obtain optimum service life from both fluid and hydraulic system, 65°C (150°F) is the recommended maximum fluid temperature, except for water-containing fluids.*

For synthetic fluids, consult fluid manufacturer or Vickers representative where limits are outside those for mineral oil.

Whatever the actual temperature range, ensure that fluid viscosities stay within the limits specified in "Hydraulic Fluids".

Fluid Cleanliness

Proper fluid condition is essential for long and satisfactory life of hydraulic components and systems. Hydraulic fluid must have the correct balance of cleanliness, materials and additives for protection against wear of components, elevated viscosity and inclusion of air.

Essential information on the correct methods for treating hydraulic fluid is included in Vickers publication 561,"Vickers Guide to Systemic Contamination Control," available from your local Vickers distributor or by contacting Vickers, Incorporated. Recommendations on filtration and the selection of products to control fluid condition are included in 561.

Recommended cleanliness levels, using petroleum oil under common conditions, are based on the highest fluid pressure levels in the system and are coded in the chart below. Fluids other than petroleum, severe service cycles or temperature extremes are cause for adjustment of these cleanliness codes. See Vickers publication 561 for exact details.

Vickers products, as any components, will operate with apparent satisfaction in fluids with higher cleanliness codes than those described. Other manufacturers will often recommend levels above those specified.

Experience has shown, however, that life of any hydraulic components is shortened in fluids with higher cleanliness codes than those listed below. These codes have been proven to provide a long trouble-free service life for the products shown, regardless of the manufacturer.

Fire resistant fluids usually have higher specific gravities than oil. The specific gravity of a fluid may be obtained from its producer.

	System Pressure Level bar (psi)		
Product	**<70 (<2000)**	**70–207 (2000–3000)**	**207+ (3000+)**
Vane pumps, fixed	20/18/15	19/17/14	18/16/13
Vane pumps, variable	18/16/14	17/15/13	
Piston pumps, fixed	19/17/15	18/16/14	17/15/13
Piston pumps, variable	18/16/14	17/15/13	16/14/12
Directional valves	20/18/15	20/18/15	19/17/14
Proportional valves	17/15/12	17/15/12	15/13/11
Servo valves	16/14/11	16/14/11	15/13/10
Pressure/Flow controls	19/17/14	19/17/14	19/17/14
Cylinders	20/18/15	20/18/15	20/18/15
Vane motors	20/18/15	19/17/14	18/16/13
Axial piston motors	19/17/14	18/16/13	17/15/12

Ordering Procedure

When placing an order, please specify full model designations of valves, subplates and kits. Refer to relevant "Model Code" sections.

VICKERS
A TRINOVA Company

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05/02/95

SYSTEM UV4000™ LOW FLOW OPERATION AND MAINTENANCE MANUAL

SECTION 7.0

Electrical Systems

Section 7.0 ELECTRICAL SYSTEMS

A typical UV4000LF™ installation requires (1) electrical service as follows:

- 1 - 480V, 3 phase, 4 wire feed, (amperage depends on system size)

NOTE:
A LOCAL OVERCURRENT PROTECTION DEVICE MUST BE PROVIDED FOR THE THREE PHASE POWER SUPPLY AND THE SINGLE PHASE MECHANICAL SERVICE.

The 480V, 3 phase, 4 wire service comes into a main distribution block in the SCC and feeds the following devices (via transformers where required):

- individual earth leakage protection devices - from which multiconductor cables are hardwired to distribution blocks within each module "suitcase"
- hydraulic pump - located in the hydraulic systems center
- coolant pumps - located in the hydraulic systems center
- pump motor starters
- bank communication boards (1 per bank)
- hydraulic controls
- step down transformer (which feeds all of the 120V equipment)

The step down transformer converts the 480V, 3 phase, 4 wire into a 120V, 1 phase, 2 wire service which goes into a distribution block within the SCC and feeds the following (via transformers where required):

- UVT analyzer
- UV intensity probes (1 per bank)
- UVT sensor / sampler
- Low water level sensor (and high water where specified) – auxiliary power from 480V feed in case of power failure of the 120V feed
- 120V, 4A service receptacle
- I/O board and operator interface

All communication from the system controller to the various devices is via the bank communication circuit boards. UV module signals, intensity signals, wiper control and status, hydraulic systems, and effluent level signals are among the standard data monitored by the circuit boards. The Operator can access these values of these parameters via the Operator Interface.

Please refer to the electrical drawings for details.

Section 7.1 SYSTEM CONTROL/POWER DISTRIBUTION CENTER

The following pages contain detailed electrical schematics along with mechanical layout drawings of the devices located within the system control/ power distribution center.

REV	REVISION DESCRIPTION	LOG NO.	REV BY	CHK BY	APPROVAL AND DATE
A	DWG RELEASED FOR SUBMITTAL ONLY.	02-1984	SF	JLW	SF 02DE04
B	DWG RELEASED FOR PRODUCTION.	03-318	SF	JLW	SF 03FE18

480VAC 60Hz 66kVA 83A 3PH 4W +GND

GND 1N 1L1 1L2 1L3

102FDS 60AMP

1L1 — 60A — 1021

1L2 — 60A — 1031

1L3 — 60A — 1041

1N — 1N — TO LINE 201

108FDS 60AMP

1L1 — 60A — 1081

1L2 — 60A — 1091

1L3 — 60A — 1101

1N — 1N — TO LINE 251

114FDS 30AMP

1L1 — 20A — 1141

1L2 — 20A — 1151

1L3 — 20A — 1161

TO LINE 301

125FB 0.4A 1251 — 125XFMR 480-24VAC 60Hz 150VA — 1252

1L2 — 0.4A 1271 — 1272

125CB 4AMP — 1253 — 125RFI LINE/LOAD — 1254 / 1272 — 1273

COMMUNICATION CONTROLLER CIRCUIT BOARD BANK 1A TO LINE 401

130CB 4AMP — 1252 — COOLING SYSTEM ON/OFF CONTROL BANK 1A — 1301 (C) (NO) 1302 (A1) 130 MS (A2) 1303 — OL

COOLANT PUMP #1 MOTOR STARTER 2103,2104,2106

1272

133FB 0.4A 1331 — 133XFMR 480-24VAC 60Hz 150VA — 1332

1L3 — 0.4A 1351 — 1352

133CB 4AMP — 1333 — 133RFI LINE/LOAD — 1334 / 1352 — 1353

COMMUNICATION CONTROLLER CIRCUIT BOARD BANK 1B TO LINE 501

138CB 4AMP — 1332 — COOLING SYSTEM ON/OFF CONTROL BANK 1B — 1381 (C) (NO) 1382 (A1) 138 MS (A2) 1383 — OL

COOLANT PUMP #2 MOTOR STARTER 2111,2112,2113

1352

MAIN POWER DISTRIBUTION SCHEMATIC

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES: 2 PL DEC ± N/A
3 PL DEC ± N/A
ANGLE ± N/A
REMOVE ALL BURRS
ALL CORNERS R 0.010 OR BREAK
▽ - WIN RECEIVING INSPECTION PT

TROJAN TECHNOLOGIES INC.
LONDON, ONTARIO, CANADA

DESCRIPTION: SCC ASSY, UV4LF WILLIDGEVILLE

THIRD ANGLE PROJECTION

0 0.5 1.0
1.0" ON ORIGINAL DWG

SCALE: NTS

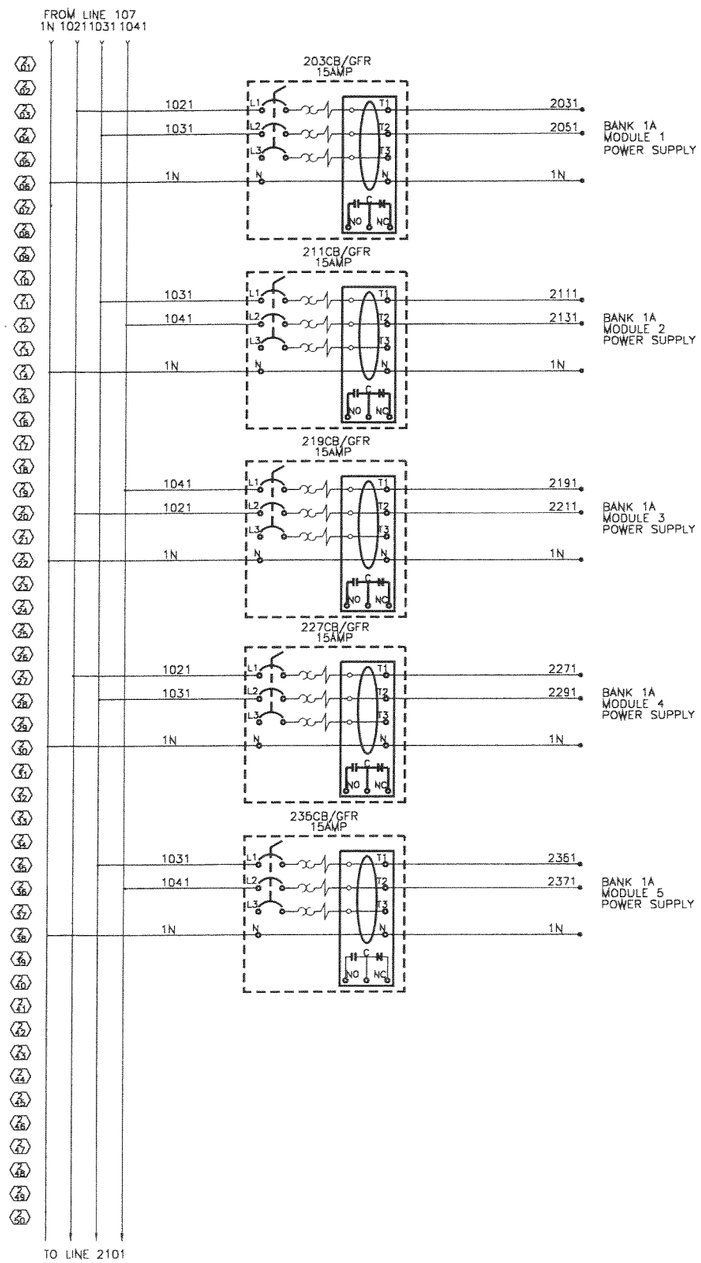
PART NO. 929206

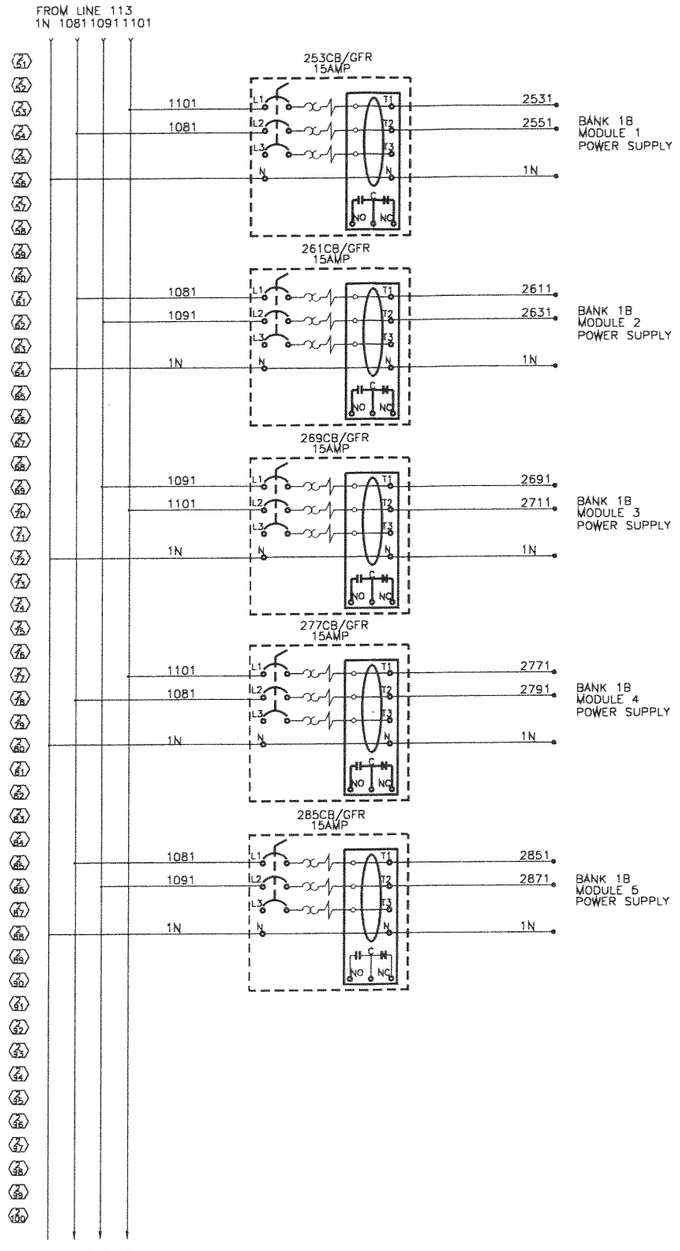
REV B

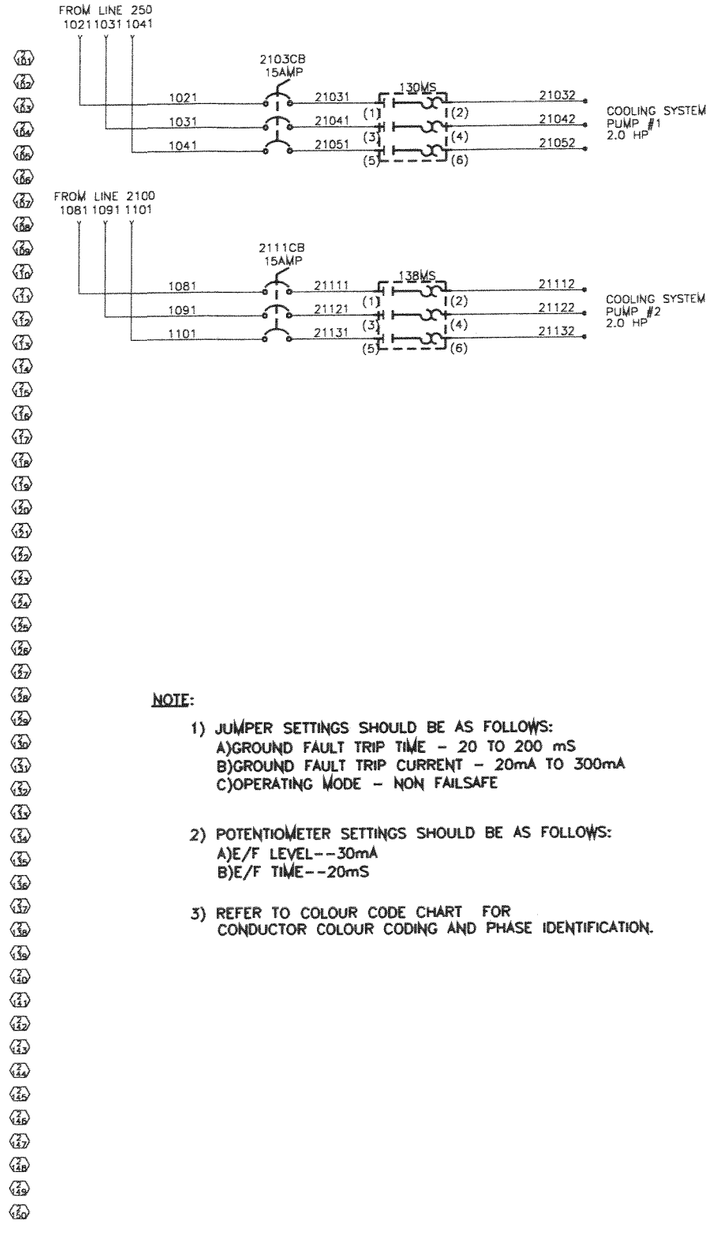
SHEET 1 OF 9

SIZE D

DWG NO. 929206







NOTE:

1) JUMPER SETTINGS SHOULD BE AS FOLLOWS:
   A)GROUND FAULT TRIP TIME – 20 TO 200 mS
   B)GROUND FAULT TRIP CURRENT – 20mA TO 300mA
   C)OPERATING MODE – NON FAILSAFE

2) POTENTIOMETER SETTINGS SHOULD BE AS FOLLOWS:
   A)E/F LEVEL--30mA
   B)E/F TIME--20mS

3) REFER TO COLOUR CODE CHART FOR CONDUCTOR COLOUR CODING AND PHASE IDENTIFICATION.

POWER DISTRIBUTION CENTER BANK 1A AND BANK 1B SCHEMATIC

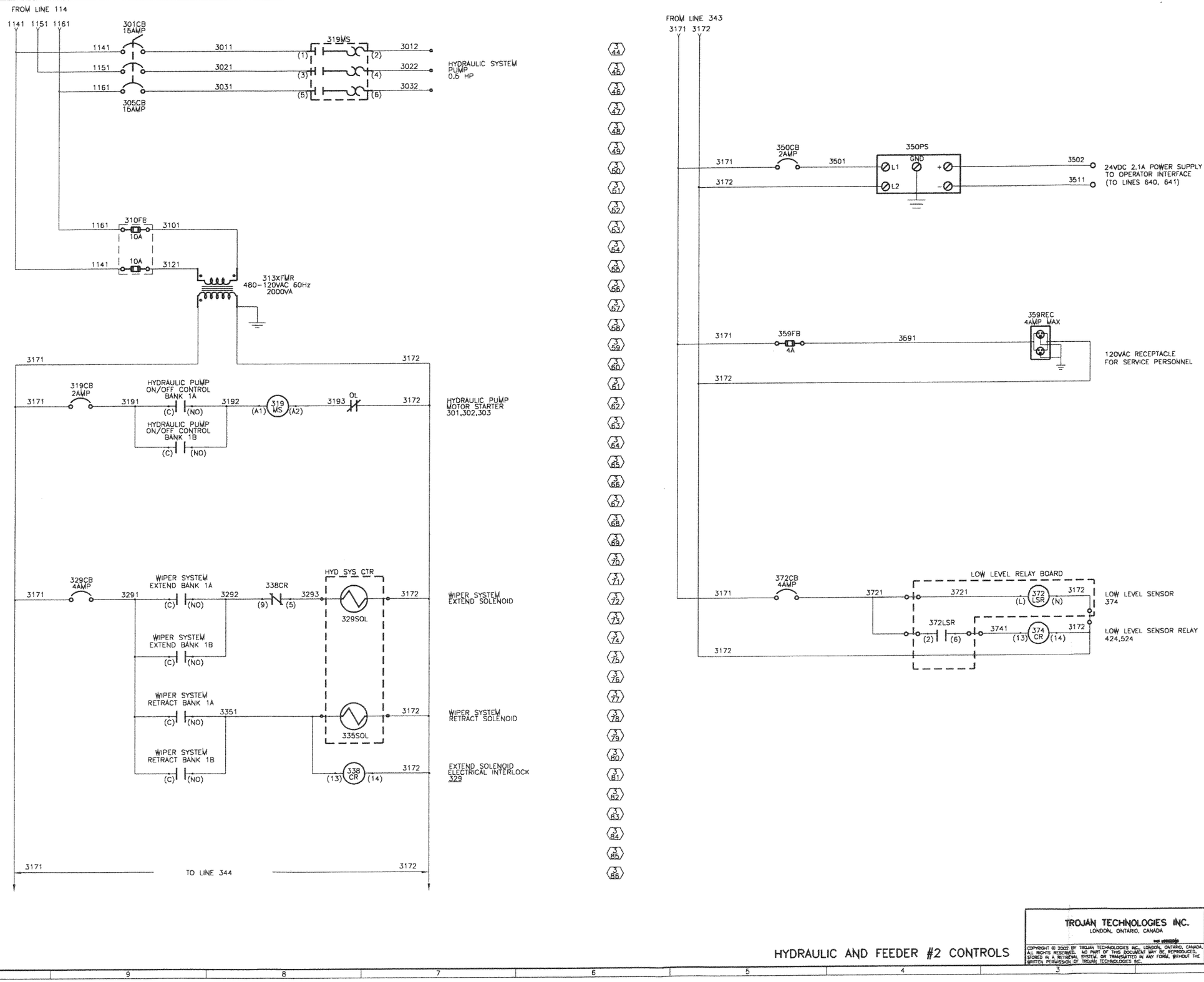
TROJAN TECHNOLOGIES INC.
LONDON, ONTARIO, CANADA

DESCRIPTION: SCC ASSY, UV4LF WILLIDGEVILLE

REVISION BY	SF	PART NO.	REV
CHECKED BY	JLW	929206	B
APPROVED BY	SF	SHEET 2 OF 9	SIZE D

0 0.5 1.0 — 1.0" ON ORIGINAL DWG — SCALE: NTS

DWG NO. 929206



HYDRAULIC AND FEEDER #2 CONTROLS

TROJAN TECHNOLOGIES INC.
LONDON, ONTARIO, CANADA

DESCRIPTION: SCC ASSY, UV4LF WILLIDGEVILLE

REVISION BY	SF	PART NO.	REV
CHECKED BY	JLW	929206	B
APPROVED BY	SF	SHEET 3 OF 9	SIZE D

0 0.5 1.0 — 1.0" ON ORIGINAL DWG
SCALE: NTS

DWG NO. 929206

FROM LINE 126

1273 1254

UV4000 LOW FLOW COMMUNICATION CONTROLLER BOARD

1273
1254

C
24B
24A
24VAC INPUT POWER SUPPLY

1273

SHIELD
GREEN
RED
0V
RL
+VDC
UV INTENSITY PROBE INPUT

411SS
BANK 1A
OFF
ON
REMOTE
1254 (X00) 4111
1254 (00X) 4121

416SS
BANK 1A WIPER
OFF
LOCAL
REMOTE
1254 (X00) 4161
1254 (00X) 4171

421SS
BANK 1A WIPER
RET
SEQ
EXT
1254 (00X) 4211
1254 (X00) 4221

HYDR SYS CENTER
1254 420PS 4201
1254 421PS 4211

374CR
1254 (9) (5) 4241
1254 425PS 4251
1254 426PS 4261

HYDR SYS CENTER

1254

1273 4111 COMMON 120VAC — INPUT #1 – INPUT – BANK STATUS, ON
1273 4121 COMMON 120VAC — INPUT #2 – INPUT – BANK STATUS, REMOTE
1273 4161 COMMON 120VAC — INPUT #3 – INPUT – WIPER STATUS, LOCAL
1273 4171 COMMON 120VAC — INPUT #4 – INPUT – WIPER STATUS, REMOTE
1273 4211 COMMON 120VAC — INPUT #5 – INPUT – WIPER STATUS, SEQUENCE
1273 4221 COMMON 120VAC — INPUT #6 – INPUT – WIPER STATUS, EXTEND/RETRACT
1273 4201 COMMON 120VAC — INPUT #7 – INPUT – PROCESS STATUS 1 (COOLING SYSTEM STATUS, HIGH PRESSURE NOT PRESENT)
1273 4211 COMMON 120VAC — INPUT #8 – INPUT – PROCESS STATUS 2 (COOLING SYSTEM STATUS, LOW PRESSURE NOT PRESENT)
COMMON 120VAC — INPUT #9 – INPUT – PROCESS STATUS 3 (WATER LEVEL STATUS, HIGH LEVEL NOT PRESENT)
1273 4241 COMMON 120VAC — INPUT #10 – INPUT – PROCESS STATUS 4 (WATER LEVEL STATUS, LOW LEVEL NOT PRESENT)
1273 4251 COMMON 120VAC — INPUT #11 – INPUT – PROCESS STATUS 5 (HYDRAULIC SYSTEM STATUS, HIGH PRESSURE NOT PRESENT)
1273 4261 COMMON 120VAC — INPUT #12 – INPUT – PROCESS STATUS 6 (HYDRAULIC SYSTEM STATUS, LOW PRESSURE NOT PRESENT)
1301 COMMON NO — OUTPUT #1 – COOLING SYSTEM CONTROL, ON/OFF
1302
3191 COMMON NO — OUTPUT #2 – HYDRAULIC SYSTEM CONTROL, ON/OFF
3192
3291 COMMON NO — OUTPUT #3 – WIPER EXTEND
3292
3291 COMMON NO — OUTPUT #4 – WIPER RETRACT
3351

CABLE 432A, TO BANK 1A MODULE 1 WIPER SOLENOID — 4321 4322 — 24VDC — WIPER SOLENOID, BANK 1A MODULE 1
CABLE 433A, TO BANK 1A MODULE 2 WIPER SOLENOID — 4331 4332 — 24VDC — WIPER SOLENOID, BANK 1A MODULE 2
CABLE 434A, TO BANK 1A MODULE 3 WIPER SOLENOID — 4341 4342 — 24VDC — WIPER SOLENOID, BANK 1A MODULE 3
CABLE 436A, TO BANK 1A MODULE 4 WIPER SOLENOID — 4351 4352 — 24VDC — WIPER SOLENOID, BANK 1A MODULE 4
CABLE 436A, TO BANK 1A MODULE 5 WIPER SOLENOID — 4361 4362 — 24VDC — WIPER SOLENOID, BANK 1A MODULE 5
24VDC — WIPER SOLENOID, BANK 1A MODULE 6
24VDC — WIPER SOLENOID, BANK 1A MODULE 7
24VDC — WIPER SOLENOID, BANK 1A MODULE 8

402CCB

"A"

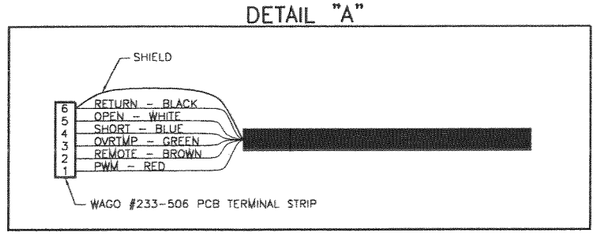
BALLAST 1 COMMUNICATIONS, BANK 1A MODULE 1 — CABLE 404B, TO BANK 1A MODULE 1 BALLAST 1
BALLAST 2 COMMUNICATIONS, BANK 1A MODULE 1 — CABLE 406B, TO BANK 1A MODULE 1 BALLAST 2
BALLAST 1 COMMUNICATIONS, BANK 1A MODULE 2 — CABLE 408B, TO BANK 1A MODULE 2 BALLAST 1
BALLAST 2 COMMUNICATIONS, BANK 1A MODULE 2 — CABLE 410B, TO BANK 1A MODULE 2 BALLAST 2
BALLAST 1 COMMUNICATIONS, BANK 1A MODULE 3 — CABLE 413B, TO BANK 1A MODULE 3 BALLAST 1
BALLAST 2 COMMUNICATIONS, BANK 1A MODULE 3 — CABLE 415B, TO BANK 1A MODULE 3 BALLAST 2
BALLAST 1 COMMUNICATIONS, BANK 1A MODULE 4 — CABLE 417B, TO BANK 1A MODULE 4 BALLAST 1
BALLAST 2 COMMUNICATIONS, BANK 1A MODULE 4 — CABLE 419B, TO BANK 1A MODULE 4 BALLAST 2
BALLAST 1 COMMUNICATIONS, BANK 1A MODULE 5 — CABLE 422B, TO BANK 1A MODULE 5 BALLAST 1
BALLAST 2 COMMUNICATIONS, BANK 1A MODULE 5 — CABLE 424B, TO BANK 1A MODULE 5 BALLAST 2
BALLAST 1 COMMUNICATIONS, BANK 1A MODULE 6
BALLAST 2 COMMUNICATIONS, BANK 1A MODULE 6
BALLAST 1 COMMUNICATIONS, BANK 1A MODULE 7
BALLAST 2 COMMUNICATIONS, BANK 1A MODULE 7
BALLAST 1 COMMUNICATIONS, BANK 1A MODULE 8
BALLAST 2 COMMUNICATIONS, BANK 1A MODULE 8

RS422 SERIAL PORT
RX+ RX- TX+ TX- COM

SEE COMMUNICATION CONNECTION DETAILS LINE 650

END

DETAIL "A"



TROJAN TECHNOLOGIES INC.
LONDON, ONTARIO, CANADA

DESCRIPTION: SCC ASSY, UV4LF WILLIDGEVILLE

REVISION BY	SF	PART NO.	REV
CHECKED BY	JLW	929206	B
APPROVED BY	SF	SHEET 4 OF 9	SIZE D

0 0.5 1.0 — 1.0" ON ORIGINAL DWG
SCALE: NTS

DWG NO. 929206

FROM LINE 134

1353 1334

UV4000 LOW FLOW COMMUNICATION CONTROLLER BOARD

G — 24B — 24A — 24VAC INPUT POWER SUPPLY

1353
1334

SHIELD — 0V
GREEN — RL
RED — +VDC
UV INTENSITY PROBE INPUT

1353

511SS
BANK 1B
OFF
ON — REMOTE

1334 (X00) 5111
1334 (00X) 5121

516SS
BANK 1B WIPER
OFF
LOCAL — REMOTE

1334 (X00) 5161
1334 (00X) 5171

521SS
BANK 1B WIPER
RET
SEQ — EXT

1334 (00X) 5211
1334 (X00) 5221

1334 — 374CR (12) (8) — 5241 — 5241

1353 / 5111	COMMON / 120VAC	INPUT #1 – INPUT – BANK STATUS, ON
1353 / 5121	COMMON / 120VAC	INPUT #2 – INPUT – BANK STATUS, REMOTE
1353 / 5161	COMMON / 120VAC	INPUT #3 – INPUT – WIPER STATUS, LOCAL
1353 / 5171	COMMON / 120VAC	INPUT #4 – INPUT – WIPER STATUS, REMOTE
1353 / 5211	COMMON / 120VAC	INPUT #5 – INPUT – WIPER STATUS, SEQUENCE
1353 / 5221	COMMON / 120VAC	INPUT #6 – INPUT – WIPER STATUS, EXTEND/RETRACT
	COMMON / 120VAC	INPUT #7 – INPUT – PROCESS STATUS 1 (COOLING SYSTEM STATUS, HIGH PRESSURE NOT PRESENT)
	COMMON / 120VAC	INPUT #8 – INPUT – PROCESS STATUS 2 (COOLING SYSTEM STATUS, LOW PRESSURE NOT PRESENT)
	COMMON / 120VAC	INPUT #9 – INPUT – PROCESS STATUS 3 (WATER LEVEL STATUS, HIGH LEVEL NOT PRESENT)
1353 / 5241	COMMON / 120VAC	INPUT #10 – INPUT – PROCESS STATUS 4 (WATER LEVEL STATUS, LOW LEVEL NOT PRESENT)
	COMMON / 120VAC	INPUT #11 – INPUT – PROCESS STATUS 5 (HYDRAULIC SYSTEM STATUS, HIGH PRESSURE NOT PRESENT)
	COMMON / 120VAC	INPUT #12 – INPUT – PROCESS STATUS 6 (HYDRAULIC SYSTEM STATUS, LOW PRESSURE NOT PRESENT)

1381 / 1382	COMMON / NO	OUTPUT #1 – COOLING SYSTEM CONTROL, ON/OFF
3191 / 3192	COMMON / NO	OUTPUT #2 – HYDRAULIC SYSTEM CONTROL, ON/OFF
3291 / 3292	COMMON / NO	OUTPUT #3 – WIPER EXTEND
3291 / 3351	COMMON / NO	OUTPUT #4 – WIPER RETRACT

CABLE 532A, TO BANK 1B MODULE 1 WIPER SOLENOID	5321 / 5322	+/– 24VDC	WIPER SOLENOID, BANK 1B MODULE 1
CABLE 533A, TO BANK 1B MODULE 2 WIPER SOLENOID	5331 / 5332	+/– 24VDC	WIPER SOLENOID, BANK 1B MODULE 2
CABLE 534A, TO BANK 1B MODULE 3 WIPER SOLENOID	5341 / 5342	+/– 24VDC	WIPER SOLENOID, BANK 1B MODULE 3
CABLE 535A, TO BANK 1B MODULE 4 WIPER SOLENOID	5351 / 5352	+/– 24VDC	WIPER SOLENOID, BANK 1B MODULE 4
CABLE 536A, TO BANK 1B MODULE 5 WIPER SOLENOID	5361 / 5362	+/– 24VDC	WIPER SOLENOID, BANK 1B MODULE 5
		+/– 24VDC	WIPER SOLENOID, BANK 1B MODULE 6
		+/– 24VDC	WIPER SOLENOID, BANK 1B MODULE 7
		+/– 24VDC	WIPER SOLENOID, BANK 1B MODULE 8

"A"

BALLAST 1 COMMUNICATIONS, BANK 1B MODULE 1	CABLE 504B, TO BANK 1B MODULE 1 BALLAST 1
BALLAST 2 COMMUNICATIONS, BANK 1B MODULE 1	CABLE 506B, TO BANK 1B MODULE 1 BALLAST 2
BALLAST 1 COMMUNICATIONS, BANK 1B MODULE 2	CABLE 508B, TO BANK 1B MODULE 2 BALLAST 1
BALLAST 2 COMMUNICATIONS, BANK 1B MODULE 2	CABLE 510B, TO BANK 1B MODULE 2 BALLAST 2
BALLAST 1 COMMUNICATIONS, BANK 1B MODULE 3	CABLE 513B, TO BANK 1B MODULE 3 BALLAST 1
BALLAST 2 COMMUNICATIONS, BANK 1B MODULE 3	CABLE 515B, TO BANK 1B MODULE 3 BALLAST 2
BALLAST 1 COMMUNICATIONS, BANK 1B MODULE 4	CABLE 517B, TO BANK 1B MODULE 4 BALLAST 1
BALLAST 2 COMMUNICATIONS, BANK 1B MODULE 4	CABLE 519B, TO BANK 1B MODULE 4 BALLAST 2
BALLAST 1 COMMUNICATIONS, BANK 1B MODULE 5	CABLE 522B, TO BANK 1B MODULE 5 BALLAST 1
BALLAST 2 COMMUNICATIONS, BANK 1B MODULE 5	CABLE 524B, TO BANK 1B MODULE 5 BALLAST 2
BALLAST 1 COMMUNICATIONS, BANK 1B MODULE 6	
BALLAST 2 COMMUNICATIONS, BANK 1B MODULE 6	
BALLAST 1 COMMUNICATIONS, BANK 1B MODULE 7	
BALLAST 2 COMMUNICATIONS, BANK 1B MODULE 7	
BALLAST 1 COMMUNICATIONS, BANK 1B MODULE 8	
BALLAST 2 COMMUNICATIONS, BANK 1B MODULE 8	

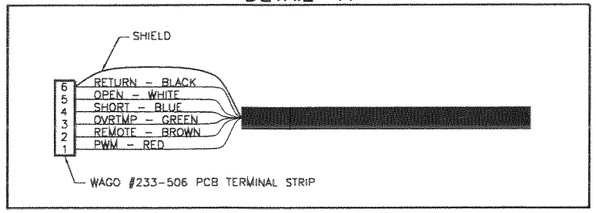
RS422 SERIAL PORT
R– R+ T+ T– COM

502CCB

SEE COMMUNICATION CONNECTION DETAILS LINE 650

END

DETAIL "A"



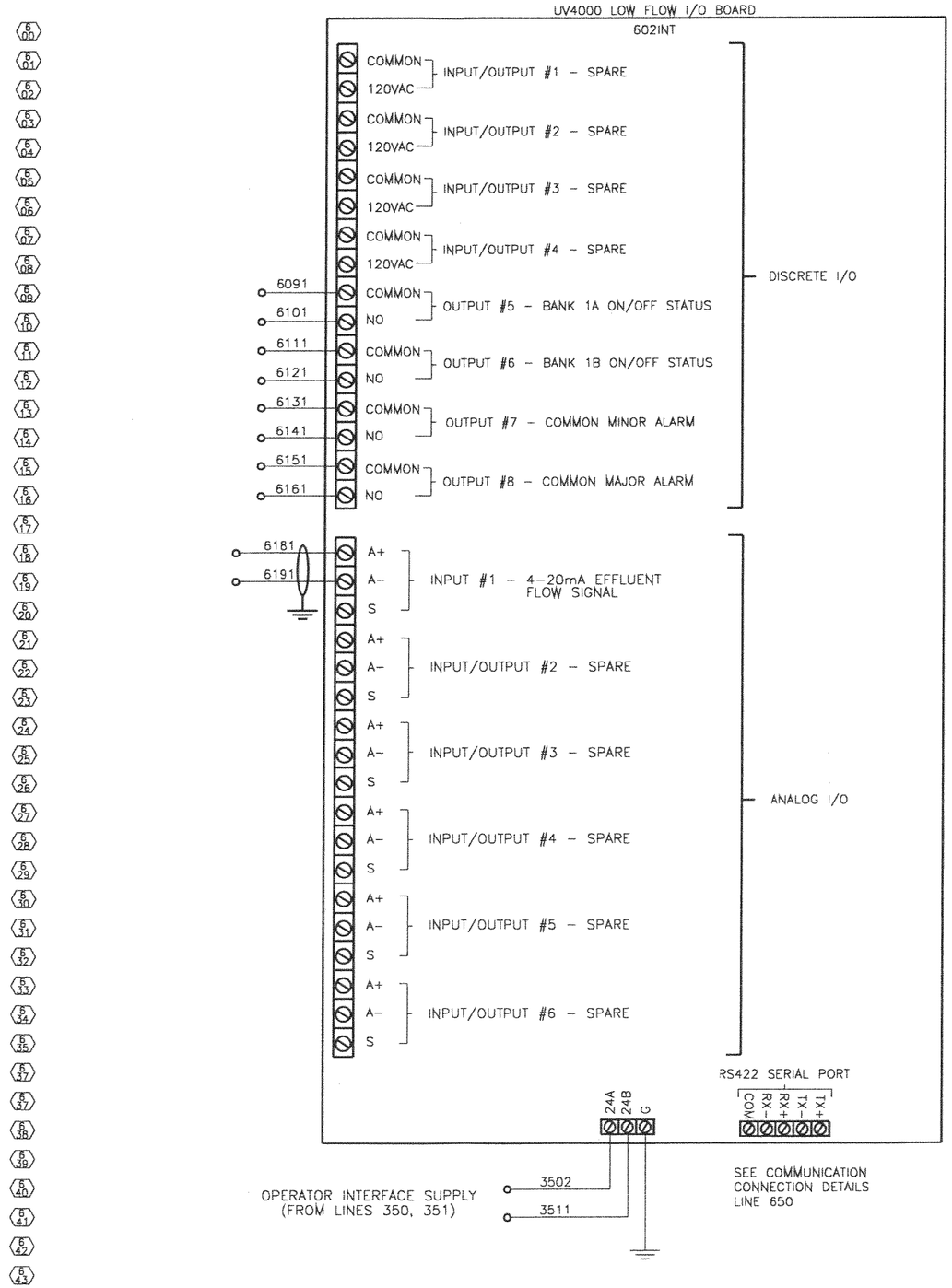
TROJAN TECHNOLOGIES INC.
LONDON, ONTARIO, CANADA

DESCRIPTION: SCC ASSY, UV4LF WILLIDGEVILLE

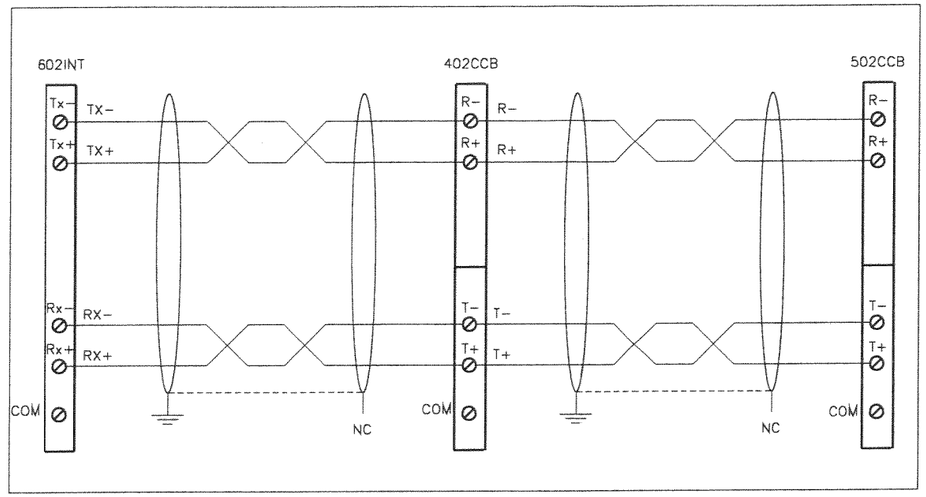
REVISION BY	SF	PART NO.	REV
CHECKED BY	JLW	929206	B
APPROVED BY	SF	SHEET 5 OF 9	SIZE D

0 0.5 1.0
1.0" ON ORIGINAL DWG
SCALE: NTS

DWG NO. 929206



COMMUNICATION CONNECTION DETAILS



COMMUNICATION CABLE DETAILS

COLOUR	OPTR INTFC	COMM BOARDS
BL/WHT	TX–	R–
WHT/BL	TX+	R+
OR/WHT	RX–	T–
WHT/OR	RX+	T+

NOTE

ALARM OUTPUT RELAYS WILL DE-ENERGIZE UPON AN ALARM CONDITION.

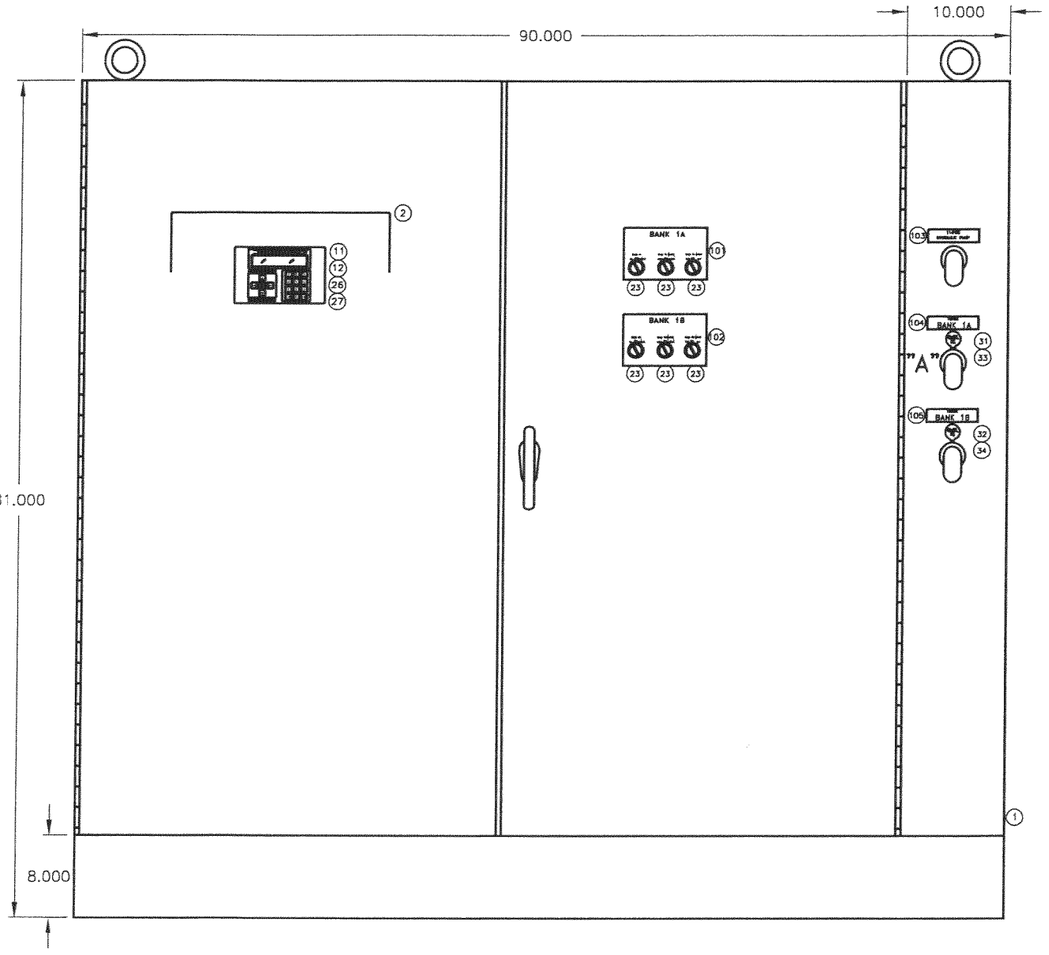
TROJAN TECHNOLOGIES INC.
LONDON, ONTARIO, CANADA

DESCRIPTION: SCC ASSY, UV4LF MILLIDGEVILLE

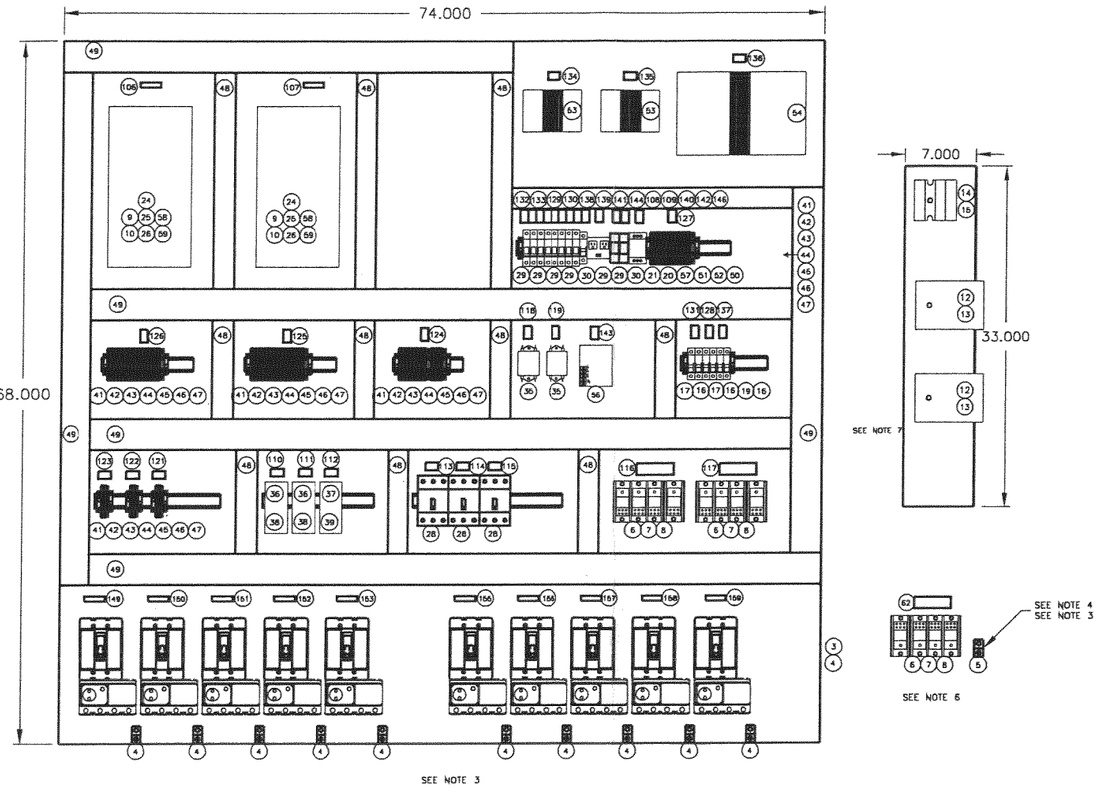
REVISION BY	SF	PART NO.	REV
CHECKED BY	JLW	929206	B
APPROVED BY	SF	SHEET 6 OF 9	SIZE D

0 0.5 1.0
1.0" ON ORIGINAL DWG
SCALE: NTS

DWG NO. 929206

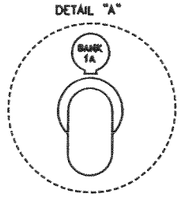


PANEL LAYOUT



BACKPLATE LAYOUT

DETAIL "A"



NOTE:

1) ITEMS #33 AND #34 ARE TO BE MOUNTED TO ENSURE KEY CAN NOT BE REMOVED WHILE DISCONNECT IS IN THE ON POSTION.
2) REFER TO SHEET #8 FOR DETAILED NAMEPLATE SPECIFICATIONS.
3) REMOVE PAINT FROM PANEL BEFORE INSTALLING GROUND LUG.
4) ITEM #7 FOR MAIN POWER DISTRIBUTION IS TO BE MOUNTED ON A LUG WELDED TO THE ENCLOSURE TO ENSURE PROPER GROUNDING.
5) ENCLOSURE TO CONTAIN EYE BOLTS ON TOP.
6) POWER DISTRIBUTION BLOCK TO BE MOUNTED AGAINST BACK OF ENCLOSURE.
7) DISCONNECT BACKPLATE TO BE MOUNTED ON STANDOFFS CLOSE TO FRONT OF ENCLOSURE TO MINIMIZE DISCONNECT SHAFT LENGTH.
8) ENCLOSURE IS TO CONTAIN MOUNTING FEET WELDED TO OUTSIDE OF ENCLOSURE, REFER TO TROJAN DRAWINGS 417447 AND 417448 RESPECTIVELY.
9) BOTTOM OF ENCLOSURE TO CONTAIN 12" X 12" CUTOUT FOR SERVICE ENTRANCE CENTERED ON BOTTOM OF ENCLOSURE WITH GASKETED COVER PLATE FASTENED ON MOUNTING STUDS PROTRUDING INSIDE THE ENCLOSURE.
10) FUSE QUANTITIES ON BOM INCLUDE SPARES TO BE INCLUDED WITH COMPLETED ENCLOSURE.
11) PANEL BUILDER TO INCLUDE RED "WARNING LABEL" ON FRONT DOOR OF ENCLOSURE ADJACENT TO HANDLE.

TROJAN TECHNOLOGIES INC.
LONDON, ONTARIO, CANADA

DESCRIPTION: SCC ASSY, UV4LF MILLIDGEVILLE

REVISION BY	SF
CHECKED BY	JLW
APPROVED BY	SF
PART NO.	929206
REV	B
SCALE:	1:14
SHEET 7 OF 9	SIZE D

DWG NO. 929206

ITEM	QTY	ITEM DESCRIPTION	PART NUMBER	TROJAN PART NUMBER
64	--	-----	-----	---
63	--	-----	-----	---
62	--	-----	-----	---
61	--	-----	-----	---
60	--	-----	-----	---
59	A/R	CABLE, 1 TWISTED PAIR SHIELDED, 24AWG	ALPHA 6412	912642
58	A/R	CABLE, 2 TWISTED PAIR SHIELDED, 24AWG	ALPHA 6413	912555
57	1	RECEPTACLE, DUPLEX 120VAC 15A	WEIDMULLER 991549	903821
56	1	BOARD, LOW LEVEL RELAY 120VAC	B/W CONT. 5600-11-120	912179
55	--	------	---	---
54	1	XFMR, 2KVA 240/480-120/240V ES	MARCUS MC2KH	912520
53	2	XFMR, 150VA 480-24V	MARCUS MC150P	912371
52	2	BASE, RELAY 2P	OMRON PYF08A-E	261069
51	2	RELAY, 5A 2P 120VAC COIL	OMRON MY2N-AC120	261225
50	1	POWER SUPPLY, 24VDC 60W SWITCHING	OMRON S82K-06024	903225
49	A/R	WIRING DUCT AND COVER, 3"W x 4"H	PANDUIT OR EQUIVALENT	---
48	A/R	WIRING DUCT AND COVER, 2"W x 4"H	PANDUIT E2X4DG6/C2DG6	903507
47	A/R	DIN MOUNTING RAIL	AB 1492-DR5	---
46	14	TERM BLK, GND 2CON 800V	WEIDMULLER 160866	912478
45	A/R	MARKER, TERMINAL BLOCK	WEIDMULLER 161000	---
44	A/R	JUMPER 10P	WEIDMULLER 160894	912464G
43	A/R	TERM BLK, 27A 4CON END PLATE	WEIDMULLER 160880	912459
42	105	TERM BLK, 27A 4CON 600V	WEIDMULLER 160857	912336
41	A/R	TERM BLK, END STOP	WEIDMULLER 038356	912472
40	--	------	---	---
39	1	CONTACTOR, 120VAC COIL FOR HYDRAULIC PMP	CH CE15BNS3AB	912138
38	2	CONTACTOR, 24VAC COIL FOR COOLNT PMP	CH CE15BNS3TB	912198
37	1	RELAY, O/L 1.0-1.4A CH	CH C316FNA3F	912504
36	2	RELAY, O/L 2.8-4.0A CH	CH C316FNA3K	912139
35	2	EMI/RFI FILTER 120VAC/10A	CORCOM 3EZ1	912780
34	1	KEY FOR INTERLOCK "BANK 1B"	---	903332
33	1	KEY, FOR INTERLOCK "BANK 1A"	---	903079
32	1	MODULAR SAFETY INTERLOCK "BANK 1B"	---	903330
31	1	MODULAR SAFETY INTERLOCK "BANK 1A"	---	903076
30	2	BREAKER, 2A 1P 277VAC CH	CH WMS1C02	903868
29	6	BREAKER, 4A 1P 277VAC CH	CH WMS1C04	903873
28	3	BREAKER, 15A 3P 480VAC CH	CH GD3015	912142
27	1	MOD, ANLG IN 5VDC LOGIC 4-20mA	DUTEC II420	903796
26	12	MOD, DISC OUT 5VDC LOGIC 240VAC	GORDOS SMOAC5A	903795
25	18	MODULE, DGTL IN 24V/5V LOGIC	WRC 1781-IN5S	903326
24	10	MOD, DISC OUT 5VDC LOGIC 24VDC	GORDOS SMODC5	903805
23	6	3 POSITION SELECTOR SWITCH NEMA 4X 1N.O-1N.C	CH E34VHBK1/10250-T2	912718
22	--	------	---	---
21	2	FUSE, 4A 600V CC TIME DELAY	FERRAZ SHAWMUT ATQR4	912130
20	1	FUSE BLOCK, 30A 1P 600VAC	FERRAZ SHAWMUT USCC1	912128
19	4	FUSE, 10A 600V CC TIME DELAY	GLOULD ATQR10	912409
18	8	FUSE, 0.4A 600V CC TD	FERRAZ SHAWMUT ATQR4/10	912484
17	3	FUSE BLOCK, 30A 2P 600VAC	FERRAZ SHAWMUT USCC2	912500
16	4	FUSE, J TYPE 20A/600VAC	GOULD AJT20	---
15	1	DISC ASSY, 30A 3P 600V ABB	912788-034	912788-034
14	8	FUSE, J TYPE 60A/600VAC	GOULD AJT60	---
13	2	DISC ASSY, 60A 3P 600V ABB	912788-064	912788-064
12	1	BOARD, UV4LF MODEM	OES 2792	912273
11	1	BOARD ASSY, TYPE MLF CONTROL	OES	903780
10	2	LEXAN DEADFRONT COVER FOR ITEMS 9	EEC	EEC
9	2	BOARD, UV4LF COMM W/PROBE	OES 977A	912070
8	3	LEXAN DEADFRONT COVER FOR ITEMS 6 & 7	EEC	EEC
7	3	DIST BLOCK, 335A 3P 1-6 CONN	MARATHON 1433553	912135
6	3	DIST BLOCK, 335A 1P 1-6 CONN	MARATHON 1431553	912134
5	1	LUG, GND 350MCM-#6AWG	MARATHON GL35	903879
4	10	LUG, TERMINAL 1 COND 1/0-14AWG	BURNDY KA25U	912763
3	10	BREAKER, 15A 3P 600VAC W/GF	CH EL4FD3015L	912692
2	1	SUNSHADE, 21"L x 5 6/8"W x 7 7/8"D	EEC	EEC
1	1	ENCLOSURE, 81"H x 90"W x 20"D 304SST TYPE 4X	EEC	EEC

ITEM	QTY	ITEM DESCRIPTION	PART NUMBER	TROJAN PART NUMBER
163	--	-----	-----	---
162	--	-----	-----	---
161	--	-----	-----	---
160	--	-----	-----	---
159	1	LAMICOID LABEL, 2" x 1/2"	285CB/GFR	---
158	1	LAMICOID LABEL, 2" x 1/2"	277CB/GFR	---
157	1	LAMICOID LABEL, 2" x 1/2"	269CB/GFR	---
156	1	LAMICOID LABEL, 2" x 1/2"	261CB/GFR	---
155	1	LAMICOID LABEL, 2" x 1/2"	253CB/GFR	---
154	--	-----	-----	---
153	1	LAMICOID LABEL, 2" x 1/2"	235CB/GFR	---
152	1	LAMICOID LABEL, 2" x 1/2"	227CB/GFR	---
151	1	LAMICOID LABEL, 2" x 1/2"	219CB/GFR	---
150	1	LAMICOID LABEL, 2" x 1/2"	211CB/GFR	---
149	1	LAMICOID LABEL, 2" x 1/2"	203CB/GFR	---
148	--	------	---	---
147	--	------	---	---
146	1	LAMICOID LABEL 1.25" x 0.75"	350PS/24VDC	---
145	--	-----	-----	---
144	1	LAMICOID LABEL, 1.25" x 0.75"	350CB/24VDC PS	---
143	1	LAMICOID LABEL, 1.25" x 0.75"	LOW LEVEL RELAY BRD	---
142	1	LAMICOID LABEL, 1.25" x 0.75"	374CR/LVL SENS L	---
141	1	LAMICOID LABEL, 1.25" x 0.75"	372CB/LVL SENS L	---
140	1	LAMICOID LABEL, 1.25" x 0.75"	338CR/WIPER INTLK	---
139	1	LAMICOID LABEL, 1.25" x 0.75"	329CB/WIPER CNTL	---
138	1	LAMICOID LABEL, 1.25" x 0.75"	319CB/HYD PUMP MS	---
137	1	LAMICOID LABEL, 1.25" x 0.75"	310FB/10A CLASS CC	---
136	1	LAMICOID LABEL, 1.25" x 0.75"	313XFMR/HYD CNTL	---
135	1	LAMICOID LABEL, 1.25" x 0.75"	133XFMR/CCB BANK 1B	---
134	1	LAMICOID LABEL, 1.25" x 0.75"	125XFMR/CCB BANK 1A	---
133	1	LAMICOID LABEL, 1.25" x 0.75"	130CB/COOLNT PMP1	---
132	1	LAMICOID LABEL, 1.25" x 0.75"	125CB/CCB BNK 1A	---
131	1	LAMICOID LABEL, 1.25" x 0.75"	125FB/0.4A - CLASS CC	---
130	1	LAMICOID LABEL, 1.25" x 0.75"	138CB/COOLNT PMP2	---
129	1	LAMICOID LABEL, 1.25" x 0.75"	133CB/CCB BNK 1B	---
128	1	LAMICOID LABEL, 1.25" x 0.75"	133FB/0.4A - CLASS CC	---
127	1	LAMICOID LABEL, 1.25" x 0.75"	TB1	---
126	1	LAMICOID LABEL, 1.25" x 0.75"	TB2	---
125	1	LAMICOID LABEL, 1.25" x 0.75"	TB3	---
124	1	LAMICOID LABEL, 1.25" x 0.75"	TB4	---
123	1	LAMICOID LABEL, 1.25" x 0.75"	TB5	---
122	1	LAMICOID LABEL, 1.25" x 0.75"	TB6	---
121	1	LAMICOID LABEL, 1.25" x 0.75"	TB7	---
120	--	------	---	---
119	1	LAMICOID LABEL, 1.25" x 0.75"	133RF1	---
118	1	LAMICOID LABEL, 1.25" x 0.75"	125RF1	---
117	1	LAMICOID LABEL, 3.625" x 1.125"	POWER DIST/BANK 1B	---
116	1	LAMICOID LABEL, 3.625" x 1.125"	POWER DIST/BANK 1A	---
115	1	LAMICOID LABEL, 1.25" x 0.75"	301CB/HYD PUMP	---
114	1	LAMICOID LABEL, 1.25" x 0.75"	2111CB/COOLNT PMP2	---
113	1	LAMICOID LABEL, 1.25" x 0.75"	2103CB/COOLNT PMP1	---
112	1	LAMICOID LABEL, 1.25" x 0.75"	319MS/HYD PUMP	---
111	1	LAMICOID LABEL, 1.25" x 0.75"	138MS/COOLNT PMP2	---
110	1	LAMICOID LABEL, 1.25" x 0.75"	130MS/COOLNT PMP1	---
109	1	LAMICOID LABEL, 1.25" x 0.75"	359REC/4A MAX	---
108	1	LAMICOID LABEL, 1.25" x 0.75"	359FB/4A - CLASS CC	---
107	1	LAMICOID LABEL, 2" x 1/2"	502CCB	---
106	1	LAMICOID LABEL, 2" x 1/2"	402CCB	---
105	1	LAMICOID LABEL, 3.625" x 1.125"	SEE DRAWING	---
104	1	LAMICOID LABEL, 3.625" x 1.125"	SEE DRAWING	---
103	1	LAMICOID LABEL, 3.625" x 1.125"	SEE DRAWING	---
102	1	LAMICOID LABEL, 8.00" x 5.00"	SEE DRAWING	---
101	1	LAMICOID LABEL, 8.00" x 5.00"	SEE DRAWING	---
100	1	LAMICOID LABEL, 3.625" x 1.125"	480VAC 66KVA 3PH 4WIRE 60HZ	---

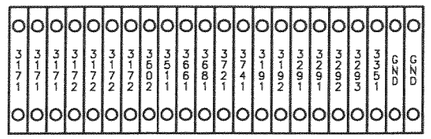
TROJAN TECHNOLOGIES INC.
LONDON, ONTARIO, CANADA

DESCRIPTION: SCC ASSY, UV4LF MILLIDGEVILLE

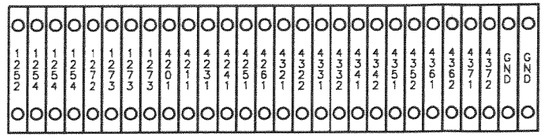
REVISION BY	SF	PART NO.	REV
CHECKED BY	JLW	929206	B
APPROVED BY	SF	SHEET 8 OF 9	SIZE D

0 0.5 1.0 — 1.0" ON ORIGINAL DWG — SCALE: NTS

DWG NO. 929206



TB1



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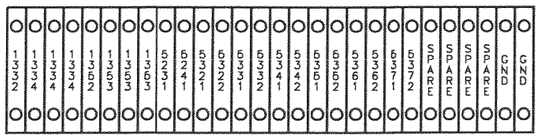
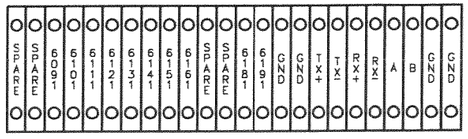


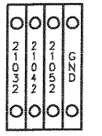
TB3

FOR UVT SENSOR SAMPLER (IF REQUIRED)



TB4

FOR SERIAL COMMUNICATION CONNECTIONS



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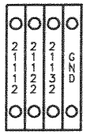

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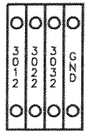
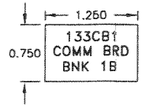
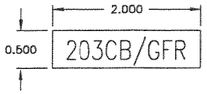
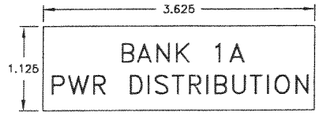
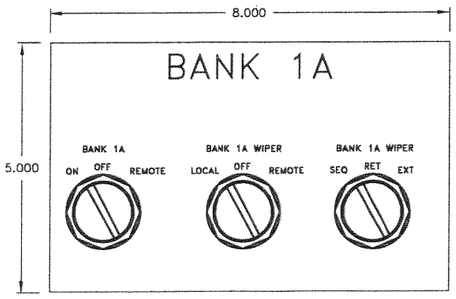


TB7









NOTE:

1) USE NAMEPLATE DRAWINGS FOR BASIC DIMENSIONAL REFERENCES ONLY.

2) ALL NAMEPLATES TO BE 1/16" WHITE LAMICOID WITH BLACK LETTERING.

3) WHEN CONNECTING SIGNAL CABLES WITH SHIELDING, ENSURANCE MUST BE MADE THAT FOR EACH SIGNAL CABLE, THE SHIELD REMAINS TIED TOGETHER THROUGH TERMINAL BLOCKS AND IS GROUNDED AT ONE END ONLY.

TROJAN TECHNOLOGIES INC.
LONDON, ONTARIO, CANADA

DESCRIPTION: SCC ASSY, UV4LF WILLIDGEVILLE

REVISION BY	SF	PART NO.	REV
CHECKED BY	JLW	929206	B
APPROVED BY	SF	SHEET 9 OF 9	SIZE D

0 0.5 1.0
1.0" ON ORIGINAL DWG
SCALE: NTS

DWG NO. 929206

SYSTEM UV4000™ LOW FLOW OPERATION AND MAINTENANCE MANUAL

SECTION 8.0

Additional Equipment

Section 8.0 ADDITIONAL EQUIPMENT

Section 8.1 OPERATORS KIT

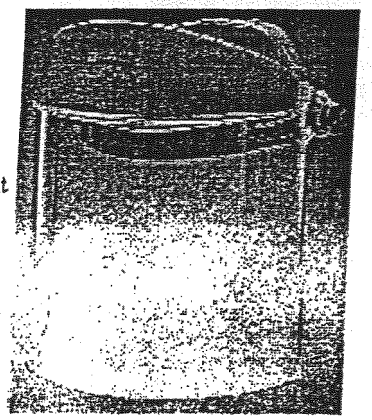
An operators kit is provided with each project. The following items are included in each kit:

- 1 – UV resistant face shield
- 1 – 4 litre jug of cleaning solution (Limeaway)
- 2 – pairs disposable vinyl gloves
- 1 – plastic wash bottle
- 1 – strap pipe wrench
- 1 – sleeve nut tool
- 1 – Pincers for Ear Clamps
- 1 – 6" galvanized steel funnel

Please note no other special tools are required for routine maintenance or operation of the unit.

OBERON

The Clear UV Protective Faceshield



Prolonged operation of equipment emitting UV light could cause burns to eyes and face. The Clear UV Protective Faceshield absorbs the UV energy before it reaches the worker. The faceshield provides extended protection from 200nm to 405nm. Other faceshields making similar claims may protect only from 200nm to 365nm.

Oberon's specialty coatings are available to further customize the protection. Permanent antifog and scratch resistant coatings provide additional comfort and economy with the Clear UV Protective Faceshield.

The basic shield size is 8" X 14" and .080" thick. This protection can be extended with a Double Crown chin protector and Shield Extenders.
Meets ANSI Z87.1-1989

Trojan

COMPONENT SPECIFICATION (CS)

DESCRIPTION: **BOTTLE, PLASTIC WASH 1000ml**

PART/DOC. #: **901195**

SPECIFICATION: This specification is for a 1000ml (32oz) plastic wash bottle with a narrow mouth. The bottle is made from natural coloured polyethylene which is chemical resistant and shatterproof. The spout can be cut for heavier flow.

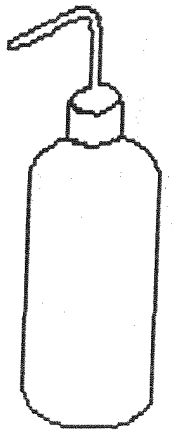
SOURCE OF SUPPLY:

Manufacturerr: Nalge Company
Rochester, NY

Part No.: **2401-1000**

Supplier: VWR Canlab
2360 Argentia Rd.,
Mississauga, Ontario
L5N 3P1
Tel: 1-800-932-5000
Fax: 1-800-668-6348

NOTE: Approved alternate vendors may be used



Trojan

COMPONENT SPECIFICATION (CS)

DESCRIPTION: **WRENCH, STRAP**

PART/DOC. #: **901196**

SPECIFICATION: This specification is for a Strap Wrench for use on polished pipe and tubing. The strap size is 1_" x 30" long and can accommodate a 5½" O.D. tube. The wrench has a strong I-beam handle with a hang-up hole and solid head, all in one piece.

SOURCE OF SUPPLY:

Manufacturer: Ridge Tool Co.
Elyria, Ohio

Part No.: **31345**

Supplier: Windsor Factory Supply Ltd.
1010 Hargrieve
London, ON
Tel: (519) 681-3790
Fax: (519) 681-9354

NOTE: Approved alternate vendors may be used

Trojan

COMPONENT SPECIFICATION (CS)

DESCRIPTION: TOOL, CLAMP EAR TYPE OETIKER

PART/DOC. #: **901216**

SPECIFICATION: Pincer used to crimp Oetiker ear type clamps to ensure proper grip (sealing capability) of clamp.

SOURCE OF SUPPLY:
Any Distributor of Oetiker clamps.

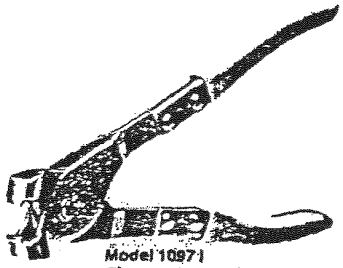
OETIKER PART NUMBER:
Model 10971

NOTE: Approved alternate suppliers may be used

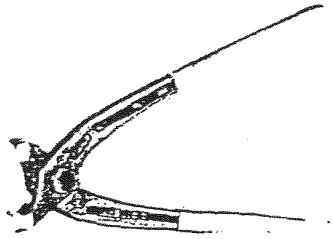
See attached catalogue sheet.

PINCERS *For Manual Installation*

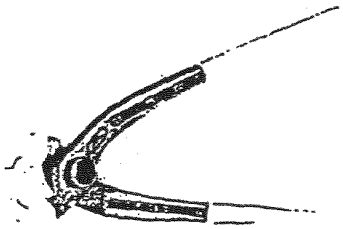
NOTE: To insure a proper grip, Oetiker Clamps should be installed with either Oetiker Pincers or a similar style of pincers approved by Oetiker, Inc.



Model 1097 I
Oetiker Pincers Narrow Jaw

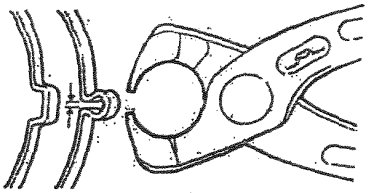


Model 1098 I
Straight Jaw Pincers



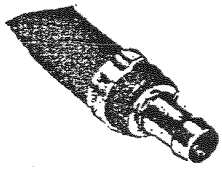
Model 1099 I – Side Jaw Pincers
This dual purpose, side jaw design allows clamps to be applied or removed in confined areas with pincers held parallel to the hose. Also used like Standard Pincers.

INSTALLATION

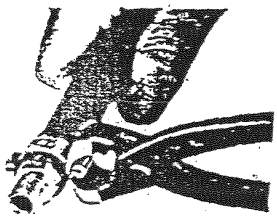


When installing Oetiker Ear Type Clamps, please note that each ear must be crimped as recommended to obtain a proper seal. An incorrectly made installation may impair the best connection. If a clamp ear can be closed all the way, the clamp size selected is probably too big and the next smaller clamp should be ordered.

HOW TO APPLY:



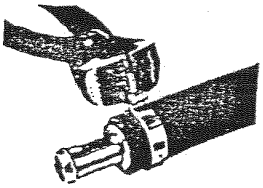
Position clamp on hose as illustrated.



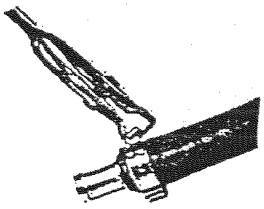
Give each ear a firm squeeze with your OETIKER Pincers.

Where access to ear is difficult, use OETIKER's Side Jaw Pincers Model 1099.

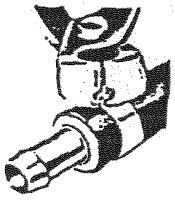
HOW TO REMOVE:



Grip the outer edge of ear firmly and cut through it with either pincers.

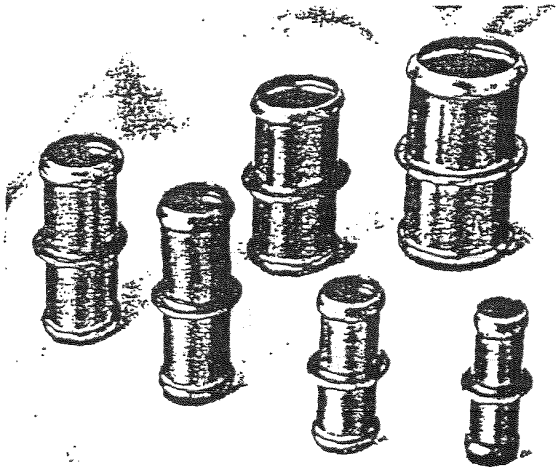


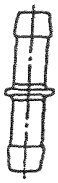
Cut the ear by taking several small bites at its base with either pincers



Then grip ear firmly and twist it off.

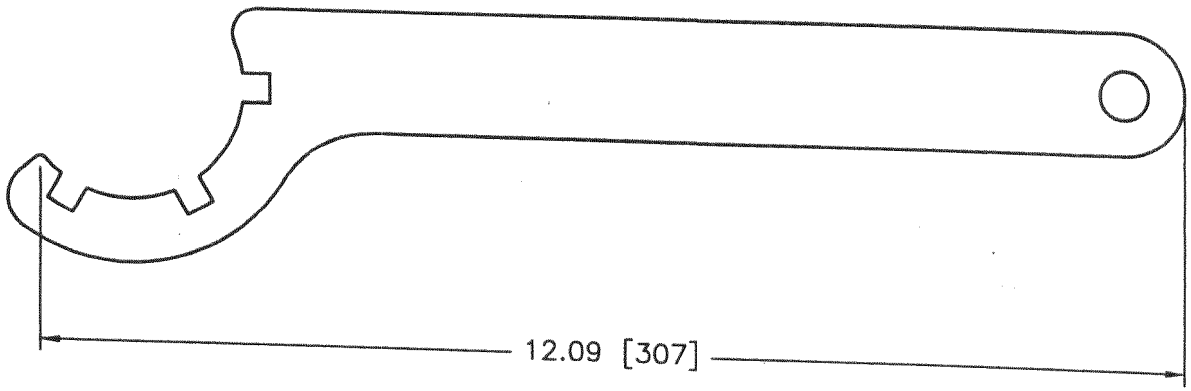
HOSE MENDERS





Part No.	Nominal Size Inches	mm	Menders Per Pkg.	Menders Per Pkg.
404*	3/16"	4	10	100
406R	1/4"	6	10	100
408R	5/16"	8	10	100
410R	3/8"	10	10	100
413R	1/2"	13	10	100
416R	5/8"	16	10	50
419R	3/4"	19	10	50
422R	7/8"	22	10	50
425R	1"	25	5	25
428R	1-1/8"	28	5	25
432R	1-1/4"	32	5	20
438R	1-1/2"	38	5	15

Available in 300 series stainless steel.
*Available in brass only



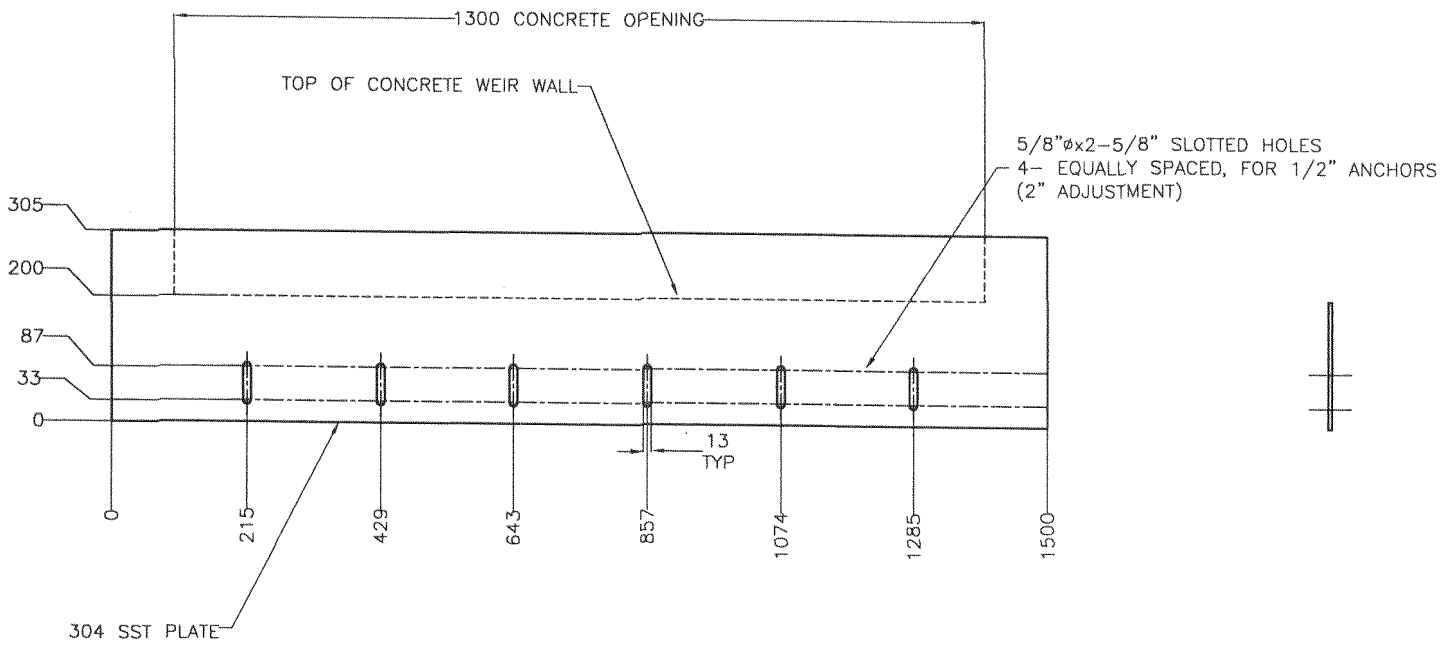
Trojan Tech[illegible]gies Inc.

DESCRIPTION: STD, UV4E/LF SLEEVE NUT TOOL

DRAWN BY : SAK	DATE : 01MY16	QUOTE NO. 4M0194
CHECKED BY : JAW	DATE : 01JN19	PROJECT NO. N/A
APPROVED BY : SDK	DATE : 01JN19	REV. B
SCALE (8½x11) : NOT TO SCALE	LOG NUMBER : 99-3341	

Section 8.2 LEVEL CONTROL WEIR

The Level Control Weir is a device that keeps the effluent at the proper level. It is positioned in the effluent channel downstream from the UV Modules to keep lamps submerged.



Trojan Tec[illegible]logies Inc.

DESCRIPTION: WEIR PLATE, UV4LF MILLIDGEVILLE NB		QUOTE NO.	EJU1927A
DRAWN BY : DAC	DATE : 02DE11	PROJECT NO.	410945
CHECKED BY :	DATE :		
APPROVED BY :	DATE :	NO. [illegible]02	REV. A
SCALE (11x17) : 1" = 1'-0"	LOG NUMBER : N/A		

SECTION 8.3 UV PHOTOMETER

P254C PHOTOMETER
INSTRUCTION MANUAL

Trojan Technologies, Inc
3020 Gore Rd.
London, Ontario
Canada N5V 4T7
Phone: (519) 457-3400
Fax: (519) 457-3030

OPERATING INSTRUCTIONS
P254C
TABLE OF CONTENTS

Page No.

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Spare Parts List 6

WARRANTY 7

1.0 SPECIFICATIONS - MODEL P254C

Range:	0 - 100% Transmittance
Resolution:	1% Transmittance
Linearity:	± 2%
Principle:	Single beam UV filter photometer with push button 100% transmittance control adjustment.
Source:	Low pressure UV Germicidal lamp
Electronics:	Integrated circuit amplification and analoge-to-digital conversion.
Wavelength Accuracy:	253.7 nM
Operating Temperature:	32° - 122°F (0° - 50°C)
Power Supply:	Wall Adapter: 120 VAC 60Hz 12W UL & CSA approved 220 VAC 50Hz 19VA CE approved
Display:	3½" Digit LCD Display
Dimensions:	11"L x 7"W x 5"H
Shipping Dimensions:	11½"L x 11"W x 13½"H
Weight:	4 lbs.
Shipping Weight:	6 lbs.

2.0 INSTALLATION

2.1 Packing List of Contents

CONTENTS	CATALOG #	QUANTITY
Power Supply (120 VAC) Power Supply (240 VAC)	905048	1
0% T Adaptor	905049	1
Cuvette/Quartz	P19314	1

A complete listing of spare parts appears on page 6 of this manual.

2.2 Pre-installation Checkout

Use care when unpacking instrument to note that all of the above contents are included and that no damage has occurred to the instrument during shipping. If there are any omissions or damage, report this immediately to the local representative of Trojan Technologies.

3.0 OPERATION

The operation of the P254C is quite simple. The wavelength of light used in this instrument is UV and the cleanliness of all glassware used cannot be overstressed. The steps for normal operation are listed below.

Warning: Do not attempt to look down into the optical well. This instrument uses an ultraviolet source, and injury to the eye may occur.

3.1 Power Up

It is important that the instrument be allowed to warm up for 15 minutes before taking any readings or attempting to calibrate. This time will allow the UV light source to stabilize and minimize instrument drift. It is important that the 0% T adaptor, (Cat. No. 21823) be kept in the light well at all times that an actual reading is not being made.

3.2 Cuvette Handling

Extreme care should be taken to avoid surface scratches on the sample cuvette. Scratches, together with dust or film cause analysis error. The sample cuvette optical surface should be wiped clean each time it is to be used and it is important to use a lint free wiper such as "Kimwipes". Cuvettes should only be handled by the frosted sides. When placing the cuvette in the optical well, the clear sides should be facing toward the front and back of the instrument.

3.3 Standardization

To standardize the instrument, place a clean cuvette filled with the 100% T standard solution or fresh distilled water in the optical well. Adjust the front panel arrows labeled "% T" until the display reads 100. The instrument is now standardized and ready to read the sample.

3.4 Sample Handling

One cuvette is provided with the P254C. It is important that the same cuvette which is used for calibration is used for measurement of the sample.

Discard the 100% standard solution in the cuvette. Gently shake the sample and rinse the cuvette three or four times to remove all traces of the standard solution. Fill the cuvette with sample. Wipe the cuvette dry with a lint free tissue and insert in the well. Vigorous mixing causes air bubbles to form in the sample and on the walls of the cuvette. This results in lower %T readings.

Samples should be close to room temperature when tested. Cold samples form condensation on the cuvette, resulting in a decrease in the %T readings. Prewarm the sample by immersing the sample bottle in warm water or leave the sample bottle on the bench until it reaches room temperature.

3.5 Read % T

The percent transmittance may be read directly from the display. A drift in the reading may be observed if material is settling or if air bubbles are rising.

A downward drift in the reading is probably due to a condensate on the cuvette.

Note: The condensate may be so slight that it cannot be seen. Refer to section 4. above and the troubleshooting guide.

Several samples may be required to get a representative sample. After use insert the 0% T adaptor to keep dust out of the optical well. To extend the life of the light source it is recommended that the instrument be turned OFF immediately after use.

4.0 ROUTINE MAINTENANCE

4.1 Cuvette Cleaning

It is recommended that the measurement cuvettes be rinsed in distilled or deionized water, and then inverted to dry immediately after use. Water marks or dried material from previous samples may be hard to remove if left to dry.

Dried material and stains may be removed by washing in detergent or by using Trojan Technologies quartz cuvette cleaner Catalog #P19311. This solution is specially formulated to clean quartz cuvettes. To use, immerse the cuvette completely in the quartz cuvette cleaning solution. Let stand at least 1/2 hour (overnight is preferable). Gently pour off the solution. Do not get on skin if splashed, rinse off skin immediately (see MSDS). Rinse cells well in deionized water.

4.2 Display Zero / Span Procedure

Turn on the instrument and allow it to warm up for at least 15 minutes before proceeding. Open accessory flap and push down the foam. There are two small screws (trimpots) located in the middle-top of chasis. The lower one is the 0%T trimpot and the upper one is the 100% T trimpot. With the 0%T adapter in place, adjust lower trimpot until the display reads zero. Replace 0%T adapter with 100%T standard solution and adjust upper trimpot until display reads 100%T. Ensure that the up and down controls allow for equal adjustment on either side of 100%T. Readjust upper trimpot as required.

1. With the (back) 0%T adapter in place, using a small screwdriver adjust the small brass screw at the front until the display reaches 00%.
   Note: If the display already reads 00% you do not have to do this step.
2. Remove the black adapter and place in the 100% solution.
3. Press the up ▲ arrow until the display does not go any higher.
4. Adjust the rear adjustment "pot" until the display reaches 120%T
5. Repeat Step 1.
6. Re-insert 100% solution and press down ▼ arrow until the display reads 100%

5.0 TROUBLESHOOTING

5.1 General Notes

The following guide will supply fundamental troubleshooting information. The intent of the guide is to eliminate common faults, not to troubleshoot down to component level.

SYMPTOM	CAUSE	CURE
No Display	1. Bad power source.	Plug instrument in at a different location
Instrument won't adjust to 100% T.	1. Cuvette oriented incorrectly.	- Orient cuvette so that the frosted sides are facing side to side. - Clean cuvette.
Instrument does not read 0% T with 0% T adaptor in well.	1. Drift in electronics.	Adjust ZERO pot as described in the Display Zero/Span Procedure (Section 4.2).
Instrument does not reach 100%.	1. Drift in electronics	Adjust Spanpot as described in the Display Zero/Span Procedure (Section 4.2).
Reading on instrument drifts.	1. Settling in particles in sample. 2. Air in sample. 3. Condensate on cuvette.	Obtain new sample or resuspend the particles by gentle mixing. Obtain new sample. Use care not to agitate. Condensate on the cuvette may be slight and may not even be seen be the eye. See sample handling procedure (Section 3.4).
Condensate forms on sample cuvette.	1. Sample is too cool for room humidity.	Immerse sample in warm water or wait until sample reaches from temperature before filling the cuvette.

5.2 Spare Parts List

Catalog No.	Description
21647	Instruction Manual
P19310	100% T Standard Solution 16 ox./500 ml
P19314	Cuvette/Quartz 1 pk
P19311	Quartz Cuvette Cleaning Solution, 16 ox./500 ml
905049	0% T Adaptor

For instrument repair contact:

Trojan Technologies, Inc.
3020 Gore Rd.,
London, Ontario
CANADA N4V 4T7
Phone: (519) 457-3400
Fax: (519) 457-3030
Customer Technical Support:
(800) 666-9459

WARRANTY

Trojan Technologies, Inc., as vendor, warrants to the original purchaser of the instruments to be free of defects in material and workmanship, in normal use and service, for a period of one year from date of delivery to the original purchaser. Trojan Technologies, Inc.'s, obligation under this warranty is limited to replacing, at its factory, the instrument or any part thereof. Parts which by their nature are normally required to be replaced periodically, consistent with normal maintenance, specifically lamps, reagent, desiccant, sensors, electrodes and fuses are excluded. Also excluded are accessories and supply type items.

Original purchaser is responsible for return of the instruments, or parts thereof, to Trojan Technologies, Inc.'s factory. This includes all freight charges incurred in shipping to and from TrojanTechnologies, Inc.'s factory.

Trojan Technologies, Inc. is not responsible for damage to the instrument, or parts thereof, resulting from misuse, negligence or accident, or defects resulting from repairs, alterations or installation made by any person or company not authorized by Trojan Technologies, Inc.

Trojan Technologies, Inc. assumes no liability for consequential damage of any kind, and the original purchaser, by placement of any order for the instrument, or parts thereof, shall be deemed liable for any and all damages incurred by the use or misuse of the instruments, or parts thereof, by the purchaser, its employees, or others, following receipt thereof.

This warranty is given expressly and in lieu of all other warranties, expressed or implied. Purchaser agrees that there is no warranty on merchantability and that there are no other warranties, expressed or implied. No agent is authorized to assume for Trojan Technologies, Inc. any liability except as above set forth.

Trojan Technologies, Inc.
3020 Gore Rd.
London, Ontario
CANADA N5V 4T7
Phone: (519) 457-3400
Fax: (519) 457-3030
Customer Technical Support:
(800) 666-9459

SECTION 8.4 Transformer

Trojan Technologies Inc.
Id Leader in UV Disinfection Systems

COMPONENT SPECIFICATION (CS)

PART#/DOC#: 912337

DESCRIPTION: **XFMR, 112.5KVA 600-480/277V**

SPECIFICATION:

EQUIPMENT DESCRIPTION:	ISOLATION OR DISTRIBUTION TRANSFORMER
POWER RATING:	112.5KVA
NUMBER OF PHASES:	3
PRIMARY VOLTAGE RATING:	600VAC 3 PHASE 3 WIRE DELTA
SECONDARY VOLTAGE RATING:	480/277VAC 3 PHASE 4 WIRE WYE
FREQUENCY:	60HZ
ENCLOSURE:	NEMA 3R
APPROVALS:	CSA, UL CERTIFIED
CATALOG NUMBER:	HAMMOND CUSTOM
MANUFACTURER:	HAMMOND
SOURCE OF SUPPLY:	HAMMOND MANUFACTURING 595 SOUTHGATE DR. GUELPH, ONTARIO N1G 3W6

"SEE ATTACHED FILE FOR ADDITIONAL INFORMATION"

912337.pdf

REV.	LOG NUMBER	REVISION DESCRIPTION	REVISION BY	CHECKED BY	APPROVED BY	DATE
B	00-1236	Revised noun coding, was "XFMR, 112.5KVA 600-480V D-Y".	JK	RSH	MP	00MY24
A	00-1161	CS Released.	MP	MP	MP	00MY08

HAMMOND MANUFACTURING™

TRANSFORMER GROUP
595 SOUTHGATE DRIVE
GUELPH, ONTARIO
N1G 3W6

PHONE: (519) 822-2441
FAX: (519) 822-9701

Distribution Type Transformers - Isolation

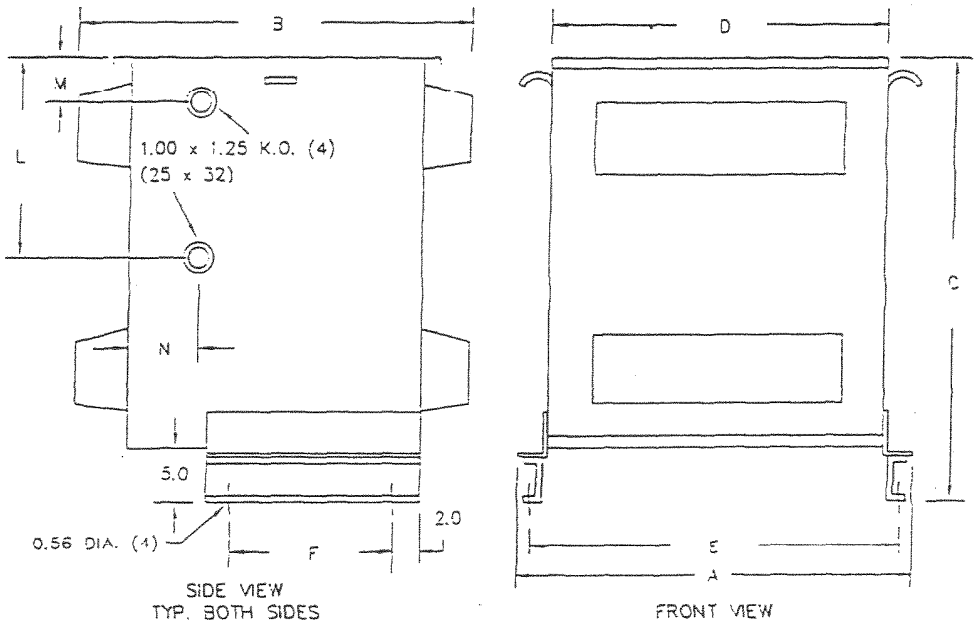
- 3 Phase
- Frequency 60hz
- Delta connected primary
- c/w 4 taps @ 2.5%, 2fcan, 2fcbn (15-750kVA)
- Wye connected secondary
- Copper windings
- 150 C temperature rise
- 220 C insulation class
- K-factor 4 rated
- electrostatic shield

- Primary voltage ratings 600V or 480V
- Secondary voltage ratings 480/y277V or 208/y120V

A) Nema 1 B) Nema 3R
Reference drawings attached for dimensions.

2. For units above 750kVA consult factory
3. For special voltages and connections consult factory
4. Production lead time 3-4 weeks for Nema 1 and Nema 3R enclosed units.
5. Production lead time 4-6 weeks for Nema 4x enclosed units
6. Freight extra

DG 3134



Case Style	DIMENSIONS (Inches)									
	A	B	C	D	E	F	L	M	N	P
H1	19.5	22.5	23.0	16.5	18.5	10.0	10.0	2.0	2.5	1.0 x 1.25
H2	24.5	26.5	28.5	21.5	23.5	10.0	12.0	2.5	2.5	1.0 x 2.0
H3	30.0	30.0	36.5	27.0	29.0	16.0	13.0	3.0	3.0	1.5 x 2.5
H4	33.0	32.0	40.0	30.0	32.0	16.0	13.0	3.0	3.0	1.5 x 2.5

HAMMOND MANUFACTURING™
595 Southgate Drive
Guelph, Ontario, Canada N1G 3W6
Phone: (519) 822-2441, (416) 456-3770
Fax: (519) 822-9688

TITLE: H SERIES NEMA-3R KNOCKDOWN ENCLOSURE QUOTATION DRAWING.

NO.	DATE	REVISION
1		
2		

DWN: Subhasn
DATE: March 08, 99
SCALE: N.T.S.

DG 3134

SYSTEM UV4000™ LOW FLOW OPERATION AND MAINTENANCE MANUAL

SECTION 9.0

Installation and Handling Instructions

Section 9.0 INSTALLATION AND HANDLING INSTRUCTIONS

The following instructions outline the duties and responsibilities of the Contractor. The Contractor shall assume responsibility for the UV4000LF™ system upon delivery to the project site. The Contractor shall demonstrate care in handling, storing and installing the equipment to avoid damages. These instructions define the requirements that must be fulfilled prior to the arrival of Trojan Service for full commissioning of the UV4000LF™ system.

Storage

Precautions must be taken to protect the equipment from direct precipitation and/or flooding during storage. Proper storage is recommended as follows:

1. **UV Reactor Insert complete with UV Modules**
   - Estimated storage area is 150ft2.
   - Store equipment indoors.

   If indoor storage is not possible,
   - Store equipment on high ground, elevated at least 6in. off the ground.
   - Completely cover equipment with tarp to prevent direct exposure to the elements (rain, snow, sand etc.).
   - Fit tarp tightly around equipment to prevent accumulation beneath tarp.
   - Inspect equipment weekly to verify tarp integrity and address any accumulation.

2. **System Control Center (SCC), Online UV Transmission Analyzer (if applicable), UV Photometer (if applicable), Lamp/Sleeve Assemblies and Spare Parts**
   - Estimated storage area is $50ft^2$.
   - Store equipment indoors

   For storage periods longer than 3 months,
   - Store in a dry warehouse.
   - Warm equipment up to a minimum ambient temperature of 60°F or 15°C before powering.

Handling

Equipment will arrive to site on a flat bed truck to facilitate off-loading by an overhead crane. Some items can be off-loaded using a forklift.

UV Reactor Insert complete with UV Modules
- Shipped loose.
- Maximum weight is 6500 lbs (less depending on system size).
- Lift reactor insert using a four point lifting sling and overhead crane.

Hydraulic Systems Centre (HSC)
- Shipped in separate crate.
- Estimated weight is 710 lbs.
- Remove from flatbed by forklift.
- Remove HSC from crate by forklift and nylon lifting strap.

System Control Center / Power Distribution Center (PDC)
- Shipped in separate crate.
- Estimated weight is 1000 lbs.
- Remove from flatbed by forklift.
- Remove SCC from crate by forklift and nylon lifting strap.

Module Removal Mechanism (MRM)
- Shipped loose.
- Estimated weight 100 lbs.
- Remove from flatbed by hand.

Spare Parts
- Shipped in separate crate.
- Weight approximately 300 lbs including crate.
- Remove from flatbed by forklift.

Automatic Level Controller (if specified)
- Shipped in separate crate.
- Weight approximately 200 lbs including crate.
- Counter balance weights shipped on pallet.
- Remove from flatbed by forklift.

Level Control Weir (if specified)
- Shipped in separate crate.
- Weight is dependent on size and configuration of weir (handle accordingly).

All Other Items
- Online UV Transmission Analyzer and Photometer are industrial control systems housed in panels.
- Take care not to dent or mark the panels.
- Unpack equipment just prior to mounting.
- Minimize handling after unpacking.
- Contractor's personnel to lift and install items by hand.

Installation

The UV4000™ Low Flow is straightforward to install. No special tools are required beyond those used in the day to day operation of a mechanical/electrical contracting firm. An appropriately sized crane will be required for off-loading and installation of the system into the channel. Should you require assistance during installation, please call a Trojan Service representative at 1-800-666-9459.

The following general steps are to be followed by the Contractor.

1) ***Site Concrete Pour***
   - Pour UV channel according to dimensions specified on the approved submittal layout drawing.
   - Pour concrete wire trough(s) if required as per the approved submittal layout drawing. Provision for drainage from the trough(s) is required. Drains should empty to the upstream side of the UV reactor. Angles to support solid cover plate over the troughs should be considered. The troughs should be protected from the elements (rain, snow, etc.) as much as possible.
   - Refer to the layout drawing for concrete ramps or supports required for the downstream level control.

2) **Mechanical Equipment Installation**
   The following general steps are listed in order:
   i) Locate kit containing all hardware and items required for installation.

   ii) Install Reactor Insert
      - Set the reactor into the channel using overhead crane and four point lifting sling.
        - Note that there is a correct orientation. Labels specifying INLET and OUTLET are provided on the insert.
      - Level the reactor across its width to within 1/8" and along its length to within ¼"
      - Anchor insert assembly to channel floor with 5/8" X 6" long wedge anchors typical to 8 places (not provided by Trojan unless specified in the contract documents).

- Use temporary timbers to close the gaps between the concrete channel wall and the outside edges (side and bottom) of the reaction chamber inset frame.
- Secure the timber to the concrete channel using tap con style lag bolts. The timber will ultimately be removed. This completes an enclosed cavity around the insert.
- Completely cover all exposed surfaces on the insert (including cabling) with plastic to protect against concrete splashing and to reduce cleanup time.
- Pour concrete around the reaction chamber in a minimum of 3 stages, vibrating each stage to eliminate voids. This will minimize future settling and reduce hydrostatic forces on the insert. The recommended pours are as follows:
  a) Fill the cavity approximately 50% full.
     - Allow concrete set for 12 hours.
  b) Continue filling the cavity to approximately 4" below the top of the channel wall.
     - Allow concrete set for another 12 hours.
  c) Fill the remainder of the cavity flush to the top of the channel.

iii) Module Removal Mechanism Installation

- Bolt the Module Removal Mechanism (MRM) Assembly to the insert frame with the 8-5/8" fasteners supplied. Note that there is a correct orientation to the frame corresponding to the pinholes allowing alignment of the mechanism with each module. The pinholes are spaced across the mounting frame that spans the reactor width.
- Verify that the cable is tagged. The metal tag indicates the cable was tested.

iv) Hydraulic Systems Center (HSC) Installation

- Place the enclosure as per the approved layout drawing.
- Add glycol to HSC reservoir to top up coolant level in reactor. The coolant is supplied by Trojan Technologies.

v) Concrete Wire Troughs

- Bolt wire trough weldment to the reactor and the wireway to the wire trough weldment (shipped separately with gaskets). These additions guide and protect conduit and cables extending from the reactor down into the trough.
- After the interconnect is completed (see Section 3.3), place covering plates over the troughs. Note that the wireways extend below the concrete into the trough. Notches in the covering plate may be required to accommodate the wireways and coolant hoses. Allowance for the wireways is required if angles are used to support the cover plate.

vi) Online Transmission Unit (if specified)

- The Trojan Online UVT is comprised of 2 units – sensor/sampler and analyzer.
- Mount the sampler/sensor enclosure at the edge of the channel downstream of the reactor before the level controller (refer to approved layout drawing).
- Mount a section of plastic pipe approximately 6" off the channel wall. The pipe should extend to the mid-depth of the regulated water level. This pipe will guide the UVT sampling hoses into the effluent and prevent them from floating downstream. It is recommended that a T-fitting parallel to flow be fixed to the end of the pipe. The pipe diameter should be large enough to facilitate easy removal of the sampler for cleaning (3" diameter).

vii) Automatic Level Controller (ALC) (if specified)

- Align the ALC square across the width of the channel to minimise leakage from around the perimeter.
- Use anchor bolts (3/8" diameter) to fix the frame of the ALC to the channel wall. The anchor bolts are not provided by Trojan. The number required will depend on the size of the ALC Refer to the ALC drawing in the approved submittal.
- Seal all concrete / frame joints using grout. Ensure grout does not come in contact with sealing gasket.

viii) Weir Plate (if specified)

- Use anchor bolts to install weir plate at the exact elevation specified on the approved layout drawing. The anchor bolts are not provided by Trojan. Refer to the weir drawing.
- Seal the weir plate watertight.
- If a serpentine weir is provided, a concrete ramp may be required (refer to layout drawing). Seal weir where applicable.

3) **Equipment Interconnections**
Please note which conductors are to be provided by the Contractor and which will be provided by Trojan. A representative from Trojan Service will terminate the connections "By Trojan". Refer to the approved layout and electrical drawings.

Cable	Quantity	From	To	Responsibility/ Notes
Reactor to SCC				
Module Power Cables	1 per module	Module	SCC	By Trojan
Module Solenoid Cables	1 per module	Module	SCC	By Trojan
* Ballast Communication Cables	2 per module	Module	SCC	Conductors by Trojan Flexible watertight conduit by Contractor (see note below)
Low Water Level Sensor	1	Level sensor box (at side of reactor)	SCC	By Trojan
High Water Level Sensor (if applicable)	1	Level sensor box (at side of reactor)	SCC	By Trojan
UV Sensor probes	1 per bank	UV Sensor	SCC (through reactor cable trough)	By Trojan
HSC to SCC				
Coolant pump power	2	HSC	SCC	By Trojan
Hydraulic pump power	1	HSC	SCC	By Trojan
Hydraulic pump solenoid valve extend/retract cable	1	HSC	SCC	By Trojan
Low/High coolant pressure cable	1	HSC	SCC	By Trojan
Low/High hydraulic pressure cable	1	HSC	SCC	By Trojan

- Ballast communication cables will run in watertight conduit from the reactor via the concrete trough to the SCC. The Contractor shall supply a sufficient length of conduit with bushings at either end to protect the cables from cut-nicking. The conduit shall be grounded at the SCC. A 2.5 inch diameter conduit is adequate for a system with up to 6 modules per bank (12 total).

The conductors supplied by Trojan are factory connected with an appropriate length of cable coiled for shipping.

Cable	Quantity	From	To	Responsibility/ Notes
From Reactor to HSC				
Coolant lines	3	Reactor (labelled A,B,C)	HSC (labelled A,B,C)	By Trojan (separate concrete trough, refer to layout)
Hydraulic lines	4	Reactor (labelled 1,2,3,4)	HSC (labelled 1,2,3,4)	By Trojan
To and From SCC				
277 / 480V 3 phase, 4 wire	1	Plant panel	SCC	By Contractor (conduit and wiring)
4-20mA analog flow signal	1	Plant flow meter	SCC	By Contractor (conduit and wiring)
120V, 1 phase, 2 wire, 500VA	1	SCC	UVT sampler at edge of channel	By Contractor (conduit and wiring)
4-20mA analog UV transmission signal	1	Trojan UVT at edge of channel	SCC	By Contractor
Telephone line	1	Local supply	SCC	By Contractor

Additional connections may be required depending on the specified design. The Contractor may be responsible for laying additional wires and conduit. These may include discrete/ analog outputs to the plant, power and control of a submersible pump, power and control of an ultrasonic flow meter etc. Please refer to the approved layout drawing for details. If you have any questions, do not hesitate to call a Trojan Service representative at 1-800-666-9459.

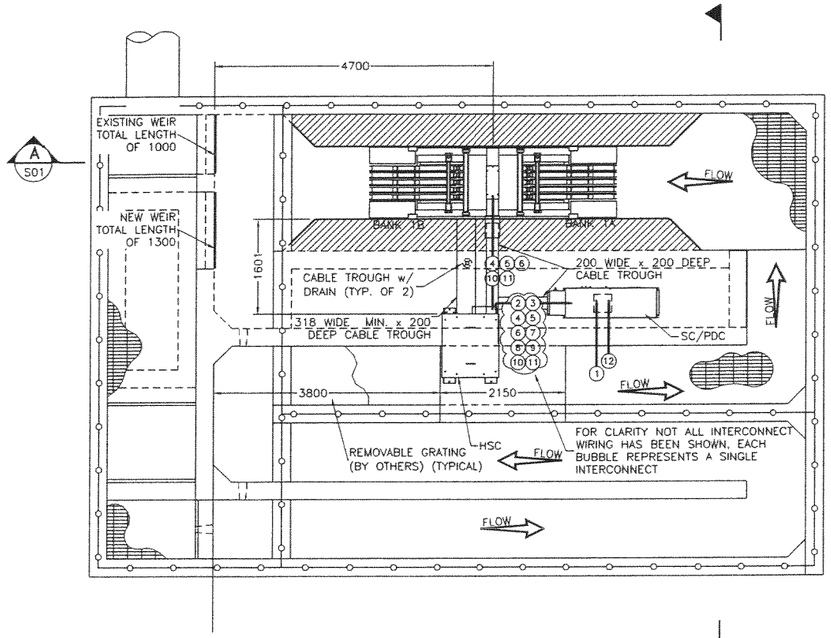
CAUTION:

HIGH VOLTAGES UTILIZED. DILIGENCE IS MANDATORY.

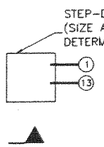
Once installation is complete, the system UV4000LF™ is *not* to be energized by anyone except the Trojan Service Department. All interconnections must be checked for correctness.

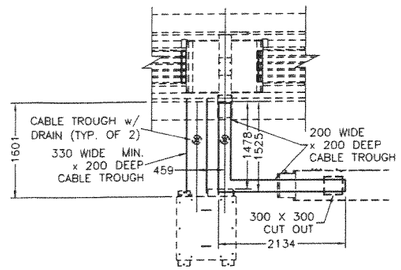
The UV channel must remain dry until commissioning by the Trojan Service Department. The system UV4000LF™ is shipped without the lamps and sleeves installed. Allowing water into the UV channel without the lamps and sleeves in place will lead to considerable damage. The contractor shall bear sole responsibility for any damages incurred. If there is a risk of water entering the channel, the modules may be raised using the MRM and secured in the upright position.

The System UV4000LF™ is now ready for official commissioning. Complete the Start-up Checklist, available from the Trojan Service Department, and return it to Service. A representative from Service will be scheduled to verify the installation and initiate start-up and operator training.



PLAN VIEW
SCALE: AS SHOWN





DETAIL OF CABLE TROUGHS

- PROVIDE SOLID GRATING TO COVER CONCRETE TROUGHS
- DRAIN TROUGHS TO UPSTREAM SIDE OF REACTOR

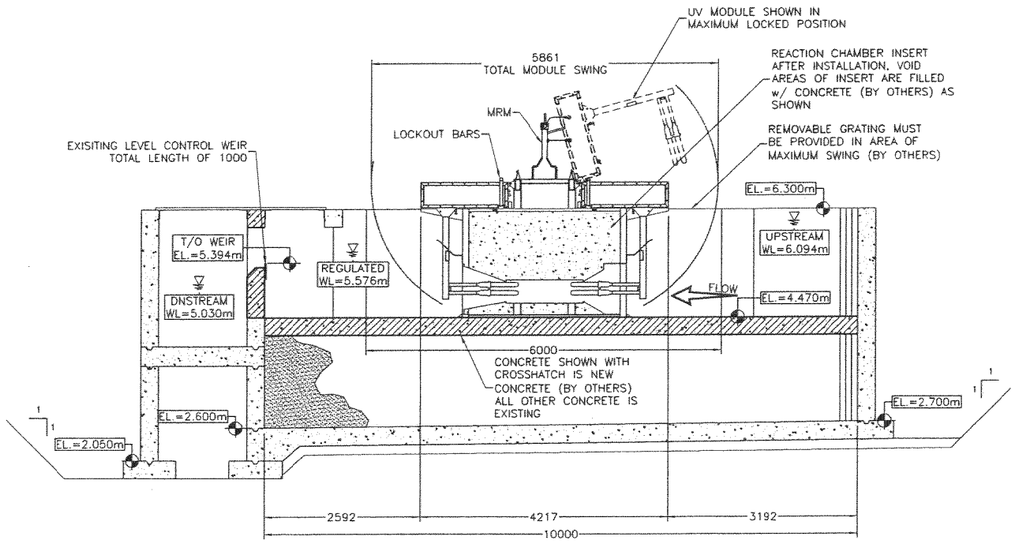
TROJAN SYSTEM UV4000 LF™

EQUIPMENT INTERCONNECTIONS

No.	DESCRIPTION	FROM	TO
1	SYSTEM CONTROL/POWER DISTRIBUTION CENTRE (SC/PDC) POWER SUPPLY 480Y/277V, 3 PHASE, 4 WIRE + GROUND 56.0 kVA POWER DRAW	STEP-DOWN TRANSFORMER (NOT SHOWN) (LOCATION TO BE DETERMINED)	SC/PDC
2	HYDRAULIC PUMP POWER SUPPLY 480Y/277V, 3 PHASE, 3 WIRE + GROUND 0.5 Hp	SC/PDC	HYDRAULIC SYSTEMS CENTRE (HSC)
3	COOLANT PUMP POWER SUPPLY 480Y/277V, 3 PHASE, 3 WIRE + GROUND 2.0 Hp (2 REQUIRED)	SC/PDC	HSC
4	UV MODULE POWER CABLES (1 / UV MODULE) 10 TOTAL	SC/PDC	UV MODULES
5	LAMP MONITORING & CONTROL COMMUNICATION LINE (2 / UV MODULE) 20 TOTAL (SEE NOTES)	SC/PDC	UV MODULES
6	MODULE WIPER CONTROL (1 / UV MODULE) 10 TOTAL	SC/PDC	UV MODULES
7	MONITORING OF HYDRAULIC PRESSURE 1 CABLE, 4 CONDUCTORS	SC/PDC	HSC
8	MONITORING OF HIGH/LOW COOLANT PRESSURE 1 CABLE, 4 CONDUCTORS	SC/PDC	HSC
9	HYDRAULIC SOLENOID CONTROL 1 CABLE, 4 CONDUCTORS	SC/PDC	HSC
10	LOW EFFLUENT LEVEL MONITORING 2 LOW LEVEL DISCRETE INPUTS	LEVEL SENSOR	SC/PDC
11	UV INTENSITY MONITORING 2x 4-20 mA ANALOG INPUT 1/BANK	UV SENSOR	SC/PDC
12	FLOW METER 4-20 mA, DC ANALOG INPUT (BY OTHERS)	FLOW METER PANEL (BY OTHERS) (NOT SHOWN)	SC/PDC
13	STEP-DOWN TRANSFORMER 575/600V, 112.5 kVA	DISTRIBUTION PANEL (DP) (BY OTHERS) (NOT SHOWN)	STEP-DOWN TRANSFORMER (NOT SHOWN) (LOCATION TO BE DETERMINED)

NOTES:

1. DO NOT SLOPE CHANNEL FLOOR.
2. CHANNEL WIDTH & DEPTH MUST BE KEPT WITHIN A TOLERANCE OF + OR - 6mm.
3. ANCHOR BOLTS ARE NOT SUPPLIED BY TROJAN TECHNOLOGIES INC.
4. SYSTEM CONDUIT, WIRING, DISTRIBUTION PANELS & INTERCONNECTIONS BY OTHERS.
5. ELECTRICAL REQUIREMENTS SHOWN ARE TO SUPPLY TROJAN UV EQUIPMENT ONLY. ELECTRICAL INRUSH FACTOR TO BE ADDED AS PER LOCAL CODE.
6. REMOVABLE GRATING SECTIONS SHALL BE EASILY REMOVED BY ONE PERSON. MAXIMUM WEIGHT OF THE SECTIONS SHALL BE IN ACCORDANCE WITH REQUIREMENTS OF THE APPLICABLE JURISDICTION.
7. CONTRACTOR TO REVIEW ALL TROJAN TECHNOLOGIES INC. INSTALLATION INSTRUCTIONS PRIOR TO EQUIPMENT INSTALLATION.



A S01 SECTION
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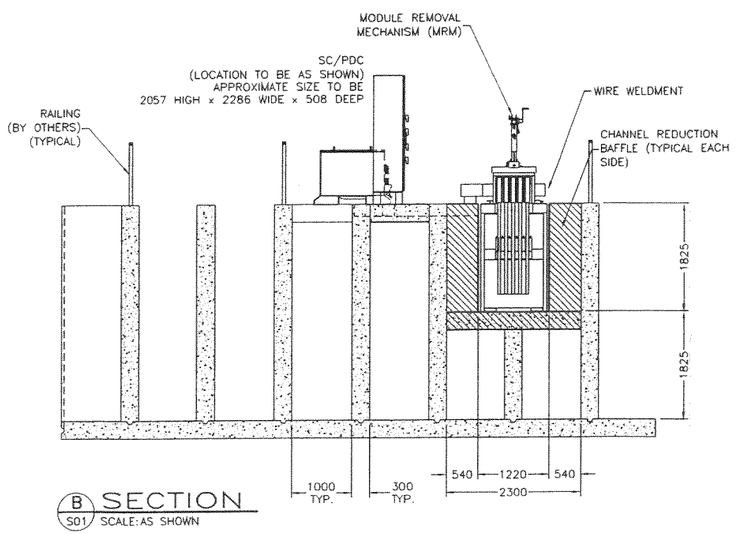

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DESIGN CRITERIA		
	PEAK FLOW	25000.0 m³/DAY
	U.V TRANSMITTANCE AT 253.7 nm	65 %
	SUSPENDED SOLIDS	30 mg / l
	DISINFECTION STANDARD	200 FC / 100ml

Trojan Technologies Inc.

DESCRIPTION: LAYOUT, UV4LF MILLIDGEVILLE WWTP NB		QUOTE NO.	EJU1927A
DRAWN BY : CAR/DAC	DATE : 03JA30	PROJECT NO.	410945
CHECKED BY : JDK	DATE : 03AP22		
APPROVED BY : AA	DATE : 03AP22	DWG NO.	S01
SCALE (11x17) : 1:50	LOG NUMBER : N/A	REV.	C

SYSTEM UV4000™ LOW FLOW OPERATION AND MAINTENANCE MANUAL

SECTION 10.0

Replaceable Parts List

Section 10.0 REPLACEABLE PARTS LIST

Common UV Module Parts

Part Description	Part Number
UV Module Assembly (2 Lamp, Short)	422366-052
UV Module Assembly (2 Lamp, Long)	422366-062
UV Lamp Replacement Package	441050
Quartz Sleeve Replacement Package	441054
Wiper Collar Seal (Captive)	445023
Hydraulic Cylinder Assembly	442644
Hydraulic Cylinder Rubber Boot	442077
Boot Clamp (Module Frame)	013037
Boot Clamp (Cylinder Body)	013038
Electronic Ballast 277V	903374

UV MODULE PARTS 5.5" LAMP SPACING

SYSTEM CONTROL CENTER

Contact local Trojan Technologies representative for part numbers and pricing.

HYDRAULIC SYSTEMS CENTER

Part Description	Part Number
Pressure Gage 0 - 60 PSI	431018
Coolant Pump	444131
Pressure Gage 0 - 600 PSI	907158
Hydraulic Pump	444094
Check Valve 1 1/4"	907154
Check Valve 1/2"	907147
Transducer 6 - 60 PSI	903449
Transducer 40 - 400 PSI	903448

Section 10.0 REPLACEABLE PARTS LIST

MISCELLANEOUS EQUIPMENT

Part Description	Part Number
Water Level Sensor Assembly	903388
UV Intensity Sensor	415014
UV Photometer	905037
Quartz Cuvette	P19314
Cuvette Cleaning Solution	P19311
100% Solution	P19310
Operators Kit UV4000	490005

The following parts are included in the UV4000 Standard Operators Kit::

- UV Face Shield	2000B1
- Lime-a-Way (4 litre)	901286
- Disposable Vinyl Gloves	906006
- Trojan Ball Hats	906007
- Plastic Wash Bottle	901195
- Strap Wrench	901196
- Sleeve Nut Tool	490083
- Pincers for Ear Clamps	901216
- 6" Galvanized Steel Funnel	906016

For pricing and availability of parts please contact the local Trojan Technologies representative in your area.

Note: The parts listed above are the only service parts approved by Trojan Technologies Inc. for use with the (insert system/assembly to which this spec. applies). Installation of components not approved by Trojan will void the warranty and could result in personal injury and / or property damage in the event of failure. Trojan expressly disclaims all legal liability arising out of the use of unapproved components.

Trojan Technologies Inc.

SYSTEM DESCRIPTION

ITEM	DESCRIPTION AND REQUIREMENTS	MATERIAL	QTY	WEIGHT (EST. KG)
1	**UV MODULE (UVM 4000LF)** REQUIREMENTS – 2 LAMP MODULES	304/316 SST	10	120
2	**UV REACTOR CHAMBER INSERT** REQUIREMENTS – 2 LAMP X 5 MODULE MATRIX	304/316 SST	1	1400
3	**MODULE REMOVAL MECHANISM (MRM)** REQUIREMENTS – 5 MODULES WIDE	304 SST	1	430
4	**SYSTEM CONTROL / POWER DISTRIBUTION CENTRE (SC/PDC) TYPE LF** REQUIREMENTS – TYPE LF CONTROLLER, W/ MODEM **SERVICE REQUIREMENTS (MAIN POWER SUPPLY)** 480Y/277 VOLT, 3 PHASE, 4 WIRE, 66.0 KVA, 60 HZ **DERIVED FROM MAIN 480/277 VOLT SUPPLY:** • HYDRAULIC SYSTEMS CENTRE 480 VOLT, 3 PHASE, 3 WIRE, 5.0 kVA • CONTROLS POWER SUPPLY 120 VOLT, 1 PHASE, 2 WIRE, 2 kVA • UV LAMP POWER SUPPLY 480Y/277 VOLT, 3 PHASE, 4 WIRE, 59.0kVA	304 SST	1 1	1000
5	**HYDRAULIC SYSTEMS CENTRE (HSC) (TYPE B)** REQUIREMENTS – STANDARD **SERVICE REQUIREMENTS** 480 VOLT, 3 PHASE, 3 WIRE, 5.0 kVA, 60 HZ	304 SST	1	75
6	**UV SENSOR** REQUIREMENTS – STANDARD	-----	2	-----
7	**FIXED WEIR PLATE (FWP)** REQUIREMENTS – MINIMUM CREST LENGTH 1300MM, SEE DWG S01	304 SST	1	-----
8	**OPERATORS KIT-UV4000** REQUIREMENTS – STANDARD	-----	1	-----
9	**UV PHOTOMETER KIT** REQUIREMENTS – STANDARD	-----	1	-----

ITEM	DESCRIPTION AND REQUIREMENTS	MATERIAL	QTY	WEIGHT (EST. KG)
10	**LAMICOID NAMEPLATE** REQUIREMENTS – FOR EACH MAJOR EQUIPMENT COMPONENT. (HSC, SC/PDC, UV BANKS, MRM)	-----	5	-----
11	**WIPER SEALS** REQUIREMENTS – STANDARD	-----	2	-----
12	**STEP-DOWN TRANSFORMER** REQUIREMENTS – 575/600V, 112.5 KVA NEMA 3R, K-4, P/N 912337.	304 SST	1	-----
13	**LIME-A-WAY 4L JUG** REQUIREMENTS – STANDARD	-----	1	-----
14	**SPARE UV LAMPS (UV 4000)** REQUIREMENTS – STANDARD	-----	6	-----
15	**SPARE QUARTZ SLEEVES (UV 4000)** REQUIREMENTS – STANDARD	QUARTZ	6	-----
16	**SPARE ELECTRONIC BALLASTS** REQUIREMENTS – STANDARD	-----	1	-----

SYSTEM UV4000™ LOW FLOW OPERATION AND MAINTENANCE MANUAL

SECTION 11.0

Certificate of Equipment Warranty

Certificate of Equipment Warranty

The following terms and conditions will govern the equipment warranty provided by Trojan Technologies Inc. to the Owner/Operator:

Trojan Technologies Inc. ("Trojan") warrants to the Owner/Operator noted above (the "Customer") that if within 24 months from equipment start-up, equipment manufactured by Trojan (the "Equipment") will be free from defects in material and workmanship and will function in accordance with the specifications agreed to by Trojan for the Equipment.

This warranty shall not apply to any failure or defect which results from the Equipment not being operated and maintained in strict accordance with instructions specified in the Operation and Maintenance manual or which results from mishandling, misuse, neglect, improper storage, improper operation of the Equipment with other equipment furnished by the Customer or other third parties or defects in designs or specifications furnished by or on behalf of the Customer by a person other than Trojan. In addition, this warranty shall not apply to Equipment that has been altered or repaired after start-up by anyone except: (a) authorized representatives of Trojan, or (b) Customer acting under specific instructions from Trojan.

Customer must notify Trojan in writing within 5 days of the date of any Equipment failure. This notification shall include a description of the problem, a copy of the operator's log, a copy of the Customer's maintenance record and any analytical results detailing the problem. If Customer has not maintained the operator's log and maintenance record in the manner directed in the Operation and Maintenance manual, or does not notify Trojan of the problem as specified above, this warranty may, in Trojan's discretion, be invalid.

Customer will fully cooperate with Trojan, in the manner requested by Trojan, in attempting to diagnose and resolve the problem by way of telephone support. If the problem can be diagnosed by telephone support and a replacement part is required Trojan will either, at Trojan's expense, ship a repaired, reworked or new part to the Customer who will install such part as directed by Trojan or will direct Customer to acquire, at Trojan's expense, such part from a third party and then install such part as directed by Trojan.

In the event that Trojan determines that the problem cannot be resolved by way of telephone support and/or shipment by Trojan, or acquisition by the Customer, of a replacement part for installation by the Customer, Trojan will send one or more persons to make an onsite inspection of the problem. If an onsite visit is made, Trojan personnel will evaluate the problem and repair or replace any Equipment determined to be in breach of this warranty. If the problem is not attributable to a breach of this warranty, Trojan reserves the right to invoice the Customer for this service.

Equipment components manufactured by third parties but furnished to Customer by Trojan are warranted by the original manufacturer, only to the extent of the original manufacturer's warranty, and are not covered by the above warranty.

This warranty is the exclusive remedy for all claims based on a failure of or defect in the Equipment, whether the claim is based on contract (including fundamental breach), tort (including negligence), strict liability or otherwise. This warranty is in lieu of all other warranties whether written, oral, implied or statutory. Without limitation, no warranty of merchantability or fitness for a particular purpose shall apply to the Equipment.

Trojan does not assume any liability for personal injury or property damage caused by use or misuse of the Equipment. Trojan shall not in any event be liable for special, incidental, indirect or consequential damages including, without limitation, lost profits, lost business opportunities, lost revenue or loss or depreciation of goodwill, even if it has been advised of the possibility thereof. Trojan's liability shall, in all instances, be limited to repair or replacement of Equipment in breach of this warranty and shall not exceed the cost of such repair or replacement. This liability with respect to repair or replacement will terminate upon the expiration date of this warranty.

In addition to the foregoing, in no event shall Trojan's liability relating to the Equipment, or the agreement between Trojan and the Customer relating to the Equipment, exceed that portion of the purchase price for the Equipment which is actually paid to Trojan.

Trojan Technologies Inc.

PERFORMANCE GUARANTEE

TROJAN TECHNOLOGIES, INC. certifies to **MILLIDGEVILLE, NB** that the **TROJAN SYSTEM UV4000LF™ DISINFECTION EQUIPMENT** supplied will disinfect to the limits of ≤ **200 FECAL COLIFORM /100 ml based upon a 30 DAY Geometric Mean** and provided the following criteria is upheld.

PEAK FLOW - 25000 M^3/DAY

SUSPENDED SOLIDS - < 30 MG/L 30 DAY AVG.

UV TRANSMITTANCE @ 253.7 nm – 65 % MINIMUM

This performance guarantee is also contingent upon proper care and maintenance of the unit as detailed within the Operation and Maintenance Manual.

SYSTEM UV4000™ LOW FLOW OPERATION AND MAINTENANCE MANUAL

SECTION 12.0

Collection of Microbiological Samples

Section 12.0 COLLECTION OF MICROBIOLOGICAL SAMPLES

The following is an outline of materials and methods required when collecting microbiological samples of ultraviolet treated water.

It is essential that all samples be stored immediately on ice in a cooler. This will prevent bacterial growth between the time of sampling and culturing. High bacteria counts often result from improper and excessive transportation times.

Containers

Sample bottles must be sterile and should hold a volume not less than 100 mL. When sampling water with residual chlorine or bromine, a reducing agent such as sodium thiosulphate should be added before sterilization of the sample bottle. (To a 120 ml bottle add 0.1 ml of 10% solution of sodium thiosulphate, Na2 S2 03.)

Sampling Procedures

Keep the sample bottle closed until it is to be filled. Do not contaminate the inside of the top or the neck of the bottle. Fill the container, recap, and immediately store in an ice chest. When control samples are required, such samples would be taken before the water is exposed to UV and the test sample would be collected right after the UV unit.

Preservation & Storage

Ideally samples should be processed by the laboratory within one hour of collection. All microbiological samples should be transported on ice in a cooler and kept in a refrigerator until cultured.

For more detailed methods of sampling we recommend referring to "Standard Methods for the Examination of Water and Wastewater" latest edition.

SYSTEM UV4000™ LOW FLOW OPERATION AND MAINTENANCE MANUAL

SECTION 13.0

Winterization of Equipment

Section 13.0 WINTERIZATION OF EQUIPMENT

In some instances wastewater treatment plants are only required to have seasonable disinfection. If this is the case for you plant please follow the procedures listed to winterize the UV Equipment.

UV Modules (UVM)

The main concern with the UV modules is the effect on the quartz sleeves and lamps if the effluent is allowed to freeze. To avoid breakage perform the following steps:

- Discontinue flow to the UV channel.
- De-water channel by means of a floor drain or submersible pump.
- Ensure lamps are de-energized by placing each bank in the "OFF" position at the Operator Interface of the control center.
- Disconnect 480V electrical service to each PDC by disengaging the local overcurrent protection device. ie fused disconnect or breaker.
- Remove and secure modules as described in Section 5.6.
- Drain cleaning solution from wipers as described in Section 5.9 of the UV4000 Operation and Maintenance Manual.
- Return module to down position.
- Repeat steps for each UV module.

Power Distribution Center (PDC)

- Ensure the 480V electrical service to each PDC is disconnected.
- Disconnect power to the UV Modules by tripping the individual Earth Leakage Protection Devices.
- Turn on 480V electrical service.

Module Removal Mechanism (MRM)

- To avoid build up of ice cover top of hoist assembly. Ensure bottom is open for ventilation.
- Reinstall lid ensuring all nuts are tightened.

Hydraulics Systems Center (HSC)

- Place Hydraulic System in the "OFF" position at the Operator Interface of the control center.
- Ensure all nuts are tightened on the service entrance lid.

Online UV Transmission Sampler (UVT)

- If your model of UVT sampler does not have a heater in the sampler or sensing enclosure disconnect piping and store panels indoors.